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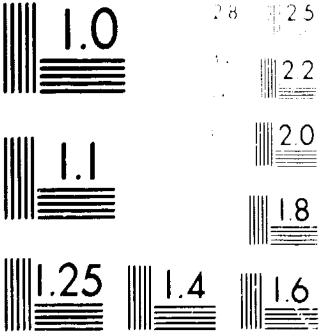
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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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Report on the
Pilot Operation of the
Industrial and Technological Information Bank (INTIB)
in the Iron and Steel Sector
1 August 1977 - 31 January 1978

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Prepared by:

Mrs. K. Banerjee
Consultant

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ACKNOWLEDGEMENT

This consultant feels grateful for the opportunity to work on the assignment for the Pilot Operation of the Industrial and Technological Information Bank (INTIB), in its field of Iron and Steel sector, which was offered to her by the UNIDO. She feels specially thankful to Mr. G.[illegible] [illegible]uri, Deputy Director of Industrial Operation Division, Mr. [illegible] Vijhawar, Senior Inter-regional Advisor, and Mr. [illegible] de [illegible]autort, Chief, Industrial Information Section. The library of the Industrial Information Section was of great help and provided much for the work accomplished: the consultant wishes to thank the staff of the library for ungrudging co-operation at all times. The acknowledgement of thanks would be incomplete without the mention of Ms. [illegible], who has given excellent secretarial support in preparing this report and the work preceding it.

CONTENTS

INTRODUCTION

1. To facilitate the interchange of information between developed and developing countries in connection with the industrialization of the latter, specially the transfer of advanced technology to them, the General Assembly of the United Nations passed on 25 December 1976, a resolution (31/183) approving of the proposal of the Executive Director of the UNIDO on the establishment of an Industrial and Technological Information Bank (INTIB) under the UNIDO's auspices. The idea of this Bank was mooted in the Lima Declaration and Plan of Action of the UNIDO on the industrial development and cooperation between the developed and developing countries, adopted by the Second General Conference of the UNIDO in March 1975.

2. In pursuance of the General Assembly's resolution (31/183) of 21.12.76 the Industrial Development Board of the UNIDO submitted document ID/B/183 of 12.4.77 on the work done for the establishment of the Industrial and Technological Information Bank (INTIB) assessing its feasibility and scope of work, and outlining the proposal for a pilot operation of the Bank.

3. The pilot activities that it proposed to undertake during 1977-1978 were as follows:

a) Mobilizing and organizing in-house information and the systematic expansion of this information in the sectors chosen for the Pilot activity.

b) Collecting selected information from external sources.

c) Creating a network of information for the identification and selection of technologies through joint action with UN Agencies and other international or national institutions.

d) Establishing interlinks between the Bank and the users in the developing countries, including a continuous appraisal of their information requirements.

e) Preparing technological profiles in the sectors chosen for the pilot operation.

f) Building up a stock of technological information and processing it for selection purposes.

g) Identifying and utilizing technological sources and capabilities available in the developing countries.

h) Evaluating the pilot activities at the end of the second year of operation.

4. The report also outlined the sectorial objectives in respect of the four sectors, namely, iron and steel, fertilizer, agro-industries, and agricultural machinery implements industries, which were selected for the pilot study.

5. The author of the present report, along with another, was appointed as consultant initially for three months from 1 August 1977, which was subsequently extended by another three months to 31 January 1978, to implement some of the activities outlined under para 3 above. This report describes the work done in pursuance of this assignment and gives certain suggestions which may help in the furtherance of the objectives of the INTIB and the pilot activities. While the report on the activities are purely an objective statement of facts, the suggestions embody the subjective assessment of the situation by this consultant and reflect purely her personal views, for which she alone is responsible.

ASSIGNMENTS ACCOMPLISHED

6. Immediately after the initial briefing on her reporting at UNIDO on 1.8.77, this consultant was given a three page "Plan of Action" (App.1) titled as under and signed by Dr. B.R. Nijhawan, the Senior Interregional Adviser:

"PLAN OF ACTION

Working Group on Iron and Steel Industry: Establishment of an Industrial and Technological Information Bank"

This document, dated the 3rd May 1977, formed the basic guideline for the activities of the two consultants connected with this pilot project. It was, from time to time supplemented by notes and discussions to crystallize the plan and specific area of action further. Arising out of such discussions, the specific area of activity of this consultant was outlined as under (App. 2)

"Pilot operation of the International Information Bank (INTIB) in the field of the Iron and Steel Industry

a) Assist in the pilot operations of INTIB in contributing to meet its need for information inputs from in-house and external sources, indexing and abstracting such information material retained or obtained for relevance to the output of INTIB in the area of the iron and steel industry.

b) Making the above material readily available for the purpose of processing for the use of INTIB and generally re-inforcing the potential of the Industrial Information Section to serve the INTIB.

c) Align and develop the above facilities vide a) and b) above in the field of iron and steel industry and thereby lead to the formulation and preparation of Information Profiles and Information Manuals.

d) Prepare a concrete Plan of Action for the follow-up activities in terms of a) to c) above prior to the end of her assignment."

In implementation of the instructions embodied in these two documents, which necessarily contain some areas of overlap, this consultant carried out the activities as mentioned below during her period of assignment of six months.

7. Mobilizing and organizing in-house information and its expansion in the sectors chosen for pilot activities (item a), App.1 and item a) under para 6)

7a. The in-house information in the context of this report refers to the information materials already available in the Industrial Information Section (ICIS/INF) of UNIDO. This Section comprises of four units: (i) a library, which subscribes to twenty periodicals on Metallurgy of which ten are on iron and steel; (ii) a country-file unit which gathers under country-heading, all information materials available on each country; (iii) an inquiry service unit that handles all inquiries addressed by each country to UNIDO and sends a suitable reply on the basis of the information available within the ICIS/INF and (iv) a UNIDO Publication unit which prepares with computorised keywords the abstracts of UNIDO reports, papers presented in the seminars and symposia. At least three issues containing nearly 250 abstracts are published in a year.

7b. The holdings and files of these units of ICIS/INF were examined in respect of the pilot sector of iron and steel which concerned this consultant. It was found that the existing resources were too meagre to meet the needs of the industrial development of the developing countries in this sector. It would require strengthening both in terms of basic reference books on iron and steel technology and industry and related areas, as also in the sector of current and latest trends and developments as reflected in periodicals, reprints, and associated documentary aids. Whatever little materials were available, were not fully classified, catalogued and indexed, so that there was a distinct possibility that they would escape attention, if and when the need for them arose.

7c. In order, therefore, to utilise the existing resources, a suggestion was given to classify, catalogue and index all materials on the iron and steel industry on the basis of the latest detailed schedule under the U.D.C. The library of the ICIS/INF did not have this schedule. As a result, all materials available in the Section on the iron and steel industry were classified under the broad notation of 669.1. This may be alright in the present circumstances when the volume of such material is not worth mentioning. As the volume grows in future and covers approximately something like 200,000 items on this sector alone, it would require a more detailed and mutually exclusive classification, without which it would be impossible to retrieve relevant data on a specific topic. We have, therefore, ordered a copy of the schedule on metallurgy including the latest additions and alterations. Unfortunately, the schedule, published by the British Standard Institution, is out of print. During a discussion with Mr. M.L. Pearle, of the Metals Society of U.K., it was learnt that the Society would be in position to supply a xeroxed copy on payment of the usual charges of £30. It is strongly recommended that it should be immediately procured. In the meantime, this consultant used her personal copy when suggesting classifications of some of the existing materials, particularly the abstracts, brochures, etc., preserved under the subject file. This will enable them to be easily referred to in the future, and it is hoped, that the classification and catalogue of these items prepared by this consultant would be maintained henceforward.

7d. The mobilization of the existing in-house materials as contemplated under the Plan of Action (App. 1) urgently requires that all other materials be appropriately classified on a systematic basis. Taking a particular sector as an example, the country-file unit of ICIS/INF puts all materials on a country in one drawer of a filing cabinet, without much internal arrangement is kept. Unless the material in each drawer is systematically classified by subject, the retrieval of material on iron and steel, which is of specific interest to this report, will become tardy now and impossible later when each country-file expands several fold in course of the next decade. The classificatory process should also be extended to the queries and their answers handled and filed in the "Inquiry Unit" of the ICIS/INF.

7e. In a related area, this consultant did some work on patents specifications which would be of help in this connection. The international Patent Classification of Vienna, which collects and files patent specifications on all subjects including iron and steel, requested the UNIDO for suggestion on the system of classification of its holdings on iron and steel. This matter was referred to this consultant for advice. It was clear that the files of this organization can be used by the INTIB to supplement its own resources in this ares, if not completely to depend on this body for patent information. We, therefore, revised and added to the existing outline on the basis of the latest thinking on the subject by the Federation of International Documentation (FID) and sent it (App.3) back to the ICIS/INF for onward transmission to the Patent body. If implemented, it will facilitate the future patent search by the INTIB in the area of iron and steel.

7f. The expansion of the information resources on the iron and steel sector is a huge task. This is so because iron and steel manufacture, and the industries based on them, is a vast subject and a dominant part of all economic activity in developed and developing countries. In fact, its extent provides an yardstick for measuring the stage of development of a country and economy. The expansion of the holdings of information material in this area is a large task and is also dependant on the scope of the sector as defined by the Bank. For instance, if the scope is to cover merely the manufacture of iron and steel, it will be comparatively much more managable than if it were to cover the secondary and tertiary industries based on iron and steel which will include many of the engineering and appliances industries. Since a clear formulation on this aspect of the expansion of the holdings was not available yet, this consultant merely indicated, subject to the availability of funds and other facilities, the procurement of a few books and journals as a start (App.4). This will, no doubt, have to be considerably augmented with quite some expeditiousness if the Bank is to be able to render effective service in respect to the steel sector.

8. Collecting selected information from external sources (item - b), App.1.)

8a. It is quite obvious that it would not be possible for the Bank in the forseeable future to furnish all necessary information that may be required by the investor or an inquirer both from developed and developing countries regarding this subject from the internal resources of the Bank. It is, therefore, quite natural that its own resources should be supplemented on a continuous basis with materials from external sources. But this would require considerable organization, planning and follow-up. As a first step, explanatory letters have been sent out to many institutions inviting them to participate in such collaboration in exchange of information generated in the UNIDO. The draft of this letter (App. 5) was approved by the appropriate UNIDO authorities before it was distributed. This small beginning will have to be vigourously pursued along the lines suggested elsewhere in this report, if the scheme is to yield the desired results.

8b. The Action Plan also enjoined on the preparation of a list of all such potential external sources of information. It is understood that such a list has been compiled. In view of the available resources of the UNIDO on the basis of which such a list can be compiled, it can be merely indicative and cannot hope to be exhaustive. After an exhaustive list is compiled by a properly equipped information scientist on the basis of the availability of further information sources in the UNIDO, it will have to be classified and indexed by the type of information, its quality and dependability, and time and cost. It is hoped that this crucial exercise would be urgently taken up, as otherwise it would not be possible to make the optimum use of such a listing or to carry out the function of the Bank.

9. Making the in-house and external materials readily available for use of INTIB (item - b, para 6) (Use of Kardveyors)

9a. With the very meagre materials now available with UNIDO, their ready retrieval does not now pose any serious problem; in fact the macro material can be easily taken and referred to. But as the holdings grow to the optimum size of some 200,000 items, it would be impossible to reach a particular item of information easily and quickly, without appropriate classification and indexing. Such indexing should cover the multiple facets of the same material - be it a book, reprint, an article, a trade catalogue, or even an advertisement. This means, in effect, that the

200,000 items may ultimately lead to an index containing say, 6/8 hundred thousand cards at the rate 3 to 4 index facets per item.

9b. A start has been made by this consultant in this area by classifying and preparing an index card each for these items. This work should be followed up, making index cards on the other facets of these materials and subsequently all other materials in the ICIS/INF, first, in respect of iron and steel and then all other subjects on which holdings a[illegible] [illegible]aintained by it.

9c. It can be easily foreseen that when the job is completed, the reference and retrieval of these vast number of cards will pose a serious physical problem. The use of ordinary card trays will mean about 84 running feet of trays, even if it is kept in four tiers. This will involve too much of legwork and movement in referring to them. It has, therefore, been suggested that compact electrically operated Kardveyor cabinets should be used for storing the index cards, so that they may be at the fingertips of a single operator without movement, and the retrieval can be as quick as required. With such a system, a single person would be able to refer to over 600,000 cards kept in a bank of six Kardveyor cabinets, without getting up from his or her seat.

9d. In pursuance of this suggestion, which has found keen support from all concerned, the ICIS/INF has with the help of this consultant, already placed an order for two Kardveyor cabinets with Remington-Rand. It is hoped that when these cabinets arrive after the departure of this consultant, they will be gradually put to use.

10. Formulation and preparation of
<u>Information Profiles (item - c of para 6)</u>

10a. In terms of volume of output and relevance to the objectives of the pilot plan falling within the purview of this consultant, this item constituted the most important piece of work. Its purpose was to try out and demonstrate how to use the resources of the ICIS/INF and the facilities available to formulate and prepare Information Profiles, which may be used by the Bank to prepare Technological Profiles w[illegible]h flowsheets and diagrams, or may be passed on, as they were, to the inquirers for an appreciation ot the status in a particular field of inquiry. As suggested by the authorities, the following subject-areas were formulated for the preparation of such Profiles using the available resources of the Section:

i) Ironmaking
ii) Steelmaking
iii) Continuous Casting

As these Profiles clearly show, with a little painstaking search and screening, it is possible to give a fair indication of the status of technology, and trends and developments in each area even from the very limited and meagre resources of the Section. These Information Profiles may then be used by technolgists as a basis for preparation of Technological Profiles with flow-sheets, cost data, etc., to facilitate decisions on the choice of technology. They also demonstrate that if the Information Profile is prepared from an economic or commercial point of view, as distinct from the technological point of view from which the Information Profiles were prepared - then the appropriate experts would be in a position to prepare for the use of the Bank, economic or commercial profiles as a basis of decision-making in these areas.

10b. In view of the extreme paucity of material on the chosen sector of iron and steel, the formulation of the subject-area of the Information Profiles had to be kept as broad as possible. They are, thus, merely indicative of the possibility and pattern of action to be followed. They are, by no means, adequate as a basis of decision-making. This point cannot be overemphasised, and it should be borne in mind while going through these Profiles. For instance, ironmaking is a vast subject involving materials, processes, plant and equipment, cost and other data, which are essential for decision-making. Since enough in-house information is not available, the Profile has been made on the broad subject formulation. But in actual practice, when the Bank becomes operative, the subject headings or formulations would be far narrower and specific, such as, say, top charging gear of blast furnace, the movement of the burden at, say, the tuyere level or, the consumption pattern of coke with variable injection of other fuels. With such specific formulations or headings, and the availability of adequate information from in-house or external sources, it would be possible to prepare Information Profiles which would provide ready-made basis for decision-making. It is hoped that the inadequacies of the present Profiles attempted in this assignment would not blind the reader to this aspect of the pilot exercise. The following paragraphs highlight some points of interest regarding these Profiles.

11. The Profile on Ironmaking (App. 6)

11a. The information profile on Ironmaking contains 350 items in some 100 pages. It has been compiled broadly to indicate the current status and thinking regarding the making of iron, mostly in the blast furnaces. The information was compiled on the basis of the material available from the in-house resources of UNIDO. The material, which itself is far from comprehensive, thus gives an incomplete and partial view of the material available with respect to a very narrow period of time, say, 1974-1976, and may have missed material that may be of greater relevance, as also that which may be of no use. All the same, in the absence of a pre-selection of the material and its scrutiny, it is not possible to have an assurance about the comprehensiveness and quality of the data.

11b. In spite of this shortcoming, the profile broadly covers the several iron-making processes which are currently in vogue, such as electric iron-making, iron-making in the blast furnace, iron-making in charcoal blast furnaces, etc. It omits any reference to the several processes for direct reduction of iron ore which are in an advanced stage of technological investigation and experimentation.

11c. In its approach, the profile mainly concentrates on the blast furnace process of ironmaking and on improving its performance and efficacy. This takes several directions, such as the reduction of the coke consumption and the associated steps, viz injection of oil, powdered coal, etc., and the preparation of the burden. As claimed in an item of the profile (p. 63 top), the best blast furnace of today works with about 380 kg of coke per ton of hot metal and 100 kg of fuel oil. The coke input is practically half of that in the average blast furnace and indicates the extent of advance that has been and can be made in this area.

11d. The preparation of the burden has taken various directions such as sintering, pelletizing, briquetting and pre-reducing of the ore before its charging into the blast furnace. As the profile indicates, in some cases, attempts have been made to use 75% reduced iron ore briquettes called high iron briquettes (HIB) having an iron content of about 86% (p. 16).

11e. The profile also deals with the internal operation of the blast furnace such as the descent and distribution of the burden, the kinetics of chemical reaction within the furnace as well as the plant and machinery connected with the control of operation of the furnace, e.g., the operation of tuyeres. In some cases, it gives an indication of the future thinking regarding the blast furnace, such as doubts expressed about the continuous growth of the size of the blast furnaces (p. 2 item 2) as well as plans to control the operation of the blast furnaces through the manipulation of the volume, composition, temperature and pressure of the up-moving gases, as in the proposed zone-controlled blast furnaces, which are still in the realm of investigative speculation. But in science and technology, what is speculation today is reality tomorrow, or after ten of fifteen years.

11f. The profile thus attempts to give some indication of the current status and future trend in an important area of the iron and steel industry, although within a very very limited scope and comprehensiveness. It is not sufficient as a basis for any technological decision-making; but it demonstrates and gives an idea of the possibility. A pilot operation, understandably, can only attempt and achieve this much. Information profiles with a much larger number of items or much narrower, specific aspects of the subject would be necessary to develop and refine this as a practical, viable instrument for technological or other decision-making.

11g. After these inadequacies are removed, it would still be necessary to evaluate the information presented in such profiles before any practical decisions for investments or operation can be taken on its basis. This will require the comparison of information of similar types, assessing their comparative reliability and practicability and connecting them up with numerous other related information before they can form the basis of any operative decision.

11h. The profile also includes some specimen cost data on iron-making in blast furnace and electric furnace in pages 1C, 1D and 86B.

12. Profile on steelmaking (App. 7)

12a. The Information Profile on steelmaking, spread over seventy pages, covering some 291 abstract items, is roughly divided into 11 sections. The time span of the data coverage is about seven years, starting from 1970. Although most of the items selected were published during the three years 1974-1977, the information not only reflect the status and trend of technology and economic thinking during this limited period and scope, but also give an insight into the problem areas that were agitating the minds of technologists and administrators connected with steel plants during this particular period.

12b. The collection of data - here the abstracts - being dependant on the availability of material from in-house sources - the sections or aspects selected here for highlighting are uneven in [illegible] ient. Of the eleven sections, the first has 32, second 21, [illegible] and the eleventh 104 items. This uneven strength hampers an [illegible] in-depth understanding of the different sections, which are merely indicative of some among many possible areas of interest within a broad category. However, the intelligent reader would not fail to see that with the enrichment of the information sources and the proper organization of the available data, each section may be further strengthened in coverage, provided, of course, the area has been able to claim the interest of technologists, economists and administrators, leading to study and research and, hence, the publication of their results.

12c. The first section deals with general trends, and among others, draws attention to the scope and prospect of using nuclear energy in steelmaking, in view of its contribution to a cheap, direct reduction process and to the operation of a pollution-free steel plant. Eight out of 32 items of this section (pp.5-7) are devoted to this interesting possibility.

12d. Section two deals with the cost of steel plants and of steelmaking. Though the figures are rough and ready and merely give order of magnitude estimates, they provide a valuable clue to the investment cost in about 18 countries of the world, 8 of which are developed (UK, USA, France, Germany, Italy, Australia, Canada and Sweden) and the remaining 10 developing, which give a reasonably good idea of the investment cost per ton of steel in the various countries and provides a basis of comparison.

12e. The small section 3 (in fact the smallest of the eleven sections) gives six items of information, which gives a clear indication of the emphasis laid on the consumption of energy in steel plants including their availability, alternative sources, costs, pollution factor, etc. Most of the items, published in 1975, were a response to the world oil and energy crisis. They are a pointer to the sure crop of further work in this area which followed the escalation of the energy problems and the longterm policy response of US and European governments to this problem.

12f. Sections 4 to 11 deal with the different process routes to steelmaking. As new processes and technological possibilities come to light and are investigated for eventual industrial production, the old and new processes have to co-exist for varying periods of time. Such co-existence offers a welcome opportunity to review and reasses the existing and new processes against each other so that after the inevitable period of coexistence dictated by investment costraints, the process most suitable for a particular country and set of conditions may be selected with complete confidence.

12g. Section 11, the last and the longest section of the profile (26p. - pp. 45-70 - and 104 items) covers the electric furnace steelmaking process. Apart from the easy availability of this material from the in-house journals used for the purpose of this profile, such emphasis seems more than warranted by the interest in electric steelmaking in developing countries, which do not have either the capital needed for investment in integrated steelplants, or the material resources for the operational viability of such plants, and which want to curtail the gestation period between an investment decision and operation of a plant. Its obvious advantages as regards pollution is an added attraction of this process. The detailed discussions try to do justice to all these aspects of this process.

13. Information Profile on Continuous Casting (App. 8)

13a. Continuous casting may be called more a technology of the future than of the present. There is no doubt that this technological breakthrough of the recent decades will gain further momentum in development, as more and more plants with even larger capacities come into existence after the teething troubles that still plague the technique are over.

13b. The profile on continuous casting covering some 115 items is divided into six sections, and offers a glimpse into the world of continuous casting as obtainable from the available in-house material and some external material to which access could be had.

13c. The profile items cover the period 1971-1976, when a lot of work was done in the area of extending the process to different type of plants and products - increasing their capacity, output range and sophistication - and these are fully reflected in the items that are presented. As far as possible, the items selected have been made representative in geographic distribution, state of technology and developmental prospects.

13d. The first section deals with the continuous casting process and practice in general - the emphasis being on various experimentations and trials in this area. Items 2 (p.1), items 1,2 and 3 (p. 2), item 2 (p.3) and others give a very able summary of the historical developments of the process and its future trends. The remaining items in this section deal with the experience of the process in different plants and countries and the problems and promises of the adaptation of the process under varying circumstances.

13e. The second section containing 26 items spread over 8 pages, deals with the technical aspects of the process details in precise areas. For instance, item No. 3 (p.8) deals with continuous casting of beam blanks, item 2 (p.9) that of long products; item 1 (p. 10) of 09G2 stee item 1 (p.13) continuous casting of steel in the German Democratic Republic and item 2 (p.14) the manufacture of fine profiles of pipe semis from continuous ingots.

13f. Sections 3 and 4 deal with specific products: section 3 with billets and section 4 with slabs. They give an insight into the problem in specific product areas and how these problems are being tackled.

13g. Continuous casting plants - individual or integrated into steel plants - claim the 5th and the largest section of the profile spread over 12 pages. (38 items). The plants cover a wide range of types, locales, products, etc., and the details give a good bird's eye view of the status of the operating technology as it prevails now.

13h. The profile concludes with an investment and cost section, which gives investment and operating cost data from seven countries and also by process and product. The estimates, although indicative, give an idea of the magnitudes involved, and provide a basis for comparison, which, it is hoped, would be found useful.

14. Preparation of concrete plan of action for the follow-up activities in terms of items a to c, para 6 above

The accomplishments in the area assigned to this consultant clearly throw in bold relief the steps that need to be taken to establish a successful industrial data Bank to fulfil the needs of the developing countries in the area of the iron and steel industry. It also shows that careful advance planning should precede all such actual assignments for optimum results. In what follows as Part II of this report, therefore, an outline is given of what needs to be done in future to develop this pilot operation into a full-fledged Information Bank.

Part II

FOLLOW-UP RECOMMENDATIONS

SOURCES OF INFORMATION

Identification and Development

15. The development of sources of information in order to be able to help developing countries in industrializing in the area of iron and steel industries should be taken up with the understanding that the information to be collected and stored would fall under several types, which, in view of the possible demand for such information within the area of the aims of the Bank, may be categorized as under:

a) Technological information on the type of technology to be adopted for a particular purpose.

b) Economic and commercial information to assess the viability of any scheme.

c) Social and governmental information related to the continued smooth operation of such an industry.

Each of these items deserve separate consideration.

Technological Information

16. Technological information on the iron and steel industry is available in great detail and profusion in technical journals and publications. In fact, here the problem is not that of dearth, but of selecting the necessary and usable information from a flood of publications, which is growing at an exponential rate. However, experience shows that much of this information is of a repetitive nature, where the same idea or data on technological operation or progress and breakthrough is repeated in hundreds of major journals with minor changes, or even without that. As even the Information Profile, prepared by this consultant shows, items p.16i, p.33ii, p.17i and p.22ii, of the part on ironmaking, to give only two instances, are repetitions. The main questions, therefore, are how to

a) Make a selection of the relevant material to be actually stored,

b) Identigy and list the other material that is to be on call and their sources,

c) Keep a track of such sources, and

d) Identify the specialists and consultants who can evaluate such information and their suitability to the special cases where they are to be used.

Limits of comprehensiveness

17. In determining the aim of such selection, total comprehensiveness should be ruled out from the beginning. It will be well-nigh impossible and probably a wasteful duplication of effort to cover the entire range of iron and steel technology within the scope and resources (funds, sraff, space) of INTIB. The objectives of the INTIB are a pointer to this conclusion. The basic purpose of the UNIDO is to help the industrialization of the developing countries in certain well defined areas. But even these few areas, e.g., iron and steel, fertilizer and agro-economy, cover a vast area of science and technology, economics, politics and geography. To build a complete storehouse of information on technological progress and development even in these few and related subjects will require vast resources, and their maintenance and use may be quite expensive in staff and funds. But even if the constraints of funds and staff are ignored, it may be wasteful to try to aim at total comprehensiveness for the simple reason that there will be hardly any scope or feasibility for the application of some of the most advanced technologies to the developing countries: for instance, the scale of production of such an advanced technology may be too large for the developing country or economy concerned.

18. These and other factors as well as the question of resources will thus require that some of a selective approach should be adopted for the procurement of the basic collection of material that will be actually stored in the INTIB in respect of any industry including the iron and steel industry with which the present note is concerned.

Internal resources

19. It is, therefore, suggested that the internal resources of the INTIB should be limited to:

a) A selected group of basic, authoritative books for reference and back ground purposes, which will lend a perspective to the understanding of a demand in respect of a particular aspect of the iron steel industry and its scope and compass, so that search can be initialed for the retrieval of the desired material. As already furnished by this consultant, this collection would comprise of volumes, such as ASM Handbook of Metals, Cast Metals Handbook, Yearbook of the Iron Steel Industry, AIME Yearbook, and such other encyclopedic or reference treatments of different aspects of the technology and industry.

b) Subscription to a selected group of authoritative and representative journals which gives a feel of the status and the trend in the field of its coverage, such as, to give a few instances, the Journal of the Iron and Steel Institute, Metallurgia, Stahl und Eisen, etc. These journals, that are decided to be subscribed, should be retained in bound volume for a moving fixed period, say for 10-15 years,to keep the holdings manageable and up-to-date. Representative journals like these should be kept in respect of the different branches of the iron and steel industry - manufacture of iron and steel and their primary products, and the processes associated with the industry, viz., casting, shaping, welding, powder metallurgy and so on, to yield information about the present status of the industry and where breakthroughs are being made within a certain period of time (the 10/15 years of the retention.).

c) Subscription to a few reliable abstracting, reprint, and translation journals and services. While the selected abstracts should be retained in the holdings of the INTIB, the translation and the reprint service should be selective and should be on call rather than on storage basis. That is, as and when the Bank is required to furnish or supplement a request information, they should be collected from the identified sources on the basis of promt supply and full coverage of the indent.

However, once the information is procured on the basis of a particular inquiry or demand, this may remain with the holdings of the INTIB till weeded out.

d) A thorough catalogue and classified index of the information available from within UNIDO and the other agencies of the United Nations located in Vienna and elsewhere, with complete information on the method of call and the system of obtaining and using them, including identification of agencies, persons whose clearance and authorization is required. This information should be continuously updated on the basis of catalogues or lists published by these agencies, which should be required to put the Bank on the mailing list of their actual publications or catalogue of such publications. For the agencies located in Vienna, it may not always be necessary to have the actual material on the holdings of the INTIB. But for those outside, it may be better to do otherwise, to save the time spent in calling it, as also to forestall the chances of non-spareability.

External resources

20. The external resources would comprise of special libraries and information services, and institutions like Iron and Steel Institute, American Society of Metals, VDE (Verein Deutsche Eisenhuttenleute), OECD, EEC and such other organizations, from which material can be obtained on call. The information available with them should be, on the basis of their published indexes, entered in the appropriate index cards of the Bank in the areas where they may be needed. These institutions should be classified by type of information available and the time taken to procure it. Each type of information should be duly classified and put in an index system with a colour code to signify their external character and the fact that they will require time in procurement. This can be done either by using index cards (5" x 3") of a distinctive colour, or marking them by coloured cellotape or indicators. (App. 9).

21. It may e clearly seen that here, that is, in the matter of external resources, the collection of material and the process of developing the resources of the Bank will depend on a considerable exercise

of the selective method. At the present moment, these may be supplied by the Bank on the basis of the demands as and when received by it. But a large part of it will have to be an exercise in 'futurology' and an extension of the information already obtained to predict what information is likely to be required. Because unless the information is collected, processed and stored before the demand for it is made, it cannot be easily supplied when required. Therefore, the collection of information on the basis of an estimation of the demand is always an essential activity in the building up of an information service. The Bank should provide to each of its information sectionsguidance on these lines on the basis of its existing experience, supplemented by the Information staff, who may be in a position to contribute considerably in this respect.

Evaluation

22. The above will, however, only ensure the identification of the sources - both institutional and materialwise - for obtaining the information. Since, by the nature of its objectives the Bank will be called upon not only to furnish information, but information which will be put into use, hopefully, with success, a process of evaluation and selection from among the material obtained will be essential. This cannot be done by the Information Section, and will require the services of a large number of specialists, who can distinguish and evaluate different types of technology and give an opinion on which two or three would be more relevant to the requirements of a case. They would also be able to point out which areas or which aspects of the information already in store have to be supplemented with further details, so that the system of call, mentioned above, can be put into operation to prepare an adequate profile in any area of information required with maximum economy and efficiency. A list of such specialists with complete note on how to contact them and a method for the processing of their opinions should be a part of the resources of the Bank. Since the system should be independant of human memory and intelligence, as far as possible, the method of procurement of information at any point and on any subject from the resources of the Bank should be put down in writing, constituting the information manuals that are contemplated in the terms of reference of this project.

Lon index (App. 9)

Information Manuals

23. The system of reference for evaluation should be such that it can locate experts who are able to assess the suitability of already tried and new techniques, not merely from the technological point of view, but are also able to assess the chances of their success or failure in a developing country. This warning is particularly necessary as most of such experts may be from comparatively more developed countries and may take the non-technological, e.g., economic, social or geographical conditions relating to the transfer of technology more or less for granted. It should, therefore, be advisable to cross-check such evaluative reviews from specialists both in the developed as well as the developing countries. While those in the developed countries may be able to assess the technological merits of the process quite soundly, they may lack the requisite background information about the problems on the transfer of such technology to a less advanced industrial climate. The technologists from the developing countries, on the other hand, may be fully aware of these limitations, but may not be fully aware of the construction, commissioning and operation of such plant and machinery, except indirectly. The bringing together of these two complementary points of view, which are essential in assessing technological information, will be a problem, and precise guidelines for such assessment will have to be incorporated in the manuals in each area of information requirement.

Level of technology

24. It may also be mentioned here that in many developing countries, because of their economic and industrial level, it may be necessary to give them a tehcnology, which may be considered obsolete from the point of view of the most recent advances or the technology in the developed countries, but which may be just appropriate to the level of industry or economy in the developing country. In such cases, it may not be entirely rare to come upon a situation where information and expertise is required on a technology which has become obsolete in the developed countries and, as such, where experts for their true assessment may be difficult to find. In such cases, the evaluating experts may have to be drawn from the scientists and technologists from countries whose technology is at a level in between those of the most modern and the most backdated ones. Needless to say, such problems would not conceivably arise

where it is possible to lift the technology direct from the "bullock cart to the aeroplane" stage. All the same, there will be cases, where this middle level will be necessary, as amply evident from the experience of a country like India, where technologies at varying levels co-exist at the same time.

Economic and Commercial Information

25. Technologies pertain to the scientific and engineering aspects of an industry. But their selection and suitability to an actual operation depend, to a very great extent, on the economic and other conditions prevailing in a certain country. The feasibility and viability and the continued prosperity of any technology as reflected in an industry depend on these conditions and, therefore, for a fruitful supply of information, the INTIB will have to store as much information on these conditions as on the technological aspects. Economic and commercial information may be grouped under several heads:

Level of industry

a) Information on the level of industrial development of the country, such as the type of industries prevalent, sources of raw material, availability of finished and semi-finished products or facilities for processing, prior to or following the industry. Depending on the nature of industry, these conditions will very largely determine whether or not in a particular developing country an industry can be successfully installed and operated.

State of economy and finance

b) Information on the state of the economy and market, the demand for the product, present and potential, so that not only an industry can be established, but there can be a reasonable prospect of its products being sold, and the industry operating on a continued basis. It is not rare to find that an industry is developed without developing a market for it. Information on financial aspect of an economy, banking, and credit facilities, etc., are also important, as the aim of UNIDO is not to 'mother' for all times to come an industry it has aided in a developing country, but rather to see that it can stand on its own legs. This aim requires that all information on the status of an economy and market is available, or, at least, the extent of the absence of such data and the institutional support they signify, is clearly known.

Social and state

c) Social and governmental information pertain to the infra-structure facilities which are essential for running an industry, viz., communication (road, rail, sea), trans-portation facilities, post and telegraphs, etc., economic legislations, government regulations, tax and other in-formation, which control the industry and investment; social information on the labour market; availability of skilled staff, trade union relations and requirements, man-datory or conventional social responsibilities, pollution laws, religious and social taboos, such as prohibition law in a country like India, piggery products in muslim countries, and, so on.

Dearth of reliable information

26. Unfortunately, reliable information in all the three areas is rather difficult to get in a developing country. To the developed countries of the West, where private institutions, universities, chambers of commerce, Govt., scientific institutes, all have come to stay, and where reliable information on past performance and data on present operation may be had merely for the asking, the nature and extent of the lack of dependable information in these areas on a comprehensive scale in the developing countries, is quite unthinkable. Unfortunate as it may be, even in middle level developed countries, such information is extremely difficult to come across.

Basis of inaccuracy

27. The inaccuracy starts from the generation of data at the unit level. There may be plant and machinery which are so old that their make, name-plate data etc., are absent, or have been lost. The compi-lation of data suffers at the different levels through the manual clerical transcriptions and transfers, where mistakes creep in due to the level of education of the staff handling them. Sometimes ,

there is deliberate attempt to misrepresent data to bypass Govt., Company Law, or tax regulations, etc. As a result, one can never depend on the data that is finally put in publications. This does not happen in an industrially developed free market economy, where competition forces the commercial and economic data to be accurate. This factor has to be borne in mind in meeting the demand for essential information of these three types from the developing countries. In most such countries, depending on the state of development, such information will range from totally absent to full information in a few areas. But, mostly, such information will have to be developed or derived from existing raw data.

Different sources

28. The procurement of economic and commercial information will, therefore, in many cases, require the development of information sources and indexing (see App. 9) in these countries, which would be of the following types.

Govt. agencies

a) Govt. agencies dealing with the area: These agencies will have to be identified and contact established for information that is still 'in-process' or has not reached the publication stage, with appropriate information on the original source, so that it can be checked with the original source, wherever possible.

Institutions

b) Research institutions, universities and educational institutions, etc. In many cases, these prove to be the source of detailed information on one or other aspect of an industry, arising out of their contact with industry (i) where they are researching a project given by an industry, trying to solve a problem in an area and (ii) where students are preparing their doctoral theses after a study of one aspect of an industry, which may cover an area where the INTIB may be interested. Here also, wherever possible, the original sources should be identified and located, so that when an information supplied by the INTIB has to be authenticated, this can be done by reference to the actual sources.

Consultants

c) Consultancy firms concerned with industries in question. These firms accumulate a lot of data directly from the field or from other sources, and because of their long association with the industries in their specialization, they are sometimes in a good position not only to supply, but to evaluate the quality of the information. They may be tapped either on a free exchange-of-information basis as in the case of the Govt. and the universities, or on a retainer basis, or on the basis of payment on spot items, negotiable in each case. A decision on this point will affect the availability of quite a good deal of information in certain cases.

Chambers of commerce

d) Chambers of commerce and other economic or commercial organizations: These often keep a good bit of information regarding the industries and the areas covered by their constituents. Such information may be mroe dependable than those supplied by, say, Governmental agencies. If such information can be procured on a basis of confidentiality and reciprocity, it will be a great asset to the INTIB.

Banks

e) Like chambers of commerce, they also collect a lot of commercial information to serve their clientele. Since such information is available by any client on a service basis, there should be no difficulty for the INTIB to get this information, provided, of course, the service charges are met.

Special Libraries and Information Services

f) While all the above will supply the current up-to-date position, information of past performance, statistics and data etc., may have to be obtained from special libraries or similar agencies in respective areas. These have to be identified and listed, and the method of obtaining information from each incorporated in the manual, so that their procurement and use do not depend on individual memory or intelligence.

Developing information sources

29. A part of the developmental activities of the INTIB would be to develop, particularly where they do not exist, institutions of the above categories to aid the Bank in its gathering of information and their processing and documentation. These can be comparatively easily done in the case of (b) and (f) above, although others also can be helped to be useful sources of information. This point has already attracted the attention of the planners of the Bank as evident from the listing of the information sources in the note on the Establishment of Interlinks betwwen the Bank and the Users in Developing Countries.

PROCUREMENT

30. Once the information sources have been identified, as described above,in terms of a selected, delimited field, strictly in keeping with the aims and requirements of INTIB, the next task would be to see that such information can be obtained and made available to the user as and when asked for. This process starts with procurement and storage. For the in-house information or internal resources, the organization of these activities would be comparatively easier and less elaborate and time-consuming. But for external information, because of the multiplicity of sources and the time involved, it will require an elaborate organization, which have to be clearly defined and stated in the manual and constantly maintained and up-dated.

Procurement policy and procedure

31. The use of most in-house information will require that the material containing it be procured and stored. Clear-cut policies will have to enunciated for this purpose and made known to the staff operating the Bank. Questions such as when and how to activate the procurement process, what will be the time lag between the demand and the procurement, who will authorise such procurement and what would be the funds available, all these questions will have to be clearly answered. In view of the financial commitments and involvements, and time involved, unless clear policy decisions are taken and stated in this respect, procurement will never be able to keep up with the demands.

Procurement time

32. The procurement policy should, therefore, answer the above questions and the activity should proceed along the following lines:

a) Identification of the information sources and the areas on which information has to be procured.

b) The placement of order for the material or calling it on the basis of an estimate of the optimum time and cost for such procurement.

c) An assessment of the quality of such information, i.e., its dependability or comprehensiveness and the actual cost and time of the procurement. The Bank should add its own processing and forwarding time to these data, and the total should constitute the time lag between supply and demand. Where the information is not readily available on call, the time will have to be left indefinite. Where information sources are known and it is known that it can be procured, the approximate procurement time as recorded in the manual, plus the processing time at the Bank should constitute the delivery time.

Cost decisions

33. A firm decision on cost should be taken and made known. Would the INTIB supply such information, free of cost from its own resources or in respect of in-house information? Would it charge the receiving party on a 'no profit - no loss' basis? Would it charge the receiving party the actual cost of procurement + an additional sum as profit or overhead? A decision on these points will determine the extent to which the information can be procured from already identified sources. If it is to be funded from the Bank's own resources, it will be naturally limited by the extent of the funds. If on the other hand, the receiving party is to reimburse the cost, then it will be possible to procure more material. A part from the funds available, a decision on the policy of procurement on the basis of the above cost considerations would be a vital requirement of building up INTIB.

<u>Procurement: Related aspects</u>

34. Procurement would also be largely governed by the space and other facilities available to store and supply the material when required. If the space or processing facilities and staff are not available to the extent required, the procurement may have to be slowed down or halted altogether. The extent of procurement and the nature of the material procured will also determine the type of classification, cataloguing and the eventual system of withdrawal of the material from the holdings of the Bank in order not to clutter up valuable space.

STORAGE

35. In view of the industries, such as iron and steel, chosen by the Bank, as its field of assistance, the information material at the disposal of the Bank is likely to be voluminous and grow at a very fast rate. The storage of these vast quantity of material will pose serious problems, as it would be continuously added to. Apart from the question of space to accommodate them, the maintenance of an ever larger body of material will add to the length of the processing and searching time and, to that extent, if unchecked, will gradually make the system cumbersome and inefficient. It will, therefore, be necessary to lay down certain guidelines in this respect, namely,

<u>Selection</u>

a) The material will have to be stored on a selective basis. For instance, journals and card abstracts, which will be subscribed, should be continuously screened and material which are of peripherial or doubtful utility rejected outright. This should also apply to all material received on an exchange or complimentary basis, which, in view of the nature and sponsorship of the INTIB, will be considerable. Specific guidelines and authority for such rejection would have to be laid down in writing. This screening should also be carried out in respect of procured items, such as abstract cards, reprints, translations, catalogues, lists, etc., and those to be retained should be specified by material type or category, region, alternative availability, etc.

Retention

b) The stored material should be continuously weeded out, each according to its own retention schedule, which must be determined, marked and processed for follow-up at the time of the storage itself. For instance, yearbooks, demographic data, statistics, etc., may be weeded out after the next editions or issues are out, the previous issues being referred to if required, from resources on call. Periodicals may be bound at the end of the year after removing unnecessary material or, better still, after keeping microfilm or microcards to reduce burden on storage space and for better indexing, classification, retrieval and supply. Even where the books and journals are retained because of their more or less permanent nature, a re-examination time should be determined to review their usefulness.

Storage economy

36. As regards the actual storage, utmost economy should be exercised in the storage of material whether in the macro or micro form. This is essential, as otherwise a considerable part of the time of the processing staff is likely to be spent in useless movement. The more compact the storage, the lesser is the extent of such useless unproductive movements. A few ideas are recommended:

a) The reprints, translations, etc., should be kept after punching in Lever Arch files of $1\frac{1}{2}$" to 2" spine width, which will facilitate easy insertion and removal. Such files should be stored on 12" shelves with the spine of the files alternatively kept front and back, so that they may be kept even.

b) The abstract and index card trays should be kept in revolving shelves in mechanisms like Remington Kardveyor or similar equipment which makes for compact storage of such cards with maximum economy of space and facility of movement.

c) Catalogue cards also may be kept in Kadveyors, or the cabinets may be placed on tables supported on hydraulic or pneumatic jacks, so that they may be raised or lowered with the help of switch or control to get at the appropriate trays. If the catalogue cards are kept on a table which can be elevated or lowered in this manner, and the table is kept in a pit in the floor, then trays required can be easily brought up to the desired level by the use of a foot lever. Normally, now, the space below the catalogue card tables is wasted, it also becomes difficult to refer to the lowest and the highest trays without bending or getting up under the present arrangement. However, a pit, 2 ft. or more deep, may be made only in the case of the ground floor and may not be easy in the case of higher floors. Therefore, the Kardveyor may be the solution for catalogue cards also.

d) The use of conveyor belts or pneumatic tubes for the movement of material in the Bank.

e) Microfilms and microcards should be stored in the usual manner; photographs and others also can be kept in lever file.

RETRIEVAL

37. The retrieval of the material procured and stored in the Bank or items available on call with different time lags from internal or external sources is the key operation which is most closely concerned with the supply of information to the user. It calls for greater ingenuity and preparation, and is of a more frequent and continuous nature than the other two activities described earlier. In fact, once the preliminaries have been settled and the Bank and its services set up, retrieval will constitute the major day-to-day activity of the Bank. This activity will depend on how the material has been processed, how the inquiries are received and the policy regarding the supply of information.

Information requests

38. A retrieval activity should begin with the perception and enunciation of a demand. This may be internal or external, that is, required by the staff of the Bank or UNIDO itself, or required by outside parties. In most cases, the success of a retrieval operation will depend on the retrieval staff clearly understanding the intent and extent of the retrieval requests. Unfortunately, this is one area of information service which is still left to chance. In most cases, the form and content and clarity of request for the information on a particular topic depend on the requesting individual's style of expression. This may be put forward in numerous ways in respect of even the same information. As a result, the area on which information is required remains vague, the quality of information remains unspecified, the scope of information undefined, the end use unstated, and other parameters of use, such as time, person using and follow-up on the use, are left out of consideration. These characteristics of the information requests, unfortunately reflect on the quality of information supplied,in spite of serious and sincere efforts of the information staff.

Request form

39. To eliminate the chancy nature of this transaction and to drive some business sense into it, the Bank should, from the beginning, insist on a clear statement of all requests for information on the analogy of the request for withdrawal in a financial bank (e.g. amount of the sum, to whom to be given, nature of payment, such as A/c Payee, bearer, etc.). An excellent effort has been made in this direction in Annexure II of document UNIDO/ISID 63/Rev. 1 of 15.10.1973. For further effectiveness and usefulness to the Bank, it may be modified as indicated in App.10 and sent to all who request for information from the Bank. Such a step will considerably facilitate the work of the Bank and the information staff and will produce results which are much superior to what are likely to be available otherwise

Retrieval policy

40. The format will ensure that the request for information would be available in a easily actionable manner. But even when it is otherwise, at least in the initial stages, the information staff

would have to try to supply the information, or at least direct the inquirer to the source from where it may be obtained. In the case of the Bank, it may not be desirable to have re course to the latter, that is, it should, in most cases, be able to give the information, unless it is outside its scope. But even in the cases where the request is outside its scope, wherever possible, the source from which it can be obtained should be indicated for good image and public relations effect.

Information processing

41. Retrieval of information from internal or external resources would depend entirely on the way the actual material or information about its availability have been processed. The processing of information indicators, (i.e., pointers actual material or its likely source of call) in any information data Bank or information service will depend on the classification, cataloguing, indexing, anotation etc., of such indicators.

PROCESSING

Classification

Classification system: UDC

42. Unless all materials in an information storage are properly classified, they cannot be retrieved for use. Unless they are classified according to a good, flexible, and synthetic system, the material cannot be fully used - either one or an other aspect of the information may be lost sight of. There are several good classification systems for classifying information on the iron and steel industry, but we recommend the Universal Decimal Classification for the use of the Bank, as it has become a more or less universally accepted system of classification for information material in this area in the greater part of the world. The major information sources on this industry either use this system or none. If, therefore, this classification is used

a) The work of classification would not be necessary in respect of those areas from where the materials come with pre-classification, such as abstracts from the Iron and Steel Institute of UK.

b) Unclassified new material can be easily spliced with the existing material.

c) Interchangeability of information and reference to information from external sources become easier.

Cataloguing

Rationale for cataloguing

43. A classification system can operate in practice only with the help of a catalogue and index, since because of their bulk, the material cannot be kept at the finger tip, and one item may have multiple facets, but for storage purpose can be kept only in one place (unless, of course, the item is reproduced into multiple copies and kept in as many places, which, again, exerts pressure on the space, funds, and handling, and makes it difficult to weed out the material). The preparation of catalogues and indexes are, therefore, essential activities in the processing of information for its eventual retrieval.

Punched cards

44. Cataloguing and indexing is usually done on the 5" x 3" catalogue or index cards. Because of the two dimensional nature of the cards and their fixed location in an arranged order, an item of information may require multiple number of cards to cover all its facets fully. This adds to space and search time. To reduce the search time and yet to be able to make use of all information available, it is suggested that indexing and cataloguing should be done on punched cards of the type developed by American Society of Metals for the metallurgical industries to be handled manually or, better still, electronically, if that has been developed in the meantime. Such punched card cataloguing and indexing system will not only reduce the search time, but will also make it possible to have the use of all the facets of an item of information for the preparation of bibliographies, profiles, etc., and will eliminate the time taken to replace the cards and to maintain their order, as required in the ordinary catalogue or indexing system.

Information profile format

45. To facilitate the preparation of information profiles on the basis of the indexes or cataloguing or abstracts relevant to a particular enquiry, these should be arranged in a sorting tray and reproduced xerographically/photographically in a suitable standard form to facilitate reference. On the basis of the proforma already submitted by the author, the layout and size of this profile proforma should also be laid down.

PREPARATION OF INFORMATION PROFILES

Actionable information

46. The services of an information system may be of two types:

a) Giving the enquirer, as far as possible, the information he wants, which he then absorbs, evaluates, edits and uses for his purpose

b) Supply the enquirer with 'actionable' information, namely, information on the basis of which immediate decision or action can be taken.

47. The first type is generally welcome and useful where the enquirer posesses superior knowledge and information about a subject and capability of processing and evaluating raw-data given to him. Research scholars, technologists and professional engineers in universities, research institutions or consultancy agencies normally fall in this category. In such cases, they, in fact, guide and direct the information workers in procuring, by the use of their special knowledge of the resources and of their processing and retrieval, the information required by the enquirer. But as evident from the objective of the INTIB, it will be more in keeping with its objectives, if it supplies information of the second type for three specific reasons:

Quality of service needed

a) The information will be wanted by developing countries where the investing or the decision-making authority may not be in most of the cases, enquirers of the first type. They will prefer evaluated and as complete an information profile as possible, where thay can directly use the information for their purposes. In several instances, they may like the comparative internal or external data against which to assess the data supplied by the INTIB. This would throw the moral responsibility for the quality, dependability and comprehensiveness of the information supplied on the Bank itself.

b) Even where the enquirer has the data and the will to evaluate the information given by INTIB, he may not have the professional expertise within his country to make a dependable assessment and may, thus, fall back on the INTIB for such assessment, after receiving the information. It will, thus, be better, if the Bank can give processed and evaluated data in the first instance.

c) Even the developed countries, which would be partners in the transfer of technology or industrial development resulting out of the use of the INTIB information, would require the economic and sociological part of the related information as mentioned earlier before they can themselves decide on the appropriateness of the technology which they wish to adopt and on their participation in any project arising out of it.

Retrieval parameter

48. This would mean that the evaluation of the relevance of the information supplied to the objectives in view will have to be done internally within the Bank rather than leaving it to the users. This, of course, does not prevent the user from re-evaluating it for his own satisfaction, but in the best of arrangements, such re-evaluation should not, in any way, alter the nature of the decision which can be arrived at on the basis of the information supplied. In sum, both the potential users of the INTIB's services, be they in the developed or developing countries, will be seeking information on which they would like to act and which they would not be in a position easily to evaluate by themselves, particularly in the area where

they will be seeking it, namely technological information in the case of the developing countries and economic and social information in the case of developed countries.

Evalu-tion machinery

49. To ensure the supply of information of this type, it will be essential to have an evaluative, selective machinery within the Bank itself. Even if the Bank cannot fully achieve this aim immediately, the information supplied should contain, either by arrangement or by anotation or through moderation by specialists in that field, some clue to the value of the information, its range, scope and reliability, its comprehensiveness and updatedness, so that a judicious specialist can easily come to a conclusion about its value, and the information profile processed through such a specialist may be confidently passed on to the user as a firm basis for decision-making without any further scrutiny or review.

Retrieval procedure

50. The process of retrieval would, therefore, have to proceed along the following lines:

a) To obtain from the enquirer a total picture of the information requirement indicating the area, nature, volume quality, purpose, time and cost of the information in a standard proforma (App. 10) already suggested above.

b) In the light of study, and scrutiny of this demand, identify and retrieve the complete related information on the topic available with the Bank and call for supplemental information that would be needed to meet the requirements. Needless to say, the information of the second category to be procured from outside resources, will require greater scrutiny in view of the time and cost involved.

c) Comparison and evaluation of the information available to select the items which meet the demand for reliability and practicability as well as comprehensiveness most adequately. While this process of selection can be done elaborately in the case of the internal information after the retrieval of the material, in case of the external material on call, it should be done before calling for the material, to avoid wastage and delay.

d) Prepare information profiles and send them to the specialists in the INTIB for their comments, criticism and suggestions for addition and alteration.

e) Submission of the profile to the enquirer after its receipt from the specialists and its modification in the light of their suggestions.

f) Follow-up of the information supplied for a feed back on its adequacy and efficacy to improve the quality of the service with the passage of time. For this purpose, a proforma along the lines of the one for the specification of requirement of the information mentioned above (App. 10) should be developed (App. 11) requiring the enquirer to please specify (i) how the information supplied by the INTIB was used and to what specific use it was put (mention what investment or operation decisions were made on its basis); (ii) was the entire information used or only part of it? If the latter, why could not the full be used; (iii) did the information have to be supplemented? What was the supplemental information and the sources from which it was procured and (iv) how is the investment or operation based on the INTIB information going on? (This will require the submission of annual report, progress report, statement of account and the like).

Disposal of material

51. The process of retrieval will also pose the question of the disposal of the retrieved material. Should it be sent to the party? or should copies be sent? In view of the advancement of the reprographic processes, it should invariably be that copies of the material

should be sent. A decision may have to be taken here whether to identify the source or not. A decision may also have to be taken and clearly indicated about the responsibility and liability of the Bank for the information supplied.

Training and development

52. A process of retrieval to be effective and efficient requires that the human elements concerned, i.e., the staff, should be continuously developed for the function. In spite of the development of scientific technology, the retrieval of information of a non-repetitive, specific nature, is still a long way off from mechanized operation. Retrieval and the processes preceding it essentially call for human judgment, for which the promise of a reliable substitute is still far, far off. Therefore, to develop the human judgment and to make it as far as possible uniform in respect of the interpretation and understanding of some given requirements of information, there should be a constant intercommunication between the user and supplier of the information. A direct dialogue between the user and the information worker retrieving the information is one way of helping this process. A constant exchange of ideas between the specialist evaluating the information and the information worker is another. Associating the specialists with the selection and procurement process and, where possible, in the processing of the data, offers a third possibility in this direction. In many scientific institutions, scientists are asked to scan and select the information material which is processed and stored by the information worker for future retrieval. The information worker is invited to attend discussions, seminars and conferences which bring to light the information gap. All these methods of enriching the experience of the information worker should be a part of an enlightened information retrieval system.

Technicalities

53. They should also be trained in the technical aspects of the preparation of information profiles and manuals, both in their internal and external aspects. Internally, they should know what to include, the order of arrangement, the presentation of the data, and the comments with authentication for each point made. The comments should particularly emphasize the status of the information where this is not in-

cluded in the information itself, i.e., whether this is in an experimental stage, operational stage or in the stage of investigation and speculation. Externally, there should be a standardization of the format, layout, typography and reproduction process for the production and presentation of the data or information to the enquirer.

FOLLOW-UP

Direction and nature.

54. The follow-up of the Bank's operation can have several logical directions:

a) To discontinue the activity, if it is found that there is no real need for this service or that there are other agencies of United Nations which, in their scope, encompass these activities and which either already operates it at a certain level or can operate it, if necessary.

b) To merge or associate the activity of the INTIB with such agency or agencies and

c) To continue this activity and develop it so as to be able to fulfil the original aims with which the pilot activity was undertaken.

In what has been stated above, the last alternative has been taken as the aim and direction of the follow-up. The above discussions on the procurement, processing and storage and retrieval of information has outlined the direction which each of these activities should take in the coming days. Once a decision is taken to implement them, the points and steps suggested in the above pages should provide a guideline along which these activities should be continued. They could be considerably elaborated with minute and detailed directions for conducting each step. But limitations of space and time do not permit such elaborate treatment. Also if the activities are entrusted to properly qualified personnel, the detailing of these points would constitute the initial part of the activities of creating the basis for the service. These will, in fact, take shape on the basis of initial planning as well as actual work. To put an extremely detailed plan of operation would be unfair to a future staff who would be hamstrung by it. What has been discussed would be adequate to act as a generally dependable outline of action for the development of its service in a final form.

Scope

55. However, any activity can be carried out only within the framework of space and time and with the help of people to carry them out. The spatial aspect of this programme, namely, the areas in which INTIB will operate, has been more or less broadly defined, i.e., iron and steel industry, (and the fertilizer and the agro-economic industries). In view of the needs of the developing countries, and the philosophy behind the operation of the Bank, the other industries to be included should be clearly named,and those excluded explained and made known to the information staff to give them a better understanding of the scope and compass of the programme. Again,in the case of the iron and steel industry, several points need to be clarified. As already stated, the iron and steel industry and those based on them constitute a major part of the industries in most countries. Therefore, the industries to be covered by this broad term starting from primary units like iron and steel works,secondary units for shaping them and using them for manufacturing engineering goods,to tertiary units like, say, the manufacture of refrigerator or car of bicycle and all related processes, can come under this vast umbrella. It is, therefore, essential to define the industries that will come under its scope. If, for example, the manufacture of bicycle is to be covered, then for a developing country it will not only mean knowledge and information about the electroplating and stove enamel baking industry, which will be covered under metal finishing, but also about the manufacture of rubber tyres and tubes, without which they would be incomplete. Hence, information about rubber technology may have to be stored.

Climate of operation

56. If, on the other hand, it is confined to the manufacture of primary products, namely, iron and steel, and at least to their shaping and treating carried out in an integrated iron and steel works, certain constraints and considerations that are confronting the industries today should be kept in view as overriding considerations. These refer to the pollution and conservation problems, also the problem of crisis in energy. The establishment of an iron and steel industry may no longer in the future be an overriding consideration of national 'prestige' in line with the establishment of national airlines. The economic and social considerations mentioned above may rule out the establishment of these industries even in otherwise technologically favourable climes, or they may lead to restriction of scope such as steel plants located on seashores rather than in proximity to the availability of coal or iron ore or the market, and to the export of raw materials from one country and its processing in another. These basic overriding considerations which are gaining universal ground and becoming stronger every day, should be assessed and their relevance to the operation of the Bank stated in no uncertain terms.

Time factor

57. The establishment of an information service and its operation have certain inevitable time constraints. The procurement of materials takes time, their processing takes time. A service cannot be started without a certain amount of preparation and, hence, of time. In view of these, the sooner the operations of the Bank are undertaken, the better it is for its success.

Personnel

58. The next important question refer to personnel. The selection and appointment of appropriate personnel to run the service will take the inevitable time inherent in the process. The adjustment and adaptation of the staff to the conditions and requirements of the service will take time, which may lead to the eventual rejection of some that may set the process back a full cycle to the initial stage of selection and recruitment of substitutes in place

of the rejected staff. The mutual understanding and adjustment of the staff among themselves also require time. Their exposure to the ideas of the specialists and the absorption and assimilation of these ideas and their transformation in the service plane which has been mentioned under the topic of intercommunication between the user and specialist staff on the one hand and the information staff on the other, will also require time.

Recruitment of staff

59. Thus it will be seen that the full scale operation of the Bank, which will be dependent on the staff as much as on the material, will take a lot of time from recruitment to successful operation. In view of this, the recruitment and selection of staff for the operation of the Bank should be undertaken on an urgent basis. Side by side with this, the functions and responsibilities of the staff should be clearly defined and the requirement of their qualification and background precisely spelt out, so that the executive authority can take immediate step for the recruitment of staff. Since information is a fast growing service, where awareness and understanding of the everwidening horizon is an essential requirement, an outline for the frequent training and exposure of the staff to new concepts and requirements of the service should also be planned concurrently.

CONCLUSION

60. In the end, it is hoped that the ideas expressed above would be found acceptable and early action would be taken for their implementation. But whatever may be the decision, the views should be considered as having been expressed entirely on the basis of their relevance to the noble idea of trying to assist in the industrialisation of the developing countries, which is a challenging task awaiting all mankind. This consultant feels particularly grateful for having been given an opportunity to play a part, howsoever small, in this noble and challenging endeavour.

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App. 1-1
(ref. para 6)

PLAN OF ACTION

Working Group on Iron and Steel Industry: Establishment of an Industrial and Technological Information Bank

The Plan of Action is based on:

a) Mobilizing and organizing in-home information and the systematic expansion of this information in the sectors chosen for the Pilot activity.

UNIDO in-house pool of information on the iron and steel industry needs to be defined, classified and strengthened; a well contained note outlining the available in-house sources of data will be prepared furnishing inter alia therewith:

i) Library and related documentary facilities;

ii) Availability of technical data from MET (IOD) and ICIS and its analysis;

iii) Journals/magazines, free booklets and data sheets circulated by many countries.

Furthermore,

iv) Expansion of in-house technological pool with the collaboration inter alia of:

International Iron and Steel Institute;
Japanese Iron and Steel Federation;
Steel Authority of India Ltd.
Hindustan Steel Ltd. - India National Metallurgical Laboratory;
CNRM - Belgium;
IRSID - France.

It will be desirable to exchange free technical literature freely with the above parties.

The data from these sources will be classified for use by UNIDO.

b) Collecting selected information from external services.

The external sources are many; UNIDO explanatory letters have to be sent out to external sources of technological information/data requesting them to put UNIDO on their mailing list and furthermore, for exchanging information emanating from UNIDO.

Draft letters are to be put up in this connexion.

A list has to be prepared for all such potential external sources.

c) Creating a network of information for the identification and selection of technologies through joint action with UN Agencies and other international or national institutions.

It will be necessary to identify all sources of information of general and technical nature pertaining to iron and steel industry including the raw materials needed therefor, within the United Nations Agencies and allied bodies (OECD, EEC, ASU, IDCAS, ASEAN, ANDEAN, etc.). UN Agencies will include all UN Economic Commissions; these bodies will then be addressed in order to set up a network for exchange of data/information vis-à-vis technology, raw materials processing, iron and steel production, plans and strategies, output and product mix, trade (imports and exports) and markets (home and external). Draft letters to be put up in this connexion to initiate action for the establishment of such a network.

d) Establishing interlinks between the Bank and the users in the developing countries, including a continuous appraisal of their information requirements.

In order to forge interlinks between the Bank and the users in the developing countries, the users have to be identified and listed and the information will need to be aligned to their specific needs and environments taking into account the status of their steel industry. These lists have to be prepared on an urgent basis.

e) Preparing technological profiles in the sectors chosen for the pilot operation.

Technological profiles (flowsheets, fluxograms, etc.) have to be prepared within the house with some external assistance and co-operation as appropriate. Illustrations will have to be furnished for such profiles and flowsheets.

f) Building up a stock of technological information and processing it for selection purposes.

This stock of technological information can only be built as this actively gathers experience and momentum. At this stage, we can take note of such an eventual stock-building of technological data/information and later processing it.

APP. 1-1
(ref. Para 6)

g) Identifying and utilizing technological sources and capabilities available in the developing countries.

Technological sources of information and capabilities in the developing countries will need to be defined and listed on a rational basis. It may be necessary to write to potential sources of technological information for reciprocity purposes; draft letter to be put up in this connexion on a priority basis.

h) Evaluating the pilot activities at the end of the second year of operation.

Note should be made of this eventual requirement. It is, however, suggested that such evaluations should be made on a continuous basis and at the end of the two years, a draft/final evaluation report should be prepared. A proper format will need to be drawn up for undertaking these continuous evaluations and then preparing the final write up on the evaluation of the overall work done and net results/gains achieved thereby.

3 May 1977

B.R. Nijhawan
Senior Interregional Adviser

ANNEXURE "A"

App. 2-1
(Ref. para 6)

Mrs. K. Banerjee

Pilot operations of the International Information Bank (INTIB) in the field of the Iron and Steel Industry

a) Assist in the pilot operations of INTIB in contributing to meet its need for information inputs from in-house and external sources, indexing and abstracting such information material retained or obtained for relevance to the output of INTIB in the area of the iron and steel industry.

b) Making the above material readily available for the purpose of processing for the use of INTIB and generally re-inforcing the potential of the Industrial Information Section to serve the INTIB.

c) Align and develop the above facilities vide a) and b) above in the field of iron and steel industry and thereby lead to the formulation and preparation of Information Profiles and Information Manuals.

d) Prepare a concrete Plan of Action for the follow-up activities in terms of a) to c) above prior to the end of her assignment.

App. 3-1
(ref. para 7e)

International Patent Classification code schedules C 22B and
C 21B - C 21D for Metallurgy of iron and steel as suggested to IMPA doc

IPC			BSO
C 22B		Raw materials and their preparation for use in Blast furnace burden.	
	1/00	Iron ores	
	1/02	Roasting and calcining	
	1/021	- in open kiln	
	1/022	- in reverbatory furnace	
	1/023	- in shaft furnace	
	1/0231	with grate	
	1/0232	without grate	
	1/024	- in circular kiln	
	1/025	- in rotary or revolving furnaces	
	1/026	Fluo-solid roasting	
	1/03	Sintering, Agglomerating	
	1/031	- in converters	
	1/032	- in tunnel kiln	
	1/033	- in shaft furnaces	
	1/034	- in Dwight-Lloyd Sintering machine	
	1/035	- in revolving tube machines	
	1/036	- in pans	
	1/04	Manufacture of shaped agglomerates	
	1/041	Agglomeration in rotating drums	
	1/042	Pelletizing	
	1/043	Pellets	
C 21B	3/02	Basic addition	
	3/021	Limestone	
	3/022	Calcium Phosphate	
	3/023	Acidic additions, aluminium silicates, quartz, fluorosper etc.	
	3/024	Other metallic and non-metallic additions	
	3/03	Coal	
	3/05	Coke	
	3/07	Charcoal	
	3/09	Gaseous fuels, Natural gas, Oxygen, Fuel oil etc.	

App. 3-2
(ref. para 7e)

C 21B	5/00	Making pig-iron in the blast furnace
	5/031	Charge and burden
	5/032	Reduction of oxides
	5/033	Blast furnace reactions
	5/034	Tapping of pig-iron
	5/035	Operation with various fuels e.g. injection of solid, liquid or gaseous fuels
	5/04	Making slag of special composition
	5/041	Utilization of blast furnace slag
	5/06	Using top gas in the blast furnace
	5/061	- Recovery of individual components
	5/062	By-products, e.g. recovery of zinc
	7/00	Blast furnaces
	7/021	Internal hearth
	7/0244	Hearth cooling
	7/16	Tuyeres
	7/161	Tuyere connections
	7/162	Bosh tuyere
C 21B	7/06	Lining for furnaces
	7/064	Bricks
	9/08	Iron hot-blast stores
	9/081	Heat balance
	9/082	Blast temperatures
	9/10	Blast Mains
	9/103	Blowers
	9/16	Cooling or drying the hot-blast
	9/161	Oxygen enrichment of blast
	9/162	Steam injection
	9/17	Blast volume, pressure and consumption
	9/171	Blast consumption
	9/172	Blast volume, blast losses
	9/173	Blast pressure, pressure losses

App 3-3 (ut phaze)

11/03 Electric blast furnace
11/09 Charcoal blast furnace

13/14 Multi-stage processes
13/141 Without flux
13/142 With solid reducing agent
13/143 With gaseous substances
13/144 With reducing flames
13/145 Treatment of ores with salt fluxes
13/146 Treatment of ores with reducing agents of fluxes

C 21C 1/08 Manufacture of cast iron
1/081 With cast iron
1/082 Mottled cast iron
1/084 Molleable cast iron
1/085 Grey cast iron

3/00 Manufacture of wrought iron and steel
3/10 Wrought iron
3/11 In charcoal furnace
3/12 In puddling furnace
In hearths
3/20 Wrought steel
3/21 In shaft furnaces, Bloomery
3/22 In rotary furnace, muffles, retorts
3/23 In reverbalay furnaces
3/24 In electric furnaces
3/18 In induction furnaces

5/04 Manufacture of open-hearth steel

C 21D 7/00 Modifying the physical properties of riron and steel
7/015 Steels with magnetic resistance
7/16 Transformer steels
7/17 Electrical resistant steels
7/18 Steels with special chemical properties
7/181 Corrosion resistant steels
8/182 Acid and alkali resistant steels
7/19 Non-aging steel

App. 3-4
(ref. Para 7 e)

C 21D	6/067	Crop-resistant steels
	6/068	Steels with special expansion properties
	6/0691	Steels with electrical resistance
	6/0692	Steels with magnetic resistance
	6/07	Permanent magnet steels
	6/08	Transformer steels
	6/091	Corrosion-resistant steels
	6/092	Steels resistant to hot and combustion gases
	6/093	Steels for gun barrels and valves
	6/095	Non-aging steels

List of periodicals to be procured for the INTIB (122 items) App 4 (Ref. ... 4-1)

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App 4

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METAL FABRICATING NEWS. vol.8, 1970 bi-m, $1.50. Metal Fabricating Institute Inc., 724 Forbes St., Rockford, IL 61105.

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METALWORKING NEWS (In Two Sections). 1960. w. $6. Fairchild Publications, Inc., 7 E. 12th St., New York, NY 10003.

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STEEL TIMES. 1866. m. £12 ($28.80). Fuel and Metallurgical Journals Ltd., Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS, England.

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TISCO TECHNICAL JOURNAL. 1954. q. Rs.12 ($3). Tata Iron and Steel Co., Ltd., Jamshedpur, Bihar, India.

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TOOL AND ALLOY STEELS. 1967. bi-m. Rs.60 ($25). Alloy Steel Producers Ass. of India, 332 Hind Rejasthan Bldg., D.S. Phalka Rd., Dadar, Bombay 400014, India.

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WIRE: the technical journal for the wire industry (Editions in English, German, French, Indian and Spanish). 1951. bi-m., DM 45. Prost + Meiner-Verlag, Postfach 691, 8630 Coburg, W.Germany.

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AUSTRALIAN WELDING JOURNAL. 1957. bi-m. Aus.$5.40. (Australian Welding Institute), Australian Trade Publications Pty.,Ltd., 28 Chippen St., Chippendale 2008, N.S.W. Australia.

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WELDING ENGINEER. 1916. m. $3. Welding Engineer Publications Inc., Box 128, Morton Grove, IL 60053.

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App 4
(Ref. Ex. 7 ...)

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FOSECO FOUNDRY PRACTICE. 1954. bi-m. Foseco Inc., O.O.Box 8728, Cleveland, OH 77135.

INSTITUTION OF MINING AND METALLURGY. BULLETIN AND TRANSACTIONS. SECTION C: MINERAL PROCESSING + EXTRACTIVE METALLURGY. 1892. £8 ($20). section A-C, 44 Portland Place, London W1N 4BR, England.

JERNKONTORETS ANNALER; tidskrift for nordisk bergshantering. 1817. q. Kr.60 ($12). Jernkontoret-Swedish Ironmasters' Association, Box 1721, S-111 87 Stockholm, Sweden.

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STEEL TIMES. 1866. m. £20. Fuel and Metallurgical Journals Ltd., Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS, England.

STEEL TODAY AND TOMORROW. (Text in English). 1973. bi-m. free. Japan Iron and Steel Exporter's Association, Nihon Tekko Yushutsu Kumiai, c/o Tekko Kaikan, 3-16 Nihonbashi Kayaba-cho, Chuo-ku, Tokyo 103, Japan.

STAHL UND EISEN; Zeitschrift fuer Technik und Wissenschaft der Herstellung und Verarbeitung von Eisen und Stahl. (Text in German, Contents Page in English and French, Summaries in English). 1881. s-m. DM 165. (Verein Deutscher Eisenhuettenleute) Verlag Stahleisen mbH., Breite Str. 27, Postfach 8229, 4000 Duesseldorf 1, W. Germany.

STEEL CASTINGS ABSTRACTS. 1952. bi-m. £20. Steel Castings Research and Trade Association, East Bank Rd., Sheffield S2.3PT, England.

BRITISH STEELMAKER. 1935. 6/yr. £10. British Steelmaker Ltd., 5 Pond St., Hampstead, London NW3 2PN, England.

JAPAN INSTITUTE OF METALS. TRANSACTIONS. (Text in English). 1961. m. 12000 Yen to non-members. Iron and Steel Institute of Japan, Nihon Tekko Kyokai, Keidanren Kaikan (3rd floor), 1-9-4 Otemachi, Chiyoda-ku, Tokyo 100, Japan.

[illegible]

App- 5
(Reference ...)

UNITED NATIONS NATIONS UNIES

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

LERCHENFELDER STRASSE 1, A-1070 VIENNA, AUSTRIA
P.O. BOX 707, A-1011
TELEPHONE: 43 500 TELEGRAPHIC ADDRESS: UNIDO VIENNA TELEX: 75612

REFERENCE: 472/7 21 October 1977

Sir,

The United Nations Industrial Development Organization has the main co-ordinating function regarding industrial development activities within the United Nations system. As part of its activities to promote industrial development, UNIDO has been given a mandate by General Assembly resolutions 3507 (XXX) and A/31/181 to establish an Industrial and Technological Information Bank within an overall information exchange network, the purpose being to render the developing countries easy access to information and technologies for their selection, most suitable to their individual requirements.

In order to explore a practical framework for the long-term operation of the Bank, UNIDO has recently started a pilot operation which will concentrate on iron and steel industry sector amongst other sectors, identified by the Lima Declaration and Plan of Action on Industrial Development and co-operation adopted by the Second General Conference of UNIDO in March 1975.

We would like to establish an arrangement for complimentary exchange of publications, journals, documents and reports as applicable on the subject of iron and steel sector. We shall be glad to send to you UNIDO publications, journals, reports, etc. and would like to receive in exchange your published material in order to build up a bridge for mutual co-operation on the subject.

Yours truly,

sgd. G. S. Gouri

G. S. Gouri
Deputy Director
Industrial Operations Division

DRAKA OMROEP. 1945. m. free. Draka Kabel B.V., Hamerstraat 2, Box 1013, Amsterdam, Netherlands

FABRICATOR. 1971. bi-m. free to qualified personnel. Fabricating Machinery Assn., 129 Phelps Ave., Rockford, IL 61108.

FOOTE FOUNDRY FACTS. 1970. q. free. Foote Mineral Company, Ferroalloys Division, Route 100, Exton, PA 19341.

FOUNDRY WORKER. m. contr. circ. Amalgamated Union of Engineering Workers, Foundry Section, 164 Chorlton Rd., Brock's Bar, Manchester 16, England.

IRON WORKER. 1919. q. free. Lynchburg Foundry, A. Mead Company., P.O. Drawer 411, Lynchburg, VA 24505.

ISCOR NEWS/YSKORNUUS. (Text and summaries in Afrikaans and English). 1936. m. free. South African Iron and Steel Industrial Corp. Ltd., H.Q. Bldg., Wagonwheel Circle, Box 450, Pretoria, South Africa.

METALLURGICAL TRANSLATIONS. 1961. w. free. (British Industrial and Scientific International Translation Service). Metals Society, 1 Carlton House Terrace, London SW1Y 5DB, England.

NIPPON STEEL NEWS. 1970. m. free. Nippon Steel Corporation, 6-3 Otemachi 2-Chome, Chiyoda-ku, Tokyo, Japan.

STAINLESS. 1974. q. British Steel Corp., Market Promotion Dept., P.O.Box 64, ?ount Sheffiled S10 2PZ, England.

STAINLESS STEEL. 1965. bi-m. R.3 (Southern Africa Stainless Steel Development Assn.) Felstar Publishers (Pty) Ltd., Box 6977, Johannesburg, South Africa.

STEEL FACTS. 1934. q. free. American Iron and Steel Institute, 1000 16th St., N.W. Washington, DC 20036.

STEEL HORIZONS. 1938. q. free. Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh, PA 15222.

U S PIPER. 1928. q. free. U S Pipe and Foundry Co., 3300 1st Ave., North Birmingham, AL 35204.

U S STEEL NEWS. 1936. 6/yr. price not given. United States Steel Corp., 600 Grant St., Pittsburgh, PA 15230.

U S STEEL QUARTERLY. 1947. 3/yr. free. United States Steel Corp., 600 Grants St., Pittsburgh, PA 15230.

HOBARD WELDWORLD. 1940. q. free. Hobart Brothers Co., Hobart Sq., Troy, OH 45373.

Item no. 284 USA

(a) U.S. Bureau of mines, Dept. of the Interior informs in their letter of 11-10-77 that their organization would send the following publications of the U.S.B.M.

1) Mineral Industry Surveys: Iron ore (Monthly and Annual)
2) Preliminary, Iron and steel (Annual, Preliminary)
3) Preliminary; Iron and steel scrap (Monthly and Annual)
4) Minerals Yearbook (Preprints): Chapters on Iron ore.
5) Iron and steel and Iron and Steel Scrap.

Along with the above letter they have supplied (I) Preprints of the chapters on Iron ore and Iron and Steel from the 1975 edition of minerals Facts and problems, (II) Iron and Steel in 1976 (III) Iron ore in July 1917

(b) The metallurgical Society of AIME in response to request made in letter ID 452/7 is sending their monthly publication, Journal of Metals, on complementary basis.

Item no.52 Bulgaria

Iron and Steel Research Institute, Sofia, agreed vide their letter of 5-10-77 that they had accepted the proposal of UNIDO and have added UNIDO to their mailing list for free copies of their Journals "Metallurgia and Rudodobiv.

Item no.24 Argentina

Association de Industrials Metallurgicos, Buenos Aires, communicates in response that they could be, in future, approached for any information on the areas they are connected with. Their coverage includes production of forged and cast metals, wire products, tubes, structured sections up to finished products, steels resistant to electricity and combustion gases, road machinery, locos, machine tools etc. etc.

Item no.49 Brazil

Brazil Institute of Metallurgy assures that they will regularly supply the following publications copies of which they have sent.

1) IBS Revista no.20
2) IBS Statistics no.83
3) CIS Documentação no.29

D. Response from the external sources at the request from the UNIDO vide reference no.ID 452/7 from the Chief, Industrial Information Section.

1) Item no.38 and 39 Belgium

Centre de recherches metallurgiques C.R.M. had committed vide their letter of 22 August 1977 that they would send (a) their Metallurgical reports C.R.M. (b) They have also sent a 22 page list of periodicals, some of the issues of which they could supply on exchange basis.

From this list six items, may be of not direct use for iron and steel making, were selected. They are:

(I) Al Che Journal 1976, 22 (2)
(II) Analytical Chemistry 1975, 47 (10), 13
(III) Chemical age, New York 1976, 113, (2974, 29 92)
(IV) Chemical age of India, 1976, 27 (2. 5)
(V) Chemical Engineering News Letter 1976, Sept. Oct.
(VI) Chemical Engineering 1976, 83, (26 - 27)
(VII) Chemical Engineering Journal 1976, 11 (2)
(VIII) Engineering 1977, 244 (6307)

(c) C.R.I.F. list of publications 1975 1976.

2) Item no.22 U.K.

World Bureau of Metal Statistics regrets in their letter of 18 August 1977 their inability to cater in the field of iron and steel industry as they deal with non-ferous metallurgy.

3) Item no.108 Germany, Federal Republic of

The Study Group of the Iron and allied Metal Processing Industry, Dusseldorf, Germany, responds on 3-8-77 that they are connected with raw materials used in industries and they do not have any publications.

4) Item no. 4 Sweden

Swedish Institute for Metal Research does not directly handle the iron and steel making processes. They mainly study the problems on metallography, corrosion, analytical chemistry, Structural Metallurgy etc. They have sent a copy of their report about their organisation and activities.

5) Item no.97 France

Institute de Recherches de la Siderurgine France in their letter of

2-8-77 informs that their field of study is structural mechanics, metallography, foundry and transformation of materials. The have sent annual list of reports prepared in IRSID. They are in serial numbers from the period 1974-1976.

6) Item no. 191 Poland

Instytute Metallurgii Zelaza accepts the proposal of exchanging their publication "PRACE INSTYTUTU METALLURGII ZELAZA". A copy of issue no.4, 1976 was also enclosed.

7) Item no.26 Argentenia

Institute Agrentino de Siderurgia acknowledges in their letter of 30 August 1977 that they are agreeable to send their Journals: (I) Siderurgia and (II) Boletines Estadisticos.

8) Item no.217 Thailand

Applied Scientific Research Corporation of Thailand accepts the terms of exchange programme, and they have sent two copies of their publications on (I) Centrifugally Cast Iron Liners for I.C. Engine (II) Evaluation of a local mild steel converted arc welding electrodes, made with G.S. Steel Core Wires Report no.1 and 2.

9) Item no.266 U.S.A.

American Iron and Steel Institute along with their letter of 12 Sept. 1977 had sent a latest copy of their magazine "STEEL '77", but a subscription form also with an expectation of UNIDO being enrolled as a subscriber. They have also supplied a copy of Economies of International Steel Trade Policy Implications for the United States. This give comparative study of the competitive study of the U.S. steel industry in relation to that of Japan, World Steel export phenomenon in Europe and Japan. Trade in world steel 1950-1970 and the world supply/demand outlook: 1977-1985.

10) Item no.135 India

National Metallurgical Laboratory - C.S.I.R. offered to supply regularly the following publications (I) NML Technical Report - Annual (II) NML Technical Journal - Quarterly (III) Documented Survey on Metallurgical developments, an abstracting service from the current periodicals - monthly.

11) Item no. Madrid

The National Centre of Metallurgical Investigations has sent a copy of their publication entitled "Catalogo de Publicationes del Centro Nacional de Investigaciones Metalurgicas 1976.

INFORMATION-PROFILE ON IRONMAKING

1. This profile on Ironmaking contains 350 items in 100 pages. It has been compiled broadly to indicate the current status and thinking regarding the making of iron, mostly in the blast furnaces. The information was compiled on the basis of the in-house material available in UNIDO. This material, which itself is far from comprehensive, thus gives an incomplete and partial view of the material available with respect to a very narrow period of time, say, 1974-1976, and may have missed material that may be of greater relevance, as also that which may be of no use. All the same, in the absence of a pre-selection of the material and its scutiny, it is not possible to have an assurance about the comprehensiveness and quality of the data.

2. In spite of this shortcoming, the profile broadly covers the several ironmaking processes which are currently in vogue, such as electric ironmaking, ironmaking in the blast furnace, ironmaking in charcoal blast furnaces, etc. It omits any references to the several processes for direct reduction of iron ore which are in an advanced stage of technological investigation and experimentation.

3. In its approach, the profile mainly concentrates on the blast furnace process of ironmaking and on improving its performance and efficacy. This takes several directions, such as the reduction of the coke consumption and the associated steps, viz., injection of oil, powdered coal, etc., and the preparation of the burden. As claimed in an item of the profile (p.63 top), the best blast furnace of today works with about 380 kg of coke per ton of hot metal and 100 kg of fuel oil. The coke input is practically half of that in the average blast furnace and indicates the extent of advance that has been and can be made in this area.

4. The preparation of the burden has taken various directions such as sintering, pelletizing, briquetting and pre-reducing of the ore before its charging into the blast furnace. As the profile indicates, in some cases, attempts have been made to use 75% reduced iron ore briquettes called high iron briquettes (HIB) having an iron content of about 86% (p.16).

5. The profile also deals with the internal operation of the blast furnace such as the descent and distribution of the burden, the kinetics of chemical reaction within the furnace as well as the plant and machinery connected with the control of operation of the furnace, e.g., the operation of tuyeres. In some cases, it gives an indication of the future thinking regarding the blast furnaces, such as doubts expressed about the continuous growth of the size of the blast furnaces (p.2 item 2) as well as plans to control the operation of the blast furnaces through the manipulation of the volume composition, temperature and pressure of the up-moving gases, as in the proposed zone-controlled blast furnaces, which are still in the realm of investigative speculation. But in science and technology, what is speculation today is reality tomorrow, or after ten or fifteen years.

6. The profile thus attempts to give an indication of the current status and future trend in a small area of the iron and steel industry, although within a very very limited scope and comprehensiveness. It thus demonstrates and gives an idea of the possibility. A pilot operation, understandably, can only attempt and achieve this much. Information profiles with a much larger number of items on much narrower, specific aspects of the subject would be necessary to develop and refine this as a practical, viable instrument for technological or other decision-making.

7. After these inadequacies are removed, if would still be necessary to evaluate the information presented in this profile before any practical decisions for investments or operation can be taken on its basis. This will require the comparison of information of similar types, assessing their comparative reliability and practicability and connecting them up with numerous other related information before they can form the basis of any operative decision.

8. Cost data and estimated cost data on iron-making in blast furnace and electric furnace are incorporated in pages 10 and 8C3.

C o n t e n t s

669.16

Dancy, Terence E.

Evolution of Iron Making: The 1977 Howe Memorial Lecture

Development in iron making during the past thirty years are reviewed with reference to an improved understanding of the blast furnace process. Mention is made of blast modification, high blast temperature and agglomeration in contributing to the successful increase in size of blast furnaces. More recent developments in direct reduction are also described showing this method of iron making to be a viable technical and economic alternative to the blast furnace under certain circumstances. The effect of world fuel resources on the future evolution of iron making is discussed with reference to need for development of coal gasification not only for direct reduction but also for modified blast furnace practice.

(Metallurgical Transactions B. 8B No. 2, Jume 1977, pp 201-213.)

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669.1?

Steel-Making and Processing 4-Iron Making

K. LOWCOCK

SEAISI Quarterly January 74

PKt.

The article gives a general view of ironmaking processes which are classified into the general groupings of smelting and direct reduction processes. As well as general descriptions of the various processes, some discussions of the present and probable future considerations governing the balance between the alternative processes is included.

Unique electric ironmaking process

669.16 :
621.365.22 :
669.18.054.82

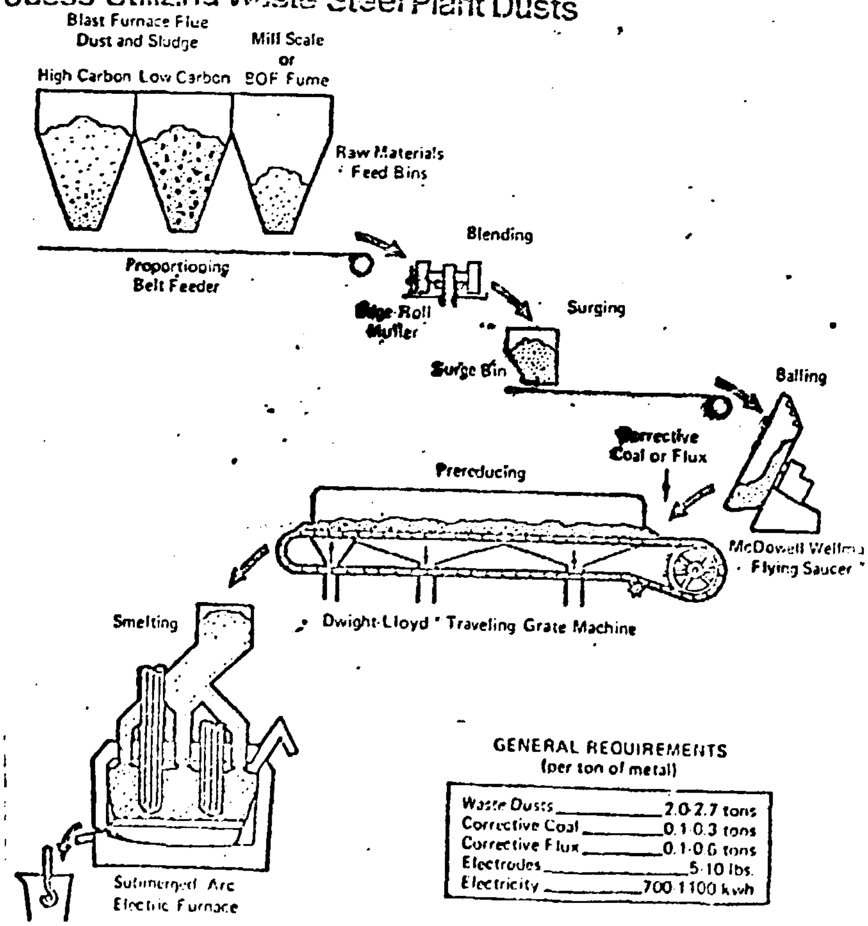
THE McDowell Wellman Engineering Co. recently completed a 30-day economic evaluation of the process using the pilot plant at its Dwight-Lloyd Research Laboratories. Results demonstrated that good profitability can be achieved at a throughput of only four ton/day.

Projected capital cost for a 500 to 1000 ton/day facility is between $25 and $50 million. The plant can be built on a relatively small parcel of land, which can help simplify planning and site selection and may also result in lower overall land acquisition costs. Overall construction costs are correspondingly reduced because there is no need for a coke plant, sinter plant, or extensive water treatment facilities.

The process uses electricity as the primary energy source, thus freeing it of the cost and availability problems of hydrocarbon fuels. With the advances in metallurgical technology, the process is freed from the need for high-grade or highly beneficiated ores.

Iron and Steel Engineer P-109
Sept 1975

Flowsheet for McDowell Wellman Electric Ironmaking Process Utilizing Waste Steel Plant Dusts



GENERAL REQUIREMENTS
(per ton of metal)

Waste Dusts	2.0-2.7 tons
Corrective Coal	0.1-0.3 tons
Corrective Flux	0.1-0.6 tons
Electrodes	5-10 lbs.
Electricity	700-1100 kwh

Estimated mill manufacturing cost of 1 ton iron produced by

(i)	Blast furnace oxygen blown process	£68.22
(ii)	Direct reduction - Electric furnace process (including water, industrial gases, lubricants, catalysts and refractories)	£50.44

Source: Ironmaking and Steelmaking, 1977, No. 5, P. 260, Table 4.

GERMANY

Krupp will build a $7,2 million blast furnace at its Rheinhausen plant with an annual capacity of 1,8 million tons.

IAMI SEP1974 P24

Construction costs for individual processes.

BF + LD

	0.5 million tons/year	1 million tons/year	3 million tons/year	6 million tons/year
Ironmaking	26.0	45.5	123.2	227.0

UNIT: Million dollars

Source: ID/WG/146/29, P.18, Table 3

Estimated mill manufacturing cost of 1 ton iron produced by

(i) Blast furnace oxygen blown process £68.22
(ii) Direct reduction - Electric furnace process £50.44
(including water, industrial gases, lubricants, catalysts and refractories)

Source: Ironmaking and Steelmaking, 1977, No. 5, P. 260, Table 4.

Developments in Iron-Making Practice. ([UN-IDO] Third Interreg. Symposium Iron Steel Ind. Brazil, Preprint, Oct.1973, [ID/WG. 146/4]. 6pp.) RIDGION J.M. Improved product control in modern iron-making practice was considered under the general headings: steelmaking requirements; burden preparation; aspects of high top pressure operation; and blast furnace control. The essential roleof S in determining the grade, and value of the blast furnace iron for LD steel making was emphasized. Features of modern charging practice were described, and problems arising from increased top pressures were discussed, with ref. to a blast furnace producing over 10,000 tonnes of iron/day. Aspects of burden preparation, and the advantages of using high basicity sinter pellets were indicated. 669.162.

Intensification of the Ironmaking Process M.Prouza (from Czech) (Hutn. listy, 1975, (4), 241-245) Factors at present supposed to be limiting the output of the blast furnace are discussed and it is argued that the present trend to enormous furnaces is not justified. (Price: £8) 669.162

42 0022 The Preparation of the Blast-Furnace Raw Materials. R Wild. J. West Scotland Iron Steel Inst., 1971-1972, 79, 71-[illegible] discussion, 88-96 [in English].
The significant increases in blast-furnace output and decreases in f[illegible] consumption during the past 20 years, largely attributable to improve[illegible] ments in raw-materials preparation, are illustrated. Ore crushing, blending, pelletizing, and sintering techniques, fuel technologies, and approaches towards relating burden properties with furnace operati[illegible] are described. Blast heating, humidification, compression, O enrichment, and high-top-pressure operation are discussed.—J. R. 669.162.1

Use of Pre-Reduced Material in the Blast Furnace and Its Economic Influence in Iron and Steelmaking. J.Gomez Saenz-Messia. (Steel Furnace Monthly, Jan.1975, 10, (1), 7-38) Historical developments in the size and capacity of the blast-furnace and in its ore, coal, and coke requirements are reviewed with ref. to fuel economy. Pre-reduction of the metallic charge is discussed, its effect on costs, productivity, energy distribution, and other factors are indicated, and details and locations of processes in present use are tabulated. Pre-reduction to 50% metallization could increase pig-iron production in Spain by 1.8 X 10^6 tons/year without additional blast-furnaces, or reduce the coke requirements by 780 000 tons. 669.162.1 622.3-15

669.162.1:
622.341.1-185

42 0129 Experimental Smelting, when Charging Blast Furnaces with a Mixture of Coke and Sinter. V. I. Loginov, S. M. Solomatin, and A. T. Korzh. Metallurg, Apr. 1976, (4), 14-18 [in Russian].

Distribution of materials over the cross-section of a blast furnace, charged with a mixture of iron ore and coke, was investigated using models and real blast furnaces of 600 and 1386 m^3 in volume. In comparison with ordinary charging, the iron-ore component of the charge was distributed more uniformly; this resulted in an improvement in the utilization of the thermal and chemical energy of the gas, a reduction in coke consumption by 3-5%, an increase in furnace productivity by 2%, an increase in CO_2-content in the blast furnace gas, and an increase in the iron-ore charge by 5-12%.—L. G.

669.162.1
622.341.1-782

42 0140 The Production of Self-Fluxing Pellets and Their Utilization in the Blast Furnace. K. Taguchi, K. Aketa, and T. Matsumoto. Rev. Métall., Mar. 1976, 73, (3), 247-258 [in French and English].

The production of self-fluxing pellets from ore and limestone and operating experiences at a Japanese steelworks are described. Thorough quality control is required to ensure consistent pellets. Up to 80-85% of self-fluxing pellets in the blast furnace burden has been achieved, but thin smooth shape causes problems in burden stability. Experiments have been made in which 'jumbo pellets' of 25 mm dia. were produced and crushed to give angular particles and this appears to overcome the problem.—P. C. K.

669.162.1:
669.054.82:
669.184.28

42 0215 Steelmaking Slag—A Blast Furnace Feed. G. G. W. Thom and J. K. Wood. Proceedings of the 32nd Ironmaking Conference AIME, 1973, 363-369 (Met. A., 7407-72 0669) [in English].

Current practices at Steel Co. of Canada in using steelmaking slag as a low-cost substitute for some of the raw materials in the blast-furnace burden are reviewed. The material replaced a substantial amount of fluxes, all the siliceous ore, and is believed to lower coke rates. The fluctuations in hot metal Si and S appear to be less with the steelmaking slag. Increases in Mn . . Cr have created some problems in the steelmaking department but have also resulted in small savings in ladle alloy additions.—M. M. R.

669.162.1:
622.72

42 0022 The Preparation of the Blast-Furnace Raw Materials. R. Wild. J. West Scotland Iron Steel Inst., 1971-1972, 79, 71-[illegible]; discussion, 88-95 [in English].

The significant increases in blast-furnace output and decreases in f[illegible] consumption during the past 20 years, largely attributable to improvements in raw-materials preparation, are illustrated. Ore crushing, blending, pelletizing, and sintering techniques, fuel technologies, and approaches towards relating burden properties with furnace operation are described. Blast heating, humidification, compression, O-enrichment, and high-top-pressure operation are discussed.—J. R.

42 0217 Basic Oxygen Furnace Slag as a Blast Furnace Raw Material. J. L. Pugh and L. N. Fletcher. Proceedings of the 32nd Ironmaking Conference AIME, 1973, 374-376 (Met. A., 7407-72 0069) [in English].

The benefits and drawbacks of recycling of BOF slag in the blast furnace are discussed, with data from operating practice. The benefits are: the excess bases are recovered; the Fe is recovered; the Mn is recovered; the use of calcite is eliminated on furnaces with high MgO slag practice; the disposal problem is eliminated. The drawbacks are: the large variation in chemical analysis; reduction in production; presence of alkalis; difficulty of handling the material if not prepared.—M. M. R.

669.162.1;
669.054.82
669.184.281

42 0216 BOF Slag in Blast Furnaces, Pro and Con. Warren R. Rombough. Proceedings of the 32nd Ironmaking Conference AIME, 1973, 370-373 (Met. A., 7407-72 0069) [in English].

At Dominion Foundries and Steel, Ltd., Canada, either openhearth or BOF slag has always been used in the blast furnace to a greater or lesser degree. It was found that the hot metal Mn content can be maintained without use of special manganiferous ores, and can reduce coke consumption, all by reusing a waste product. Methods of preparing and using the slag are described.—M. M. R.

669.162.1;
669.054.821
669.184.285

A Study on the Reduction of Various Iron-Bearing Materials. L. Krol. J. Buzek, and J. Dankmeyer-Laczny. (Hutnik (Katowice), July-Aug. 1974, 41, (7/8), 335-340) (In Pol)

Laboratory investigations on the degree of reduction adn the behaviour during the reduciton process of various iron-bearing materials, used in the blast furnace process are reported.

669.162.12

42 0210 Mass-Production of Self-Fluxing Pellets and Their Introduction Into Large-Capacity Blast Furnaces. ——. Research and Development in Japan Awarded the Okochi Memorial Prize 1975, 1975, 60-64 (Met. A., 7605-72 0068) [in English].

Because the iron and steel industry in Japan depends largely on imported ore from many sources, it was necessary to develop an agglomeration method that would be adaptable to mixtures of various kinds of ores. In pelletizing, limestone is added to the fine ore to provide the fluxing action in the blast furnace. A "dry mixed grinding system" was developed, and accurate temp. control in grate and kiln is assured by use of computers. Comparative data on quality and properties are given for the basic self-fluxing pellets, imported acid pellets and self-fluxing sinter. Bast-furnace operating data are shown.

669.162.14
622.341.1-18

42 0555 Coke as Part of the Blast Furnace Charge. Wladyslaw Sabela. Hutnik (Katowice), Apr. 1973, 40, (4), 151-157 [in Polish]. [Received 1975]
The role of coke in the blast furnace is discussed with particular ref. to its function in the furnace bosh. The possibility of reducing the proportion of fines formed in the furnace by a stabilizing pre-treatment is considered. A narrow size fraction scatter and a somewhat larger mean size of coke, the choice of which depends on the furnace size and slag volume, are necessary for good operation.

Metallurgical Coal For Iron & Steel Industry

JAMES A. GREGORY

SEAISI Quarterly April 75

The major field of usage of metallurgical coal in the iron and steel industry is of course the production of coke for the iron blast furnace. In this paper the selection of suitable coal is dealt with as an exercise in coke evaluation at the blast furnace underbin screen rather than at the coke ovens wharf.

Typical coal and coke analyses for the Australian iron and steel industry are given and the importance of plant transport breakage of coke is emphasised in relation to selection of future coal blends. Coal and coke evaluation carried out at the Newcastle Works Research Department of the Broken Hill Pty.Company Limited (BHP) is described.

Whilst recognising the areas of uncertainty still remaining in respect to in-furnace performance of blast furnace coke, emphasis is given the importance of coke evaluation, not only in terms of the generally accepted abrasion strength tests, but in terms relating to plant transport breakage which determines the yield of lump coke at the furnace. It is demonstrated that the yield of coke from transport breakage must be measured by pilot plant simulation because, although there is a strong relationship between transport breakage and standard abrasion results, the unaccounted for variance between the two is such that accurate prediction of breakage from abrasion indicies is not possible.

... Coke for Large Blast Furnaces. Tadashi Ikeda. Technical Reports of the Latin American Seminar on Carbon and Coke for the Iron and Steel Industry, 1973, 93-116 [Met. A. 7502-72 0031] [in Spanish].
Properties of coke for large-size blast furnaces and the necessary technology of such coke are discussed. Properties of coke for blast furnaces of 4000 m^3 capacity producing 10 000 tons/day are reviewed, as well as the technology to produce such cokes, as developed in Japan. At Nippon Steel Corp., ~30% of the C charge is in the form of briquettes; advantages obtained are listed.--F. R. M.

The Effect of the Properties of Metallurgical Coke on Blast Furnace Efficiency. I Janik, F Pavlik, L.Brudny, and H.Schmidt. (Hutnik (Prague), Jan.1975, 25, (i), 5-9) (in Cz.) By increasing the ash content by 1% the coke consumption was reduced by 1.6% but the blast-furnace efficiency was reduced by 1%. After introduction of limestone the coke consumption decreased by 2% but the efficiency was reduced by 1.4%. Increasing the shatter-index of the coke also affected coke consumption and blast-furnace efficiency.

42 0676 Development in the Production of Metallurgical Coke and Their Application to Latin-American Coals. Toshio Ikeshima, Kiyoshi Sugasawa and Kyoichi Akamatsu. Rev. Latinoam. Sider., Nov. 1975, (187), 62-73 [in Spanish]. Methods in use and under study in Japan to reduce the consumption of coking coal by extending the range of coals that can be used for coking purposes are described; the quality of the products obtained and results of blast furnace trials of the production are discussed. Briquetting techniques are suggested for use with certain Brazilian, Chilean, Venezuelan and Mexican coals. The combination of petroleum pitch and high-volatile noncoking coal as a substitute for medium-volatile coking coal may have applications with high-volatile coals found in Brazil, Chile, Venezuela and Colombia. Promising results of experiments with blends containing Brazilian coals indicate that the D. K. S. formed coke process would be highly suitable for use with noncoking Latin American coals.—S. M.

Coal for Blast Furnace Injection. L.N. Fletcher and A.K. Garbee. (Energy-Use and Conservation in the Metals Industry, Proc. Symp. 104th Annual Meeting AIME, 1975, 203-217). The tuyere level injection of pulverized coal is currently practiced at the Ashland, Ky., blast furnaces of Armco Steel Corp. More than 600 000 net tons have been injected. This technique is utilized to replace part of the blast furnace coke requirements. Using metallurgical for injection, 1.1 lb. of coke are replaced/lb. of coal injected. Nonmetallurgical coals have also been used. The higher-ash injection coals are reported to replace 0.78 lb. of coke/lb. of coal injected. Low-ash noncoking coals have potential for maximizing replacement ratios. Injected coals are shown to influence hot metal chemistry.

6

669.162.16

Studies of Coke Degradation in the Blast Furnace. W.Hyslop and H.C.Wilkinson. (Consistent Iron, 1975, 38-51 Metals Society Pub.) A procedure has been developed for sampling coke from the tuyere openings of blast furnaces, and a limited number of tests have been carried out to determine the changes in coke properties as the coke travels from the final skip screens to the tuyeres. Physical tests were carried out on the coke samples from skip and tuyere and the results were used to deduce the extent of breakdown suffered by the cokes. An examination was also made of the chemical properties of the cokes and of their behaviour under oxidizing conditions. It was observed that there is inevitably a degree of size reduction of the coke on its passage through the furnace, but the extent varied round the furnace periphery. The size reduction was also greater in higher-output furnaces and was accompanied by a decrease in coke strength and abrasion. The relevance of existing physical tests with regard to coke degradation in blast furnaces is discussed in the light of experimental data presented.

669.162.16.

Development of the Quality of Two Cokes Used at Sacilor-Rombas. Effects on Blast-Furnace Operations. (Centre Document. Siderurgique C. [illegible]ul. Inform.Techn., 1973, 30, (6), 1501 - 1514) (In Fr) VASSE R. The particle size, humidity and other properties of two types of coke, used in the Rombas blast furnaces, are compared. The influence of these properties on the rate of descent of the charge and on the operation, productivity and fuel consumption of a blast furnace is examined.

669.162.16

42 0088 **Effect of Different Size Ranges of Coke on the Operation of a 7.8-Meter Hearth Diameter Blast Furnace.** Ernst Teichert and Vishwa Nath Gupta. Stahl Eisen, 15 July 1976, 96, (14), 662-666 [in German].

The effect of different ranges of coke size on the operating parameters of a blast furnace was examined. The best operating conditions were achieved using sinter with an average dia. of 11 mm and coke in the range 40 to 80 mm dia. Gas-permeability tests in the laboratory showed that max. pressure loss is always encountered at the sinter/coke interface, but with 40 to 80 mm coke the penetration depth of sinter was low. 7 ref.- BA

42 0040 Savings in Metallurgical Coke [in the Blast Furnace]. Antonin Zygma and Ludvik Tejzr. Hutnik (Prague), Nov. 1974, 24, (11), 402-405 [in Czech]. 669.162.16

An increase in blast temp. from 1100 to 1200 °C decreased coke consumption in a blast furnace by 2.1% and increased productivity by 1.6%. The coke consumption in the blast furnace fell to 495 kg/ton. —M. L.

Armco Coal Injection. S.A. Bell, J.L. Pugh and J.R. Sexton. (Iron Steelmaker, Aug. 1975, 2, (8), 24-31) 669.162.16

Production trials with pulverized coal injection in steelmaking at two Armco Steel Co. sites are described. The use of powdered coal as a fuel in blast furnaces was first attempted in early 1966 in Armco's Bellefonte blast furnace and leater in the Amanda blast furnace. Flow-sheets for both systems are shown. Over 700 000 tons of coal have been injected through tuyers of these two blast furnaces to date. The Amanda system is a second generation design and employs a low-pressure air system (2.0 lb/in² gauge max. against 35-45 lb/in² gauge in the Bellefonte system). Important problems that had to be solved during operations were explosion suppression and ash removal. The former was solved by using halogenated hydrocarbon explosion suppressants and the latter by a combined cyclone and bag house filter subsystem.

42 0179 Quality of Cokes for High-Production Blast Furnaces. D. Sanna. Centre Document. Sidérurgique Circul. Inform. Techn., 1974, 31, (9), 1853-1858 [in French]. 669.162.16.003.1

In a blast furnace charge, only coke remains refractory, ensuring permeability at high temp. when other materials become liquid and flow towards the hearth. Its role in a high-production furnace was examined and two zones were distinguished: a two-phase (gas + solids) region occupying most of the furnace; and a three-phase (gas + solids + liquids) region in the lower part where gas and liquids flow through the coke. A study of the phenomena in the two-phase region shows that coke should be produced under good conditions, thermally stabilized, and sifted to remove the largest pieces. —J. M. S.

Certain Measures to Economise Coke Consumption in Blast Furnaces. S.S.Khanna, R.Sharan, and N.P.Saksena. (Tool and Alloy Steels, Nov.-Dec.1974, 8, (6), 53-56). Methods examined for the possible reuction of coke consumption are coke briquetting; sinter production; pelletizing of ore fines; use of high top pressure; injection of coke oven gas, natural gas or fuel oil, coal-powder injection, artificial humidification of the blast and charging of sized burden for greater permeability. 669.162.16.003.1

42 0194 Measures to Increase the Productivity of Blast Furnace Processes and Plants and to Reduce Coke Consumption in the Blast Furnace. N. Nakamura, Y. Ishikawa, and M. Tateoka. Internat. Iron Steel Cong., Düsseldorf, 1974, Preprints, 1974, (Vol. I), 2.1.1 1-16 (Met. A., 7501-72 0017) [in English].

669.162.16,003.1

Blast furnace productivity is determined by the combustion rate of the fuel, and the quantity of fuel charged. Measures which effectively increase blast furnace productivity include O enrichment, high top pressure, high blast temp. up to 1350 °C, oil injection, and an increase in furnace size. The properties of the sinter and coke can affect the improvements attainable, and further research is required into the blast furnace reactions, and the distribution of the softening and cohesive zones.—P.C.K.

669.162.16,004

The Effect of the Properties of Metallurgical Coke on Blast Furnace Efficiency. I Janik, F Pavlik, L. Brudny, and H. Schmidt. (Hutnik (Prague), Jan. 1975, 25, (1), 5-9) (in Cz.) By increasing the ash content by 1% the coke consumption was reduced by 1.6% but the blast-furnace efficiency was reduced by 1%. After introduction of limestone the coke consumption decreased by 2% but the efficiency was reduced by 1.4%. Increasing the shatter-index of the coke also affected coke consumption and blast-furnace efficiency.

669.162.16,00

Quality of Cokes for High-Production Blast Furnaces. (Centre Document. Siderurgique Circul. Inform. Techn. 1974, 31, (9), 1853-1858) (In Fr). SANNA. D. In blast furnace charge, only coke remains refractory, ensuring permeability at high temp. when other materials become liquid and flow towards the hearth. Its role in a high-production furnace was examined and two zones were distinguished : a two-phase (gas + solids) region occupying most of the furnace., and a three-phase (gas + solids + liquids) region in the lower part where gas and liquids flow through the coke. A study of the phenomena in the two-phase region shows that coke should be produced under good conditions, thermally stabilized, and sifted to remove the largest pieces.

Changes In Coke Properties in Blast Furnaces. K. Kojima et al (from Jap.) (Tetsu-to-Hagane, 1976, 62, (5), 570-579) 669.162.16: 539.56

From the dissections of quenched blast furnace contents the changes in coke properties (Strength and particle form) were observed in the various zones of the lump and softening-melting regions. The mechanisms by which these changes occur are discussed. (Price:- £ 17.00)

669.162.16
539.56

Structure and properties of cokes in the blast furnace

N. L. GOL'DSHTEIN, D. M. ZLATOUSTOVSKII, N. N. ZVEREVA, and V. . ZEMLYANSKOV

The reactivity and structure of the following cokes have been investigated by means of the X-ray diffraction method: skip, taken from the tuyeres and slag-notch region, and potash-impregnated skip. As coke passes through the blast furnace its impregnation with alkali-metal compounds results in a sharp rise in reactivity, and the structure and physicochemical properties become equalized, so that the normally determined reactivity for skip coke does not characterize coke behaviour in the blast furnace. As coke descends the furnace its degree of graphitization increases.

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Izvestiya VUZ Chernaya Metallurgiya, 1976, (4), 35–39

V42 0328 An Analysis of the Effect of Coke Characteristics and Other Operating Variables upon Blast-Furnace Performance. John J. Quigley and Nathaniel Sayles. Proc. 33rd Ironmaking Conf., Atlantic City, April 1974, 1974, 157-166 (Met. A., 7603-72 0040) [in English]. 669.162.16: 543

An investigation of the relationship between, coke characteristics, hot-metal chemistry, slag characteristics, metallic burden, wind rate, and oil rate is described. The results are used to develop statistical models for evaluating present and future furnace performance.
—R.E.

Consistent Iron Quality. J. Dartnell. (Ironmaking and Steel-making, 1975, 2, (2). 95-101). To supply steelmaking plants with iron of consistent quality, stable blast-furnace operation must be achieved. The blast furnace must be charged with raw materials of consistent chemical and physical quality, and thermal stability must be maintained. Slag chemistry exerts major effect on iron analysis. The control of coke, sinter, other raw materials, burden: coke ratio, and blast-furnace conditions are discussed. The production of iron of consistent quality will require considerable capital expenditure, particuarly in the area of materials preparation. 669.162.16: 543.536

Studies of Coke Degradation in the Blast Furnace. W. Hyslop and H.C. Wilkinson. (Consistent Iron, 1975, 38-51 Metals Society Pub.) A procedure has been developed for sampling coke from the tuyere openings of blast furnaces, and a limited number of tests have been carried out to determine the changes in coke properties as the coke travels from the final skip screens to the tuyeres. Physical tests were carried ou on the coke samples from skip and tuyere and the results were used to deduce the extent of breakdown suffered by the cokes. An examinatio was also made of the chemical properties of the cokes and of their behaviour under oxidizing conditions. It was observed that there is inevitably a degree of size reduction of the co on its passage through the furnace, but the extent varied round the furnace periphery. The size reduction was also greater in higher-output furnaces and was accompanied by a decrease in coke strength and abrasion. The relevance of existing physical tests with regard to coke degradation in blast furnaces is discussed in the light of experimental data presented.

669.162.16.004.2

42 0113 Coke and Its Influence on Blast Furnace Aerodynamics. V. Giedroyc and W. Hyslop. Symposium on Blast-Furnace Aerodynamics, University of New South Wales, Wollongong, Australia. 1975, 86-93 [Preprint-English].

It is shown that coke has a major influence on the pattern of operation and on the aerodynamics of the blast furnace and that the physical and chemical characteristics of coke, at each stage in the furnace, determine its ability to satisfy requirements for Fe production and coke economy. Analysis of coke sampled from operating furnaces is compared with furnace behaviour. The available data suggests the importance of segregation, strength, size change and chemical degradation of coke on furnace performance. Correlations are presented for coke breakdown ratio as a function of coke rate and hearth dia. which show that breakdown increases with hearth dia. and with decreasing coke rate. It is also shown that the Micum tests do not reflect the coke strength in a predictable way and that solution reactions appear to play an important role in giving rise to a pitting effect on the cell walls of the coke with the resultant deterioration in coke properties. The catalytic effect of activating substances, such as alkalis, is noted and results are presented which show the effect of C solution on the coke strength. The importance of coke in the stack and in the bosh is discussed and flooding results are presented for British Steel Corp. (BSC) furnaces which show the probable driving limits for the furnaces considered. It is also shown that coke sampled from different tuyeres in a furnace gives quite different flooding limits. Other applications of the coke test work at BSC are also noted and the relevant objectives listed. 9 ref.—AA

669.162.16
533.6

Permeability Behaviour of Formed Coke-ore and Lump Coke-Ore Systems. H.J. Schltz and O. Abel (from Ger.) (Arch. Eisen., 1974, 45, (5), 279-285). Measurements were made in permeability tubes of various layer systems of ore and coke, using formed coke, lump coke and pellets to determine pressure loss, and the results are applied to blast furnace practice to determine the charging schemes with the minimum pressure loss. (Price: £8.00).

669.162.16;
539.217.2;
662.749.2

Certain Measures to Economise Coke Consumption in Blast Furnaces. S.S.Khanna, R.Sharan, and N.P.Saksena. (Tool and Alloy Steels, Nov.-Dec.1974, 8, (6), 53-56). Methods examined for the possible reuction of coke consumption are coke briquetting; sinter production; pelletizing of ore fines; use of high top pressure; injection of coke oven gas, natural gas or fuel oil, coal-powder injection, artificial humidification of the blast and charging of sized burden for greater permeability.

669.162.16
622.231
622.78

Progress Achieved In The Blast-Furnace Process. Z. Radominski (from Pol.) (Prace Inst. Hutn., 1973, 25, (1-3), 25-32)
Reduction of coke rate by injection of natural gas and of non-coking coals as lumps or as powder has been studied in Poland; the equipment for coal grinding and injection is shown. (Price:- £ 9.00)

669.162.16
662.69

42 0206 *Size Grading of Metallurgical Coke and Blast-Furnace Working.*—II. Yu.S. Karabasov, A.N. Pokhvisnev, and A.A. Olisov. Izvest. V.U.Z. Chernaya Met., 1974, (7), 26-29 [in Russian].
Cf. ibid., (5), 24; Met. A., 7502-42 0081. An analytical sample was developed for the more accurate determination of the average size of the pieces of coke.—M. L. T.

669.162.16
622.74

Blast Furnace Operation on Formed Coke. (Stal', Nov.1974, (11), 977-981. (in Rus); Steel in the U.S.S.R. Nov. 1974). NEKRASOV, Z.I MAZOV, V.F. GLADKOV, N.A. ZHEMBUS, M.L. and DYSHLEVICH. I.I. Formed coke, obtained by a continuous process from cheap and plentiful coals possessed high hot and cold strengths, and an improved uniformity in size grading, compared with normal blast-furnace coke. Trials, carried out in a blast furnace (700 m^3 volume), confirmed that the formed coke behaved satisfactorily, and that the productivity of the furnace was marginally improved. The formed coke maintained its strength and shape in its descent down the stack, thus enabling a sufficiently high gas permeability to be maintained in the stack column.

669.162.16
662.749.2

42 0055 Use of ICEM [Romanian Ferrous Metallurgy Institute] Formed Coke in the Blast Furnace and in Other Applications. I. Barbu and I. Stefănescu. J. Iron Steel Inst., Oct. 1973, 211, (10), 685-688; discussion, 726 [in English].

669.162.16
662.749.2

Experiments are described made between 1960 and 1970 in the production of formed coke in the USA; in Belgium at the low shaft experimental blast furnace, where cokes made by the Carmonolx and the Bergbauforschung processes were tested; in Poland, where results were inconclusive, and in Russia where Sapozhnikov formed coke was tried. Romanian work of the period 1955-1965 is described, when formed coke made by the ICEM process was successfully used in blast furnaces making both foundry and steelmaking pig irons. It is stressed that out of all the processes only the ICEM, and possibly the Sapozhnikov and the Bergbauforschung, gives a structure similar to that of metallurgical coke, because coking proceeds, in this process, in a way similar to that in which the coking of coking coal takes place It is claimed that replacement rates of 1 ton, or less, per ton of metallurgical coke have been attained, and that the material has many other uses, in the foundry and for anodes. 39 ref.—BA

Coal for Blast Furnace Injection. L.N. Fletcher and A.K. Garbee. (Energy-Use and Conservation in the Metals Industry, Proc. Symp. 104th Annual Meeting AIME, 1975, 203-217). The tuyere level injection of pulverized coal is currently practiced at the Ashland, Ky., blast furnaces of Armco Steel Corp. More than 600 000 net tons have been injected. This technique is utilized to replace part of the blast furnace coke requirements. Using metallurgical for injection, 1.1 lb. of coke are replaced/lb. of coal injected. Nonmetallurgical coals have also been used. The higher-ash injection coals are reported to replace 0.78 lb. of coke/lb. of coal injected. Low-ash noncoking coals have potential for maximizing replacement ratios. Injected coals are shown to influence hot metal chemistry.

669.162.161
662.87

42 0569 Armco Uses Pulverized Coal Injection at Ashland. C.J. Labee. Iron Steel Eng., Aug. 1976, 53, (8), 51-52 [in English].

669.162.16;
662.87

Blast furnace injection systems hold prospects for added economy by using pulverized coal to replace up to 30% of the coke used in the charge (up to 40% if added O is used). A description of the process and equipment employed at the facility includes a photograph of the blow pipe and fuel line assembly and a system flow diagram indicating equipment interface. Several years of operating experience with the system have proven the cost saving advantage in its use of the cheaper, more abundant, nonmetallurgical coal.—J. B. T.

Armco Uses Pulverized Coal Injection at Ashland. C. J. Labee. (Iron Steel Eng., Aug. 1976, 53, (8) 51-52)

669.162.161
662.87

Blast furnace injection systems hold prospects for added economy by using pulverized coal to replace to 30% of the coke used in the charge (up to 40% if added O is used). A description of the process and equipment employed at the facility includes a photograph of the blow pipe and fuel line assembly and a system diagram indicating equipment interface. Several years of operating experience with the system have proven the cost saving advantages in its use of the cheaper, more abundant, nonmetallurgical coal

669.162.16
662.87

Coal-dust injection into the blast-furnace hearth

A. A. YARMAL', S. L. YAROSHEVSKII, L. R. RUZHINSKII,* L. Z. SUPLIN, and A. I. RYABENKO

The existing equipment for the injection of coal dust into the hearth of a blast furnace 700 m³ in volume at the Donetsk works has been improved, and new equipment developed. A brief description is given of an aeration feeder with adjustable and individual coal-dust feed to each of the 12 tuyeres; the layout of the automatic systems in the distribution and feed department is shown. Arrangements for introducing coal dust into the tuyere and blowpipe are described. During industrial use of the installation in 1972 - 74 (360 d) the coal-dust consumption reached 60 - 80 kg/t pig iron; good technico-economic indices were obtained.

Stal', 1976, (9), 788--792
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669.162.014.7
669.162.26

42 0134 **A Method for the Selection of the Charge Size for a Blast Furnace.** A. I. Bondarenko and M. Ya. Ostroukhov. Izvest. V.U.V. Chernaya Met., 1973, (4), 33-34 [in Russian].
The charge size is dependant upon the gas permeability of the ore fraction of the charge. The gas permeability can be expressed as the volume of gas passing through the furnace in unit time, and is proportional to the air consumption. An equation has been derived such that $P = 5 \times 10^{-4} \cdot Q^{1.34}$, where P is the charge supply size in tons and Q, the volume of air, injected under normal conditions, in m³/min.

669.162.16
669.162.263.4

Changes In Coke Properties in Blast Furnaces. K. Kojima et al (from Jap.) (Tetsu-to-Hagane, 1976, 62, (5), 570-579)
From the dissections of quenched blast furnace contents the changes in coke properties (Strength and particle form) were observed in the various zones of the lump and softening-melting regions. The mechanisms by which these changes occur are discussed. (Price:-

669.162.16
669.162.263.4

Stal', 1975, (11), 977–981
STEEL IN THE USSR Nov '75 P 899-901

Coke reactivity in the blast furnace

N. L. GOL'DSHTEIN, D. M. ZLATOUSTOVSKII, N. N. ZVEREVA, and V. A. ZEMLYANSKOV

The gasification rate of different cokes has been investigated in laboratory conditions during reaction with CO_2 and H_2O diluted with nitrogen to the concentration in blast-furnace stack gases, and with the addition of reducing agents (30% H_2 or 30% CO) at various gas-mixture consumptions. Tuyere coke is considerably more reactive than skip coke as a result of impregnation with alkali-metal oxides $K_2O + Na_2O$, producing a change in crystal structure. In experiments this can be simulated by impregnation with potassium carbonate. The differences in the degree of oxidizing-agent conversion observed in the experiments almost disappear under blast-furnace conditions. Attempts to lower the coke rate by changing its initial reactivity are evidently unpromising.

(14)

Effect of coke reactivity on its consumption in blast furnace. (Hutnicke Listy, Dec. 1973, 28, (12), 833-839) 669.162.16; 669.162.263.4

MALY, J. Coke consumption in a blast furnace is not directly related to its reactivity. Although a high reactivity decreased coke consumption, the total effect of coke reactivity can be considerably influenced by other coke properties. The values of coke reactivity were not sufficient alone to evaluate coke properties in the blast furnace. At 1100°C coke reactivity increased probably as a result of the etching of the coke surface by CO_2.

669.162.16; 669.162.263.4

42 0431 Modelling the Coke-Segregation Processes in the Tuyere Zone of a Blast Furnace. V.G. Manchinsky. Stal', Mar. 1974, (3), 201-203 [in Russian].

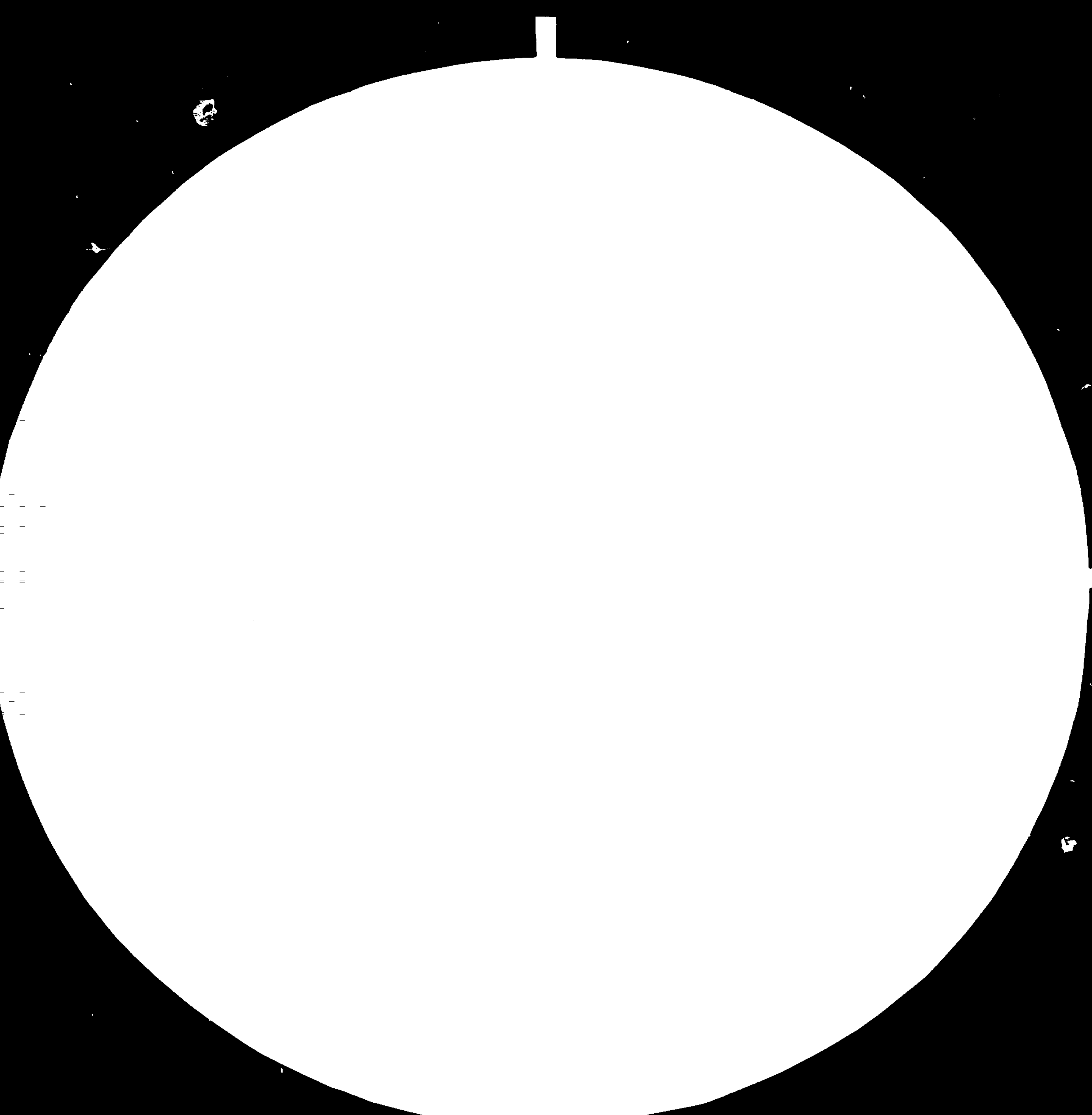
The gas stream in the tuyere zone of a blast furnace was simulated using a hydraulic model, with graduated water flow, and broken porcelain fragments, of graded sizes. Dry ice was also used to simulate coke combustion, and further tests were made with dyed NaCl grains of different sizes. The tests illustrated that coke fires will concentrate in a narrow layer immediately above the raceway zone. The gas pressure drops in this layer should be approx. eight times greater than the specific pressure drops in the bosh parallel to it. The concentration of fines resulting from the use of low-strength coke, is one of the reasons for uneven blast-furnace operation, and a reduction in the lower size limit of lower-strength coke cannot be tolerated.—J.W.

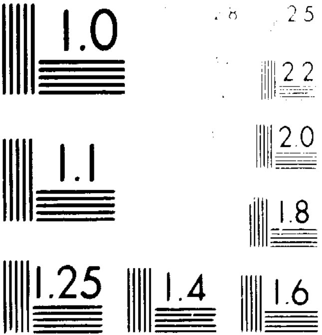
Development In Blast Furnace Equipment Design. B. Kolarz (from Kolarz (from Czech) (Hutnike Listy 1975 (10) 697-701) 669.162.2

The increased size of blast furnaces and the greater output required form them has led to various improvements in cooling systems, charging equipment, where arrangements for sealing and charge distribution have been separated, better arrangements for teeming, raised blast temperature and so to improvements in stove design. (Price:-£ 7.00)

Replacing The Charging Apparatus of a Large Blast Furnace. V.I. Stekachev, V. M. Gratsilev, and V.K. Kayuda. (Metallurg, Aug. 1975, (8), 14-16) (In Rus.) 669.162.2

A new method of replacing the charging device of a blast furnace of 3200 m³ capacity was developed. Dismantling and mounting of the device were accomplished in shorter time by means of two large blocks, each weighing 175 tonnes, with the aid of hoists and special suspension supports.





1.0
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

669.162.2

Concepts for an improved blast furnace system

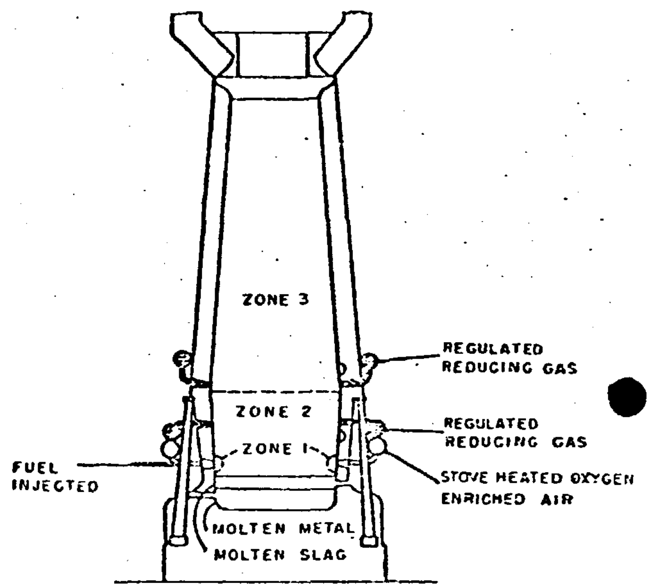
H. B. Claflin, Manager—Special Projects, Steel Manufacturing Div., Kaiser Steel Corp., Fontana, Calif.

Iron and Steel Engineer

November 1976

A zone-controlled modified blast furnace is closely regulated by adjusting, in a unique manner, the volume, composition, temperature and pressure of the upward moving gas stream.

Fig. 1 — Outline of an improved blast furnace design.



669.162.2

A Modern High-Capacity Blast Furnace. The No.4 Blast Furnace at Dunkirk. (Centre Document. Siderur-gique Circul.Inform.Techn.,1973,30 (6),1515 -1526) (in Fr) CORDIER.J. Factors tending to make a large blast furnace more economical than two of equivalent capacity are considered. Difficulties in operating very large furnaces are discussed and solutions are proposed. Some characteristics of blast furnace No.4 at Dunkirk having a hearth dia.of 14 m and producing about 10 000 tonne/day are detailed.

Operational Limitations of Blast Furnaces. B.N. Mojumder and R.G. Gupta. (Trans. Indian Inst. Met., June 1975, 28, (3), 217-224) 669.162.2

Factors which limit the incorporation of improvements in blast-furnace practice are discussed with ref. to the use of high blast temp., high top pressure, and O enrichment of the blast. The effect of degradation of the sinter during the reduction on the productivity of blast furnaces is described, and consideration is given to blast-furnace size and to the number of blast furnaces which can be installed in a particular plant.

669.162.2(51)

H. WEIDENMULLER
K.M. SINHA

The first Blast Furnace of China Steel Corporation in Kaohsiung

In the middle of 1977, the first blast furnace of China Steel Corporation in Kaohsiung will go into production. This blast furnace is designed and built by DEMAG of West Germany. The overall layout of the blast furnace plant shown in Fig. 1 which is part of the first construction phase of an integrated steel plant with an initial annual capacity of 1.5 million tons of crude steel, located in Kaohsiung.

The project includes an ore preparation and sintering unit as well as a coke oven plant, steel- and rolling mills. The aim of this plant would be to reduce the import of certain industrial goods and to meet the growing need of steel. This island has very few raw material resources of its own. Iron ore, pellets, coal, fuel oil and fluxes etc. have to be imported. The lump ore and coking coal are mainly imported from Australia and the U.S.A.

SEAISI Quarterly April '77 P16

669.162.2 (477)

THE WORLD'S BIGGEST BLAST FURNACE

SEAISI Quarterly July 75

At the end of 1974, blast furnace No. 9 at the Krivoi Rog iron and steel works in the Ukraine, USSR, went into production. It took less than 2½ years to build–a very short time in view of the complexity of the project. The useful volume of the furnace is 5,000 cu. metres and its capacity is 4m. tpy of iron. This is not only the biggest, but also the most up-to-date blast furnace in the world. It is characterised by advanced technological and design solutions: the furnace shell is a self-supporting structure made of high-tensile steel plate; hot blast stoves of a new design result in a blast temperature of up to 1,450°C–200 to 300° higher than in conventional furnaces: an original design of charging hopper, weighing over 1,600 tons, is operated hydraulically, which increases its life five or six times and makes it possible to repair it while the furnace is operating.

The furnace makes extensive use of electrical and computer control. Working conditions in the furnace area have been improved with the installation of a ventilation system. Meeting the burden requirements of such a furnace is a serious problem. For the first time in world practice the furnace has no ore stockyard; raw materials are supplied by two belt conveyors, each 1.5km long. Every day these conveyors deliver 600 wagon-loads of pellets, coke and iron ore concentrate. These requirements made it necessary to raise the output of iron ore by 9m. tpy at the Krivoi Rog basin, and to increase the output of iron ore concentrate by 4.45m. tpy.

The gigantic size of the furnace is not an aim in itself: capital expenditure per unit of production was reduced by almost 12%, and labour productivity shows an increase of 30% compared with a conventional furnace with a volume of 3,200 cu. metres. The 5,000 cu. metre furnace has a 13% higher productivity and the production cost of pig iron is 1.9% lower. One man – the shift foreman – controls the whole complex, including the operation of the nearby granulator which processes slag directly into building materials.

Blast furnace No. 9 is just a step in the task of converting the Krivoi Rog iron and steel plant into the largest steelworks in the Soviet Union. In a short while another blast furnace of the same volume will be built next to this one, and steel converters and cogging and finishing mills and auxiliary services will also be built.

Construction and Operation of large Blast Furnaces at Fukuyama works NKK

669.162.2 (520)

MASAAKI HIGUCHI
MOTOHIKO IIZUKA
TSUNEMORI SUGAWARA
KOICHI KURODA
MINORU IKEDA

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Vol.16 (1976) No.8

There has been a marked trend for the construction of large capacity blast furnaces in Japan in recent years. The largest inner volume of the furnace in 1964 was 2,021 m³, but in November 1973, No. 5 blast furnace was blown in at Fukuyama Works, N.K.K. which has an inner volume of 4,617 cubic meters and a hearth diameter of 14.4 m.

An important task imposed on a large capacity blast furnace is to maintain stable operation, and to realize this, it is necessary to give particular considerations both to its construction and operation.

Fukuyama Works has constructed many large capacity blast furnaces during the last decade, each having the world's largest inner volume at that time.

The construction of No. 5 blast furnace has been made possible by a comprehensive compilation of N.K.K.'s excellent operational technology for maintaining efficient and stable operation of large capacity blast furnaces accumulated during this period.

The purpose of this paper is to describe some of the problems encountered at Fukuyama in the construction and operation of large capacity blast furnaces and the various measures taken to solve such problems.

42 0301 Prediction of Blast Pressure Change by a Mathematical Model. Naochika Miyasaka, Masayasu Sugata, Yukiaki Hara and Shin-ichi Kondo. Trans. Iron Steel Inst. Jap., 1975, 15, (1), 27-36 [in English].

669.162.2.001.5

Simulation of blast furnace condition based on a mathematical model is one of the means by which the phenomena observed in a blast furnace, especially in the high-temp. zone, are quantitatively understood. To clarify blast furnace conditions, the regions from the top of the bed to the tuyere level were divided into five parts by considering deadman, i.e. the indirect reduction zone, the smelting zone, the direct reduction zone, the tuyere zone and the raceway zone. In each zone, 12 simultaneous ordinary differential equations, consisting of the heat transfer and reaction rate equations, are set up. The rate equations for six kinds of chemical reactions and the equations concerning the flow of fluids, which are expected to occur in a blast furnace, were obtained experimentally. Furthermore, a few parameters were determined, so as to agree the computer curves of pressure drop and temp. with those measured in an actual large blast furnace. In the actual blast furnace, the blast pressure can increase abnormally and then the state of the furnace becomes worse and finally serious. As a result of analysing such a case by the use of a mathematical model, the increase of the blast pressure could be predicted at the time ~3 h before. 19 ref.—AA

Design of Blast-Furnace Lines from a Mathematical Analysis of Blowout Line Data. E.J. Ostrowski and S. H. Klinvex. (Proc. 33rd Ironmaking Conf., Atlantic City, AIME, April 1974, 1974, 294-306)

669.162.2.001.5

The use of regression analysis equations with blowout line data to predict new furnace lines is described. The calculation show that it is desirable to decrease the bosh angle and to have a straight section at the bosh/mantle junction. Difficulties of achieving this in practice are discussed. Adequate cooling of refractories is also of prime importance.

Determination of Some Parameter Values in the Mathematical Model of the (Finnish) Koverhar Iron-and Steelworks by Means of Regression Analysis. K. G. Eriksson and G. Lundqvist. (Jernkontorets Ann., 1974, 158, (4), 155-158) (In Sw.)

669.162.2.001.5

The results of measurements in a 569 m^3 blast furnace were treated statistically by regresssion analysis in order to determine the relationships between production rate and, inter alia, amount of slag, oil consumption, O content of the blast, and blast velocity. Coke consumption was also determined as a function of these parameters and also of blast temp. The results are illustrated graphically.

A Mathematical Model of a Blast Furnace Based on the Assumption of Uniform Distribution of Burdens and Gas. C. Myong and M. Tate. (Tetsu-to-Haganè (J. Iron Steel Inst. Jpn.), May 1975, 61, (7), 935-947) (In Jap.)

669.162.2.001.5

A math. model of the blast furnace was developed for estimating the effects of coke reactivity on the operational results of an experimental blast furance. The model shows that coke consumption may be reduced by 119/tonne metal. The model was also applied to determine the effect of natural-gas injection on coke-consumption rate.

42 0054 Aerodynamic Model of the Blast Furnace. M. P. Bates. J. Iron Steel Inst., Oct. 1973, 211, (10), 677-684 [in English] 669.162.2.001.57

The blast-furnace aerodynamic model provides a means of relating raw material properties to furnace productivity. The development of the model is described and in general terms, the application of the model to process control is discussed. 16 ref.--BA

Optimization of Blast-Furnace Processes. R. Therman. 669.162.001.57

(Jernkontorets Ann., 1974, 158, (4), 145-154 (In Sw.)

A math. model for the processes involved in the (Finnish) Koverhar iron-and steelworks is described, with particular ref. to blast-furnace operations. The model covers sintering, blast-furnace and LD-converter processes, casting, O production, slag treatment, and power plant. Material balances are computed, and the relationship between various process parameters are illustrated graphically.

42 0259 Multimeasurement Regression Analysis of Blast Furnace Operation. I. A. Medvedev, A. A. Spasov, A. P. Lebed', and K. P. Voloshin. Stal', July 1973, (7), 660-663 [in Russian]. 669.162.2.001.57

A mathematical model has been derived based on three sizes of blast furnace (1719-2000, 1386, and 1033 m^3 volumes) to define the factors i (the melt capacity in kg/mm^2 per 24 h), k (the specific coke consumption in kg/ton of iron) and P (the specific output) which is the product ik. The model is in the form of a polynomial of the second and higher degrees.—M. R. M.

42 0580 Plant and Process Technological Problems of Large-Scale Blast Furnaces. Helmut Wysocki. Stahl Eisen, 26 Feb. 1976 96, (4), 141-145 [in German]. 669.162.2.004

The further development of large-scale blast furnaces and the associated problems are considered. These problems arise in the peripheral areas of materials transport, maintenance, and pollution control, for example. The high throughputs of bulk materials, cooling water, air blast, and blast-furnace gas, and the high energy output bring about new requirements for furnace construction and maintenance. Refractory linings, cooling systems, top-closing devices, computer control of material flow, granulation of slag for easier transport, and operation of blast-furnace stoves at high temp. and pressure are discussed.—BA

42 0244 Increasing the Productivity of the Blast Furnace. Gonzalo Ramirez Rodriguez and Rafael Blanco Manotas. [ILAFA] Mem. Tec. XV Congr. Latinoam., Bogota, Colomb., Oct. 1974, 1974, 137-161 (Met. A., 7603-72 0041) [in Spanish]. 669.162.2.004.1

Results obtained in attempts to improve blast-furnace efficiency in Colombia are described. The durability of furnace linings under various conditions is discussed.—H. S.

42 0265 The Automation of the Blast Furnace. R. Vidal, J. Lückers and A. Poos. Revista Met., Jul.-Aug. 1973, 9, (4), 245-253 [in Spanish]. 669.162.2; 651.011.56

Progress towards the automation of blast-furnace operations is reviewed. Three fields for automation are recognised: (i) charging, regulating the charge sequence and mix quality, weighing constituents and correcting weighing errors; (ii) controlling pre-heating stoves at present largely uncontrolled; and (iii) controlling processes occurring in the furnace in accordance with a dynamic model. The requirements for each field are considered. Instrumentation required for control and the selection of parameters for action are discussed. 79 ref.

Laboratory Tests to Determine the Suitability of Sinter as Charge Material four the Blast Furnace. A. N. Mitra and P.K. Chakravarty. (Tisco, July 1975, 22, (3), 75-82) On its way from the sintering machine to the skip, sinter was withdrawn and tested for its strength and structure to determine the degree of stabilization. The results of shatter, tumbler and etch tests, and chemical analysis were related to raw-material properties, and it was concluded that stabilization of the sinter is completed after passage through the storage bins. Lack of stabilization does not increase the dust losses but affects the permeabiltiy of the charge in the blast furnace. The ignition temp. and suction conditions have the most pronounced effect on thestrength and structure of the sinter. Particle-size dis tribution in thegreen mix, if not controlled, results in the segregation. 669.162.2 622.785

Low Cost Oxygen Plant for Blast Furnace. Y. Sasaki. (Energy-Use and Conservation in the Metals Industry, Proc.Symp. 104th Annual Meeting AIME, 1975, 219-236) An O plant for blast enrichment only was installed to meet increased demand. Excess O of 99.6% purity for use LD furnaces had been used for blast enrichment. It was decided to produce 90% purity O in the new plant since this O is for blast enrichment only. In addition, the O inlet was changed from after the blast blower to before. This permits use of O at atmospheric pressure and the turbo compressor of the O plant can be omitted. The enriched blast can assist in compensating for poor coke quality and help reduce the coke ratio. The new plant produces 47 000 Nm^3/h at 90% purity. The cost of the O is about 50 to 60% lower than conventional high purity, due partly to low plant cost. Flow diagrams and data on operation of the new plant are included. 669.162.2; 662.611.25

The Heat Consumption of Blast Furnaces. E. Lingner. (Metalurgia, May 1975, 27, (5), 225-229) (In Rom.) A statistical analysis of the Si content of the pig iron produced in two months was made and correlated with the total amount of heat (i.e. coke) consumed for SiO_2 reduction. The results suggested that a decrease of Si content form 0.76-0.78% to 0.68 - 0.72% would allow a lowering of the specific consumption of the metallurgical coke by about 6.4 kg coke/ tonne of iron without affecting the iron quality.

669.162.2
669.046.558.3

42 0258 Carburization and Silicon Reduction During Pig Iron Production in the Blast Furnace. I. Z. Buklan, I. D. Balon, Yu. F. Nikolin, V. N. Muravev and N. M. Mishchenko. Stal', July 1973, (7), 583-589 [in Russian].
Variations in the C and Si content of iron samples taken from horizontal levels down the furnace stack of a N-cooled blast furnace have been examined. The C content varies with the particle size of the metal granules, and generally increases towards the tuyere level. In the region of rapid temp. rise at the tuyere zone level, where Si is rapidly reduced from gaseous SiO and silicates, 3-4% Si is obtained in the metal. The level of Si is reduced at the hearth level due to oxidation by reaction with the slag. 11 ref.—M. R. M.

669.162.21
669.046.562.2

42 0245 Trends in the Dimensions of Blast Furnaces in Latin America. Enrique Ponce, Luis Prada, and Miguel A. Nicodemo. [ILAFA] Mem. Tec. XV Congr. Latinoam., Bogota, Colomb., Oct. 1974, 1974, 163-182 (Met. A., 7603-72 0041) [in Spanish].
Future outputs of blast furnaces in Latin America are projected and world trends in furnace sizes are examined. Cost aspects are considered and current output data is given. 7 ref.—H. S.

669.162.21

669.162.21

The contour of blast furnace hearths

Dr. Leonard M. Saunders, *Iron and Steel Engineer* May 1977 p41

Research has acquired experience in determining salamander penetration in conventional ceramic blast furnace hearths, uncooled carbon hearths, air-cooled carbon hearths and water-cooled composite hearths of the type installed on the Fairless works No. 2 and 3 blast furnaces. Based on this experience, research designed an essentially uncooled preshaped carbon hearth for installation on the Fairless No. 1 blast furnace.

Design of New Blast Furnaces 5000 and 5500 Cubic Meters in Volume. S. V. Gubert, A. E. Sukhorukov, S. D. Samoilovich, and F. Ya. Ol'g'nskii. (Stal', Jan. 1976, (1), 9-17, (In Rus.); Steel in the USSR, Jan. 1976)

669.162.21

A blast furnace of 5000 m^3 useful volume has been designed and commissioned, whilst one of 5500 m^3 useful volume is under construction although the design has not been completely finalized. They are provided with 36-40 tuyeres, and four iron notches permitting continuous metal tapping. The designs of the blast furnaces and ancillaries, e.g. the cast house, hot-blast stoves, dust catchers, etc. are described. A conveyorized charge delivery with computer control is incorporated. All the discharged slag is granulated.

Advantages and disadvantages of various blast furnace supporting structures. (Proceedings of the 32nd Ironmaking Conference AIME, 1973, 177-192; discussion, 193-198). ADAMSON, M., TANNER, E. R., Four types of blast furnace supporting structures are described and illustrated: multiple column and mantle design; a type of free-standing furnace with tower; fully supported ring girder tower furnace; and large free-standing furnace within a tower. The fourth type is predicted to be the most widely adopted in future blast-furnace design because it offers a min. expenditure on supporting structure coupled with full support of top hamper and bustle pipe and partial emergency support for the shell.

669.162.21

669.162.21 (52)

MASAAKI HIGUCHI
MOTOHIKO IIZUKA
TSUNEMORI SUGAWARA
KOICHI KURODA
MINORU IKEDA

SEAISI Qrly. 3, 1 Jan. 1977

Construction and Operation of large Blast Furnaces at Fukuyama works NKK

There has been a marked trend for the construction of large capacity blast furnaces in Japan in recent years. The largest inner volume of the furnace in 1964 was 2,021 m^3, but in November 1973, No. 5 blast furnace was blown in at Fukuyama Works, N.K.K. which has an inner volume of 4,617 cubic meters and a hearth diameter of 14.4 m.

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The construction of No. 5 blast furnace has been made possible by a comprehensive compilation of N.K.K.'s excellent operational technology for maintaining efficient and stable operation of large capacity blast furnaces accumulated during this period.

The purpose of this paper is to describe some of the problems encountered at Fukuyama in the construction and operation of large capacity blast furnaces and the various measures taken to solve such problems.

42 0091 Construction and Operation of No. 5 Blast Furnace, Fukuyama Works, Nippon Kokan KK. T. Sugawara *et al.* Ironmaking Steelmaking, 1976, 3, (5), 241-251 [in English].

No. 5 blast furnace, Fukuyama Works, Nippon Kokan KK, was planned as part of the fifth stage of construction of the plant. In April 1974, six months after its blowing-in on 8 November 1973, this blast furnace with an internal volume of 4617 m^3 established a world record hot-metal production of 10 550 tonnes/day (average). The world's largest blast furnace increased the record in June to an output of 10 654 tonnes/day and again in August with an output of 11 063 tonnes/day. Its fuel ratio, the measure of the efficiency of a blast furnace stands at 460 kg/tonne backed-up by the use of an NKK-type 4-bell charging system and NKK-type movable armour. This paper contains an outline of some of the problems in the construction and operation of No. 5 blast furnace and the solutions developed to meet them.—AA

669.162.21(520)

State of Development of Electrical Engineering in Construction of Modern Blast Furnaces. G. Gleissner and A. Romascan. (Consistent Iron. Metals Society Pub.) Modern blast furnaces are now being constructed with very sophisticated computerized and electronic control systems which given high operating reliability. They control all parts of the plant cycle automatically, for example the quality and quantity of materials stocks, maintenance of an optimum charging programme and loading of the correct weights of material into the furnace. During the charging cycle, the level of material in the furnace can be determined in several ways; for example, by mechanical probes, or by the use of radioisotopes or radar altimetry. The materials are transported by hoppers, skip-hoists, or conveyor belts, the last method being the most suitable one for large blast furnaces. The enormous quantities of air under pressure needed in modern furnaces are produced in compressors driven by synchronous or asynchronous motors.

669.162.21; 621.3

Large Capacity Blast Furnace for the Rheinhausen Steel Mill. F. Lenger. (Tech. Mitt. Krupp. Werksber., Feb. 1975, 33, (1), 1-6) (in Ger.) A new high-capacity blast furnace is described with a hearth diam. of 11.5 m and a useful volume of 2,355 m^3. The furnace is designed for high-pressure operation and has double inlet seals, with bells of 6.1 and 2.2 m dia. and four gas-outlet valves; the working pressure may be up to 2.5 bar. Three tapping outlets, at 90° to each other, lead into three casting shops. Both fuel oil and oxygen can be introduced into the blast.

669.162.211; 669.162.267.4

Physico-Theoretical Fundamentals of Blast-Furnace Cooling. H. D. Kramer and H. T. Seligmuller. (Stahl Eisen, 26 Feb. 1976, 96, (4), 145-152) (In Ger.) 669.162.214

The different cooling systems for the blast furnace are considered, with particular attention to the highly stressed part of the jacket between the lower part of the shaft. Double-shell cooling, spray-cooling stave coolers, and stack cooler system are discussed, and design of Cu and steel stack coolers is described.

Cooling Systems for Modern Blast Furnaces. F. Lenger and J. Luttgens. (Stahl Eisen, 26 Feb.1976, 96, (4), 153-160) (In Ger.) 669.162.214

The usual cooling systems for individual areas of the blast furnace are reviewed. For modern, high-capacity, blast furnaces two cooling systems for the highly stressed part of the shell have been establise stack coolers, designed with new knowledge; and internal cast-iron stave coolers.

Aspects of Improving Blast-Furnace Cooling. H.T.Seligmuller. (Consistent Iron, Metals Society Pub 1975, 66-72). 669.162.214 Because of the influence of effective cooling on blast-furnace availability, examples are given of the efforts of blast-furnace construction engineers to improve the cooling, particularly that of the blast-furnace shell. Consideration is given to underhearth cooling with a special aim to protect the hearth-bottom plate from heat because of its importance under high top-pressure operation. A brief outline of the double-jacket evaporative-cooling system and horizontal cooling boxes explains the possibility of the appearance of inconvenient thermal stress across the shell plate. Therefore, an alternate shell cooling system is recommended which withdraws the heat flow from the furnace in front of the shell by stave coolers of the second generation. Variations of the stave geometry by simulation through a computational model and verification of the figures by use of a stave test stand and practical performance measurements are described as progress in designing reliable staves for high-duty application in blast furnaces.

Experiences with Water-Cooled Blast Furnaces. (Metallurgy, Apr. 1974, (4), 13-16) (in Rus.) BLAZHKO, V.M., GORODETSKY, Ya. I., PUSTOVAR, V.S., ANTONOV, V.M. and DRYAKHLOV, N.A. The adoption of water cooling for six blast furnaces of a metallurgical plant resulted in: (i) doubling the working period between consecutive lining repairs, (ii) stabilization of the behaviour of the blast furnaces, (iii) a reduction in water consumption by 6 X 10^3 m^3/h, and (iv) utilization of the heat of the cooling water. 661.162.214

Material and Technology for Making the Cooling Systems of Blast Furnaces. N.N. Aleksandrov, V. I. Kulikov, and E. V. Koyalevich. (Liteinoe Proizvod., June 1975, (6), 9-12) (In Rus.) The optimum compositions and manufacturing techniques used in the materials for various parts of blast furnace cooling systems are discussed. These materials include heat-resistant cast iron and low-alloy steels. It must be understood that the parts may be subject to frequent temp. fluctuations considerable mechanical stresses and abrasive wear. Materials contg. a few percent of Cr and Si appear to give the best results, but each case requires separate considerations. Graphs facilitating a choice in widely encountered cases are presented. 669.162.214

42 0583 Effect of the Dropped Charge on the Temperature Stress of the Blast Furnace Wall. Dieter Paschmann. Stahl Eisen, 26 Feb. 1976, 96, (4), 160-164 [in German]. 669.162.214

Three cooling systems for blast furnaces are reviewed: double-shell cooling, Cu stack coolers, and stave coolers. Experience on a 9.5 m hearth-dia. blast furnace shows that if the charge is dropped with the fines concentrated next to the refractory lining, then there is a poor gas flow and a lower temp. at the inner furnace wall. This can be accomplished with a revolving-chute, top-closing arrangement. The fine-grained burden represents a 'rechargeable lining' for the blast furnace - ""

Development In Blast Furnace Equipment Design. B. Kolarz (from Kolarz (from Czech) (Hutnike Listy 1975 (10) 697-701) 669.162.214

The increased size of blast furnaces and the greater output required form them has led to various improvements in cooling systems, charging equipment, where arrangements for sealing and charge distribution have been separated, better arrangements for teeming, raised blast temperature and so to improvements in stove design. (Price:-£ 7.00)

669.162.215

42 0119 Improvement of Gas Flow in Large Blast Furnaces. M. Higuchi, R. Yamamoto, S. Kishimoto and T. Miyashita. Symposium on Blast-Furnace Aerodynamics, University of New South Wales, Wollongong, Australia. 1975, 129-135 [Preprint-English].

Following considerations of the effect of furnace size on pressure loss, pressure loss in front of tuyeres, gas flow in the lower parts of the furnace, the distribution of the burden and the gas flow in large blast furnaces is examined with particular reference to the burden distribution at the throat and the gas flow at high production rates. Improvement of gas flow is related to application of super-high top pressure and the use of moveable armour. A brief description of the NKK-type moveable armour is given and its use in controlling the gas flow outlined. The operating results under controlled gas flow show an increase in production of Fukuyama No. 5 BF from 9200 to 11 000 tons/day with a decrease in the fuel rate from 490 to 460 kg/thm. [illegible] ref.—AA

669.162.215

42 0107 Influence of Blast Furnace Operating Parameters on Top Gas Temperature Distribution. L. Munive and R. Bush. Symposium on Blast-Furnace Aerodynamics, University of New South Wales, Wollongong, Australia. 1975, 41-47 [Preprint-English].

The recent installation of top-gas temp. probes in blast furnaces at Australian Iron and Steel Pty. Ltd., Port Kembla, has provided the means for studying radial gas flow distribution in blast furnace shafts. The top-gas temp. probes are described, their development outlined and results presented of initial studies aimed at obtaining a suitable relationship between temp. profiles and furnace parameters. The effects of various combinations of burden materials have been outlined by the results reported. The use of probes has also helped to clarify the effect of casting cycles on furnace operation leading to increased emphasis on the reduction of the interval between gun-up and drill-out. Areas for future studies are also broadly outlined.—AA

669.162.215

42 0378 A Mathematical Model of a Blast Furnace Taking into Account Non-Uniform Distribution of Burdens and Gas. Chon Myong and Mitsuru Tate. Tetsu-to-Hagané (J. Iron Steel Inst. Jpn.), May 1975, 61, (7), 948-956 [in Japanese].

Cf. preceding abstract. A math. model of a blast furnace taking into account non-uniform radial distribution of burdens and gas is presented. Calculations are carried out on the basis of this model making the mean coke temp. at the tuyere level equal to a predetermined value under a given ore and coke distribution. The results indicate that an increase in CO-utilization and a saving in coke consumption can be achieved under a uniform distribution of burdens. 9 ref.—BA

669.162.215

42 0114 Investigation of Gas-Dynamics of the Blast Furnace Process. B. G. Plastinin. Symposium on Blast-Furnace Aerodynamics, University of New South Wales, Wollongong, Australia. 1975, 94-98 [Preprint-English].

Results are presented of the investigation of gas dynamics of the blast furnace process obtained on laboratory models and operating furnaces. Gas residence times were measured using a He tracer technique developed for the purpose. Residence times were determined in furnaces of 1007 m^3 and 1719 m^3 and results used in the calculation of the burden parameters and to estimate the distribution of the gas flow along the furnace radius. The effect of tuyere injection of coal dust on gas distribution was also investigated and the advantage of continuous injection compared with intermittent injection is noted. The unevenness of gas distribution across the furnace area is found to correlate well with differences in the size analysis of the Fe-bearing component of the burden. The mixing of the gas streams between the neighbouring raceways was studied. It is shown that in the central region of the furnaces gases from every tuyere are mixing together, while in the peripheral regions mixing is more localized and includes only the sections consisting of five adjacent tuyeres. A solution is proposed to the problem of a theoretical evaluation of the critical gas velocity. A simple relationship between the Reynolds and the Archimedes numbers was obtained from which, after substitution of the burden size data and the gas parameters, it is possible to evaluate the critical gas velocity. Conclusions include information relating to the optimization of the gas distribution and views on reducing gas injection at elevated furnace levels. 13 ref.—AA

669.162.215
533.6

42 0117 Role of the Distributor in Achieving Optimum Aerodynamics in a Blast Furnace. M. J. Greaves. Symposium on Blast-Furnace Aerodynamics, University of New South Wales, Wollongong, Australia. 1975, 113-121 [Preprint-English].
The overall systems approach to blast furnace aerodynamics is explored including the time and spatial interrelationships that exist between the furnace lines, tuyeres, burden characteristics, distributor capabilities and furnace operating practice. Attention is called to the time-dependent, three-dimensional aspects of blast furnace aerodynamics and to the existence of several zones within a furnace where the flow characteristics are different. Changes in furnace operating practice to take further advantage of fully beneficiated burdens, including formed coke, are discussed from a practical viewpoint. Lessons learned in a variety of shaft furnaces used for other purposes are discussed insofar as they have a bearing on aerodynamics in an Fe blast furnace. Questions are raised about the penetration of hot blast in large furnaces. Operating practices and propo... solutions are evaluated where tuyeres over Fe and slag notches are restricted or plugged. Opportunities are presented for using on-line hierarchical computer systems with adaptive tuning algorithms to provide nonlinear control of changing process conditions in real time. This will make it possible for the blast furnace operator to optimize a variety of interrelated parameters, each with different response times. Potential increases in productivity, fuel savings and improved quality control are believed to be within reach.–AA

Developments in Iron-Making Practice. ([UN-IDO] Third Interreg. Symposium Iron Steel Ind. Brazil, Preprint, Oct.1973, [ID/WG. 146/4]. 6pp.) RIDGION J.M. Improved product control in modern iron-making practice was considered under the general hea... : steelmaking requirements; burden preparation; aspects of high top pressure operation; and blast furnace control. The essential roleof S in determining the grade, and value of the blast furnace iron for LD steel making was emphasized. Features of modern charging practice were described, and problems arising from increased to... ures were discussed, with ref. to a blast furnace producing over 10,000 tonnes of iron/day. Aspects of burden preparation, and the advantages of using high basicity sinter pellets were indicated. ...162.22

Effectiveness of Using Downward-Directed Tuyeres in Blast Furnaces. I. V. Kotel'nikov, V. V. Didenko, I. Ya. Ustimenko, S. L. Yaroshevskii, and O.K. Anufriev (Stal', Dec. 1975, (12), 1075-1077, (In Rus.); BISI 14204) 669.162.221.2
The effect of tuyeres, aligned downwards at an angle of 9^{o}-15^{o} to the horizontal was assessed in a blast furnace of 1033 m^3 volume producing ferro-manganese and pig iron. Several years' operating experience with these downward- directed tuyeres indicated a marked improvement in the draining ability of the hearth. The number of tuyeres and ancillary water-cooled equipment burnt out over a given period was reduced 2-3 fold.

On the Experimental Study of Tuyere Model Ablation and Its Heat Transfer Analysis S. Matsunaga. H. Yamaoka, M. Kawasaki and K. Harada. (Trans. Iron Steel Inst. Jpn., 1976, 16, (6), 332-337) ...221.2
Experimental studies on the ablation failure of a blast furnace tuyere were made by using the model tuyeres made of Cu, phosphor bronze and brass having a wall thickness of 15 mm. The velocity of the cooling water was kept at 3 to 4 m/s on the inner surface of the model tuyere, and molten Fe was poured onto the side wall of the model tuyere. On the basis of the experimental ablation data of model tuyeres, the heat transfer simulation model of ablation was established, in which the heat transfer coefficients were determined. In the heat transfer simulation model, the velocity of cooling water should be over 13 m/s if the burn-out data published by McAdams is taken into consideration. An investigation was also made on the effects of the thickness of tuyere wall and its thermal conductivity on the ablation speed of the tuyere.

669.162.221.2

Certain Problems in the Mechanism in the Blast Furnace Tuyere Zone. N.I. Krasavtsev and L.D. Sharkevich. (Stal' June, 1975, (6), 490-494, (In Rus.); Steel in the USSR, June, 1975, 294-297)
An increase in natural-gas consumption from 0.039 to 0.054 m^3/m^3 of furnace balst has led to a decrease in the length of the coke raceway zone, Lr, from 1.22 to 1.01 m. The length of the raceway zone is determined from the point at which the probe enters the bottom of the blast furnace to that at which it contacts the cnsolidated material. In a second furnace, an increase in natural-gas consumption from 0.046 to 0.070 m^3/m^3 of blast was combined with O enrichment of the blast to 26.5% and the length of the raceway zone did not decrease. Increasing the O concentration from 23.3-26.5% was accompained by a noticeable increase in Lr.

669.162.221.2

42 0205 Distribution of Blast to the Blast Furnace Tuyeres. A.T. Korzh, S.M. Solomatin and A.D. Bezrodny. Izvest. V.U.Z. Chernaya Met., 1974, (6), 173-177 [in Russian].
The results are given of experimental measurements of blast distribution to the tuyeres of a model and an operating blast furnace. Recommendations are presented c attaining a more uniform blast distribution. 7 ref.- M.L.T.

669.162.221.2; 669.162.26

42 0208 Operation of a Blast-Furnace with Inclined Tuyeres. I.L. Kolesnik *et al.* Metallurg, May 1974, (5), 8-9 [in Russian].
The use of inclined tuyeres on a blast-furnace 1386 m^3 in volume, is described. The standard tuyeres were replaced by inclined (4-5°) ones because of imperfect operation of the axial zone of the furnace, clogging of the hearth, and mass burn-out of the tuyeres when using charge contg. a high proportion (up to 26%) of the fraction <5 mm. Inclined tuyeres reduced burn-out by a factor of 5-7, and also stabilized the operation of the furnace.—L. G.

669.162.221.2
669.162.267.4

Special Tuyeres for the Injection of Large Quantities of Fuel Oil into the Blast Furnace. (V.D.Eh.Internat.Iron Steel Cong., Dusseldorf, 1974, 1974, (Vol.1), 2.1.2.3 1-16) BORGNAT, D. DELLA CASA, R. SCHNEIDER M. and STAIB.C. To study the limitation of fuel oil injection through combustion difficulties, a high power combustion chamber was constructed capable of a blast rate of 10 000 m 3/h at 1100 oC, with pressures up to 2.5 bar and oil injection of 2000 l./h max. Three types of tuyere were compared: (i) a conventional three hole tuyere giving peak performance at 65 g oil/m^3 air ., (ii) a subsonic converging-diverging tuyere, with a corresponding value 100g oil, and (iii) a supersonic shock wave tuyere, in which oil injection can be increased to a corresponding value of 160g.

669.162.223

Blowing Out the No.2 Blast Furnace of the Italsider Works in Taranto at the end of Its Run. I.De Santis and E.Russo. (Boll.Tecn. Finsider, Feb.1974, (324)109-115) (in It).
The operational sequence adopted for blowing out a blast furnace after 8 years and the production of about 8 million tons of metal are described. The data obtained from the final tap are analysed.

669.162.229

42 0020 Blast Furnace Operation With 25 to 60% Oxygen Blast to Make Top Gas Composite Suited for Ammonia Synthesis. Takashi Okamoto, Yoshinosuke Tada and Taku Sugiura. Trans. Iron Steel Inst. Japan, 1974, 14, (2), 122-132 [in English].
The top gas of a blast furnace, which was operated with a 55% O, 45% N blast, had been directly used for ammonia synthesis. The operation of test furnaces and an industrial furnace was very successful even with such a high O blast. Based on the results on the test furnaces, the cleaned top gas or heavy oil, together with the blast, were blown through the tuyeres to lower the combustion temp. at the tuyeres and to increase the volume of the ascending bosh gas. The industrial operation had been successfully continued for over three years at max. 55% O in the blast and produced ~90 000 tons of foundry pig iron and 134 × 10^6 Nm^3 of effective gas ($CO + H_2$) equivalent to ~60 000 tons of ammonia. 19 ref.—AA

669.162.224

42 0243 Blast-Furnace Technology During the Energy Crisis. Benedito Ribeiro da Costa. [ILAFA] Mem. Tec. XV Congr. Latinoam., Bogota, Colomb., Oct. 1974, 1974, 119-135 (Met. A., 7603-72 0041) (in Spanish).
Methods of improving blast-furnace efficiency are discussed. Conditions in various countries are described. O enrichment, pre-heating of air, and recuperation are considered. 14 ref.—H.S.

669.162.224.4

Blast-Furnace Operation on a Cold Blast Enriched with 30% Oxygen. N.N. Babarykin, N.M. Kryukov, L. Ya. Levin, V.S. Novikov, and Yu. V. Yakovlev. (Stal' Sept. 1975 (9), 784- 790 (In Rus.); Steel in the USSR, Sept. 1975,)
Experiences in running a blast furnace of 1370 m^3 volume during a period when the hot-blast stoves were being reconstructed are described. A reduction in blast temp. from 1050 to 80°C, and an increase in blast O concentration to 30% secured a good hearth heat, but furnace productivity was reduced by 18.4% and total fuel consumption increased by 33.4%. Such operating schedules are justified only in exceptional circumstances, such as during hot-blast-stove reconstruction.

669.162.224.4

Low Cost Oxygen Plant for Blast Furnace. Y. Sasaki. (Energy-Use and Conservation in the Metals Industry, Proc.Symp. 104th Annual Meeting AIME, 1975, 219-236) An O plant for blast enrichment only was installed to meet increased demand. Excess O of 99.6% purity for use LD furnaces had been used for blast enrichment. It was decided to produce 90% purity O in the new plant since this O is for blast enrichment only. In addition, the O inlet was changed from after the blast blower to before. This permits use of O at atmospheric pressure and the turbo compressor of the O plant can be omitted. The enriched blast can assist in compensating for poor coke quality and help reduce the coke ratio. The new plant produces 47 000 Nm^3/h at 90% purity The cost of the O is about 50 to 60% lower than conventional high purity, due partly to low plant cost. Flow diagrams and data on operation of the new plant are included.

669.162.224.4

Measures to Increase the Productivity of Blast Furnace Processes and Plants and to Reduce Coke Consumption in the Blast Furnace. (V.D.E.h.Internat Iron Steel Cong., Dusseldorf,1974,1974. (Vol.1), 2.1.1 1-16) NAKAMURA,N. ISHIKAWA,Y. and TATEOKA,M. Blast furnace productivity is determined by the combustion rate of the fuel, and the quantity of fuel charged. Measures which effectively increase blast furnace productivity include O enrichment, high top pressure, high blast temp. up to 1350°C, oil injection, and an increase in furnace size. The properties of the sinter and coke can affect the improvements attainable, and further research is required into the blast furnace reactions, and the distribution of the softening and cohesive zones.

669.162.224.4

42 0036 **Trial Heats in Blast Furnace with a Volume of 2000 m^3 with Blast Enriched to 35% Oxygen.** Z. I. Nekrasov *et al.* Stal', Feb. 1973, (2), 97-104 [in Russian].
Results obtained with trial blast furnace heats with O-enriched blast to 35% O and the injection of natural gas are described. On the blast furnace in question (with a volume of 2000 m^3) an increase in the O content of the blast from 26.7 to 34.7% in conjunction with a rise in the amount of natural gas injected from 8.6 to 14.3% increased the furnace productivity by 15.3% and lowered the coke consumption from 484 to 445 kg/tonne of pig iron, with a coke replacement factor by natural gas of 0.91 kg/m^3. The thermal and reduction processes are not impaired by the increased O content, and no deleterious effects on the operating parameters of the furnace were observed.—L. D. H.

669.162.224.4
669.162.267.6
662.69

Use of combined blast in Magnitogorsk Combine blast furnaces

N. N. BABARYKIN, N. M. KRYUKOV, V. S. NOVIKOV, F. A. YUSHIN, and S. K. SIBAGATULLIN

At Magnitogorsk Combine investigations have been carried out of the operation of a blast furnace 2014 m^3 in volume (with horizontal probing at two levels and vertical probing) with oxygen enrichment of the blast to 24.9% and natural gas (NG) injection. The change in indices with different relations between O_2 and NG consumptions is analysed. With 25% O_2 in the blast and an NG consumption of about 100–105 m^3/t pig iron, the productivity rose by 1.8–2.2% and the coke consumption fell by 2.4% for each percent of oxygen in the blast over 21%. A nomogram has been constructed from which it is possible to calculate the limiting permissible (varying over a fairly wide range) consumptions of NG with a blast oxygen content of 21–40%. To obtain the greatest coke saving the NG consumption used should be at the upper limit, while for the greatest productivity increase it should be at the lower limit.

Stal', 1976, (3), 204–208

STEEL IN USSR Mar '76 PP 118-152

669.162.227

42 0329 Burns Harbor [US] High-Top-Pressure [Blast-Furnace] Operation: Its Problems and Rewards. Ralph A Greenawald and Edward L. Auslander. Proc. 33rd Ironmaking Conf., Atlantic City, April 1974, 1974, 167-173 (Met. A., 7603-72 0340) [in English].

Some of the operating practices and equipment modifications made during the successful operation of two blast furnaces with high top pressures of ~1 atm are described. Technological considerations are discussed and show that it is possible to use high wind rates whilst controlling gas velocity through the stack to maintain a steady, smooth furnace operation.—R. E.

669.162.227

42 0105 Bell-Less Top for High Top Pressure Furnaces. G. Heynert and E. Legille. [Conf. on] Developments in Ironmaking Practice, London, Nov. 1972, 1972, 100-130 (Met. A., 7502-72 0034) [in English] [Received 1974].

A design fitted to a 9.5-m dia. furnace is described, with a system of charging hoppers, storage bins, and distributing chute and spreaders, which dispenses with throat armour and degrades the charged pellets much less, while having smaller and lighter components requiring smaller lifting gear for replacement. The technological aspects are described, and the metallurgical points are detailed, together with possible modifications.—BA

669.162.227

42 0102 Benefits of High Top Pressure. R. Else and R. Thomas. [Conf. on] Developments in Ironmaking Practice, London, Nov. 1972, 1972, 81-87 (Met. A., 7502-72 0034) [in English] [Received 1974].

An historical review of the development and application of high top pressure is given, together with a brief review of the theoretical benefits expected. The effect on production rate in particular is considered in detail and the benefits are discussed in general terms considering results achieved in practice. 11 ref.—BA

42 0103 High Top Pressure Equipment. G.C. Carter and M. M. Adamson. [Conf. on] Developments in Ironmaking Practice, London, Nov. 1972, 1972, 83-97 (Met. A., 7502-72 0034) [in English] [Received 1974].

669.162.227

The developments in blast-furnace top design are given. Two distinct functions of a top are the distribution of charge material into the furnace and the maintenance of an effective seal against furnace top pressure. The concept of the bell-less top is discussed, whereby the large bell is dispensed with and material is distributed on the stock-line by a rotating chute, and sealing is effected solely by small valve seals. Improvements to the system are also outlined.—BA

669.162.227(520)

42 0104 High Top Pressure Operation at Nippon Kokan KK. M. Higuchi, M. Iizuka, and T. Shibuya. [Conf. on] Developments in Ironmaking Practice, London, Nov. 1972, 1972, 98-108 (Met. A., 7502-72 0034) [in English] [Received 1974].

At Nippon Kokan, the world's largest blast furnace, having a volume of 4197 m^3 and a hearth dia. of 13.8 m was completed and operating in Apr. 1971. The features of the high top pressure facilities, effects of high top pressure operations, and important points of operations are presented.—BA

669.162.227(520)

42 0018 High Top Pressure Operation of Blast Furnaces at Nippon Kokan KK. M. Higuchi, M. Iizuka, and T. Shibuya. J. Iron Steel Inst., Sept. 1973, 211, (9), 605-614 [in English].

In planning the construction of the world's largest blast furnace, theoretical calculations were conducted on the basis of an idea that the primary condition for stable blast-furnace operation was the maintenance of an appropriate furnace permeability. Simultaneously, the furnace top of Fukuyama no. 4 blast furnace was designed to bear the max. pressure of 3.0 kg/cm^2 and to be in normal service under a pressure of 2.0–2.5 kg/cm^2, as derived from analyses of operating data of the other operating furnaces and calculation of the top pressure required for a large-capacity blast furnace. In constructing this furnace, NKK-type movable armour and many other new ideas were incorporated into the basic conception of NKK-type four-bell, high top pressure facilities completed in Fukuyama no. 3 blast furnace. This report presents features of Nippon Kokan's high top pressure facilities, effects of high top pressure operations, and important points in operation as well as in facilities for such operations.—BA

The Heat Consumption of Blast Furnaces. E. Lingner. (Metalurgia, May 1975, 27, (5), 225-229) (In Rom.) A statistical analysis of the Si content of the pig iron produced in two months was made and correlated with the total amount of heat (i.e. coke) consumed for SiO_2 reduction. The results suggested that a decrease of Si content form 0.76-0.78% to 0.68 - 0.72% would allow a lowering of the specific consumption of the metallurgical coke by about 6.4 kg coke/tonne of iron without affecting the iron quality.

669.162.228

42 0256 Intensification of the Blast Furnace Smelting Process with Normal B[illegible]t by Charging Burden Materials in Separate Size Fractions. V. G. Pyzhov, F. K. Admakin, and Zh. E. Sleptsov. Izvest. V. U. Z. Chernaya Met., 1973, (10), 28-32 [in Russian].

669.162.228

The influence of charging burden materials in separate size fractions (coke +60 mm, sinter +50 mm; coke 60-40 mm, 50-30 mm and above 40 mm; sinter 15-50 mm) on the intensity of operation of a blast furnace 2000 m^3 in volume is investigated. When using coke screened into 60-40 mm and 50-30 mm and sinter 50-15 mm fractions, the intensity of smelting increased by 3.6 and 5.4%, resp., and the coke consumption decreased by 4.7 and 4.6% resp. in comparison with the operation on coke screened at +40 mm. Operation of the furnace with coarse coke and sinter was less economical than with a narrower sized burden.—M. G.

669.162.228

Concepts for an Improved Blast Furnace System—Use up to 50% Less Coke to Make Better Hot Metal and Gas

H. B. CLAFLIN, Manager—Special Projects, Steel Manufacturing Div., Kaiser Steel Corp., Fontana, Calif.

IT appears that less coke for ironmaking will soon be an attainable goal. A patented blast furnace system advantageously applied to gain these ends is described in this paper. The basic process knowledge for the project was laboriously acquired over the years by a worldwide host of competent operators and researchers. The zone-controlled modified blast furnace described will be closely regulated by adjusting in a unique manner the volume, composition, temperature and pressure of the up-moving gas stream.

P-44 Iron and Steel Engineer , Sep. 1976

669.162.228.2
669.162.231

42 0257 The Use of Measured Quantities of Blast and Blast Furnace Gas Yield in Calculations of Direct Reduction Indices. M. A. Stefanovich and A. I. Vaganov. Izvest. V. U. Z. Chernaya Met., 1973, (12), 35-38 [in Russian]. (x)

Calculating the degree of direct reduction on the basis of blast volume and the yield of blast furnace gas instead of, or additionally to, the usual method based on the gas composition and coke rate, is advocated. It is suggested that the proposed method is particularly suitable for calculating current values of the direct reduction. The accuracy of the method can be improved by placing the measuring points for the blast and gas closer to the blast furnace.—M. G.

42 0071 Pressure Losses in Coke/Sinter Layers and Mixtures. Hans-Joachim Schultz and Otto Abel. Arch. Eisenhüttenwesen, July 1974, 45, (7), 445-448 [in German].

669.162.228.3

Pressure losses in a blast furnace are measured for six formed-coke shapes, a lump-coke and normal ore-sinter, charged either in layers, or as ideal mixtures. The specific pressure loss, at a blast flow rate of 1 m/s., was greater, by 100% or more, for mixtures than for layered charges. With layers the shape of the coke made little difference to the pressure loss, but with mixtures the results were not easily reproducible. The effect of improved aerodynamic shapes was masked by the packing of sinter in the voids between coke lumps of different sizes. The optimum coke-lump size could not be determined, but must depend on the particulate size spread of the sinter. 16 ref.

Calculations on the thermal Balance of the Blast Furnace. N.Pilly. (Metalurgia, Apr. 1975, 27, (4), 186-190) (In Rom.) The thermal balance of a blast furnace was calculated for a period of one month. The results are tabulated and presented in a pictorial form indicating the proportions of heat input and output in each case. 669.162.232.4

The use of measured quantities of blast and blast furnace gas yield in calculations of direct reduction indices. (Izvest. V. U. Z. Chernaya Met., 1973, (12), 36-38) [in Rus.] STEFANOVICH, M. A., VAGANOV, A. I., Calculating the degree of direct reduction on the blast volume and the yield of blast furnace gas instead of, or additionally to, the usual method based on the gas composition and coke rate, is advocated. It is suggested that the proposed method is particularly suitable for calculating current values of the direct reduction. The accuracy of the method can be improved by placing the measuring points for the blast and gas closer to the blast furnace. 669.162.228.4 669.162.282

Special Tuyeres for the Injection of Large Quantities of Fuel Oil into the Blast Furnace. (V.D.Eh.Internat.Iron Steel Cong., Dusseldorf, 1974, 1974, (Vol.1), 2.1.2.3 1-16) BORGNAT, D. DELLA CASA, H. SCHNEIDER M. and STAIB.C. To study the limitation of fuel oil injection through combustion difficulties, a high power combustion chamber was constructed capable of a blast rate of 10 000 m 3/h at 1100 oC, with pressures up to 2.5 bar and oil injection of 2000 l./h max. Three types of tuyere were compared: (i) a conventional three hole tuyere giving peak performance at 65 g oil/m^3 air ., (ii) a subsonic converging-diverging tuyere, with a corresponding value 100g oil, and (iii) a supersonic shock wave tuyere, in which oil injection can be increased to a corresponding value of 160g. 669.162.228.5 [illegible].752.225

A Road to Highly Efficient Hot Blasting: (Effect of Improved Efficiency in Hot Blast Production on Blast Furnace Operations). (V.D.E.h. Internat.Iron Steel Cong., Dusseldorf, 1974, 1974, (Vol.1) 2.1.2. 1 1-15) KOBAYASHI.S. Experiences with a blast furnace operating at a blast inlet temp. in excess of 1300 °C are described, and particulars are given of suitable hot stoves, and blast equipment. Operational efficiency of the hot stoves, is improved by their staggered parallel operation, with computer control of heat storage, and switching by fixed aperture butter-fly valves. The use of such a high temp.blast improves the combustibility of injected heavy oil. Dehumidification of the blast was studied, and a decreased in humidity of 10 g/m^3 at S.T.P. corresponds to an increase in hot blast temp. of about 70 degC. [illegible].162.23

669.162.232(…)

Use of the No.1 Blast-Furnace Cast House at Nippon-Kokan, Fukuyama. (Centre Document, Siderurgique Circul.Inform.Techn., 1974, 31, (10), 2099-2107) (in Fr) ANNICHINI, A. and THIRION, C. The blast furnace has a useful volume of 1920 m^3, 27 tuyeres, and a production of 5500 tons/day. The layout and dimensions of the cast-house runners are outlined, and details of, inter alia, the blast-furnace tapping techniques are given.

669.162.238.2

42 0030 Calculations on the Thermal Balance of the Blast Furnace. N. Pilly. Metalurgia, Apr. 1975, 27, (4), 186-190 [in Romanian]. The thermal balance of a blast furnace was calculated for a period of one month. The results are tabulated and presented in a pictorial form indicating the proportions of heat input and output in each case. 13 ref.—C.T.

669.162.238.2

Optimum level for installing peripheral thermocouples in a blast furnace. (Izvest VUZ, Chernaya Met., 1973, (11), 37-39 (in Rus.); Steel in the USSR., Nov 1973) SHUMILOV, K.A. and TSILYK, V.D. Non-uniformity in the perripheral gas flow in a blast furnace can be assessed by the extent of the temp. deviation, at monitored positions, from the average peripheral temp. Provided the height, at which such temp. deviations are at a max. be found, operational corrections to improve gas flow distribution should be made as soon as possible. Equations are derived to determine the height at which thermocouple should be installed. The results indicate that the optimum positions can vary, but the range of possible locations has been determined, and the optimum level is approx. 2.0 m below the stock line level.

669.162.238.21

42 0482 Investigation of the Inter-Relationship Between Temperature in the Blast-Furnace Stack and Process Parameters. B.P. Dovgalyuk, A.I. Parfenov, N.M. Yaroshenko, and I.L. Kolesnik. Stal', Dec. 1975, (12), 1073-1075 [in Russian]. The temp. have been taken simultaneously at five levels in a blast-furnace stack, and the variations contrasted with the composition of the gases and the pig iron. The temp. at all stack levels change almost simultaneously and are determined by the amount and heat content of the ascending gases. An inverse relationship exists between hearth heat and stack temp. which can be explained by secondary-oxidation processes of the pig-iron elements in the vicinity of the tuyeres. In controlling the thermal regime of blast-furnace operation it is convenient to use monitoring and stabilization of secondary oxidation of pig-iron elements at the tuyeres.—J.W.

A Model for the Thermal Processes in a Blast Furnace Based on Material and Thermal Balances. W.Ringelband. (Thesis,Techn.Univ.Clausthal,1973, 126 pp) (in Ger) An analysis of processes occurring in a blast furnace is developed, leading to the formulation of a model and its experimental realization and testing in service The results are described and suggestions for further development made. 669.162.228.1

Experiences in the Use of Blast Furnace Charging Equipment with a Rotating Bell. K.I.Kotov, N.M.Zatulovsky, Yu.F.Zhdan, A.P. Katsyubenko, and V.I.Prizemnov. (Stal,'May 1975, (5), 402-403, (in Rus.) Steel in the USSR,May 1975). A method of increasing the life of the charging gear of a blast furnace by indexing the bell through a predetermined angle every sixth charginghardfacing the contact surfaces along a stepped line, and cooling the hopper body with steam is described. The average service life was 2.25 times longer than that of conventional charging gear, but certain features need further development. 669.162.24

Controlling the Level and Profile of the Charge in a Blast Furnace. V.A.Smolyak,B.V. Shcherbitsky,N.T.Evseeva, and V.I.Vasilenko. (Metallurg, Feb.1975, (2), 11-12) (in Rus.) An account is given of the results of testing and adoption of an automated system for controlling the profile and level of the charge in a blast furnace of 1719 m^3 volume by means of a radioisotope level gauge and a γ profilometer 669.162.24-52

Improved Blast Furnace Operation. P.L. Woolf. (Efficient Use of Fuels in the Metallurgical Industries, 1975, 263-296 (Symposium, Chicago Dec. 1974) Several tests conducted in the Bureau of Mines experimental blast furances are discussed briefly. They are related to the remarkable improvements in blast furnace performance which the industry has achieved over the past 20 years. The tests selected from the many which had been conducted were those which resulted in coke economy, and which it is believed were significant contributions to the blast furnace industry. They include burden benefication, substitute cokes, high top pressure and 1400°C enriched with cold O. Definite fuel savings were obtained using processes (i), (ii), but the major savings were incurred with (iv). Productivity increased over 20% and this was achieved with a reduction in coke consumption of between 22 and 29%. The results obtained were confirmed by heat-balance data. 669.162.26

R.E. WARNER

Recent Developments in Medium Size Blast Furnace Operations

In recent years blast furnaces have been constructed with increasingly large capacities and with greatly increased complexity of ancillary and control equipment. An example of a medium size furnace is the No. 5 Blast Furnace at the Hoskins-Kembla Works of Australian Iron and Steel Pty. Ltd. (AIS) which was commissioned in March 1972. This furnace has an inner volume of 2670m^3 and has many features which are not incorporated in the smaller operating Port Kembla furnaces which have inner volumes of 1152m^3, 1386m^3 and 1883m^3.

To secure stability of operation from medium and large blast furances, and thereby obtain output rates commensurate with furance size, high standards and attention to detail must be applied to raw material preparation, furnace operation and equipment maintenance. This paper concentrates on the equipment and standards which have been adopted or are made with the requirements of the small furnaces.

Physical and chemical specifications of both coke and ferrous burdens (sinter and lump ore) are given, together with a general description of the facilities required to generate the required raw materials. Since the physical quality of coke is especially stringent and difficult to produce with available coking technology, this factor is an important consideration involved in determining the optimum furnace size for many locations.

Critical areas of medium-sized furnace operation have been found to be: casting, with taphole clay quality being particularly important, control of gas distribution by charging sequence and moveable stockline armour, and avoiding the build-up of accretions in the dust catcher. To avoid the disruptive effects of water ingress, significant improvements in cooling systems have been necessary, including cooling element design, water purity and velocity and reliable leak detection systems. AIS has progressively adopted stave cooling of the bosh and shaft zones, initially with its own design, and subsequently with the Soviet evaporative system, installed first on No. 4 Blast Furnace in 1972.

: SEAISI Manila Seminar at Philippines 1976

P31

Contribution to the Metallurgy of the Blast Furnace. Th. Kootz & E. Wilms (from Ger.) (Thyssenforsch., 1972, 4, (3/4) 91-105) The possibilities of blast furnace control, particularly to obtain constant silicon contents in the iron, are discussed in relation to changes in boundary composition, blast temperature and steam or oil addition. The lags in the effects of these changes are found. It was also observed that silicon content was little influenced by any of these changes and in this respect differs greatly from Mn [illegible] that reduction of SiO takes place earlier than that of the other elements, and part at least carried right through to the final stage in the metal. (Price: £14.00) 669.162.26

Investigation on Gas-Flow in a Blast Furnace by Means of Pressure Measurements, Temperature Measurements, and Gas Analyses Using a Horizontal Probe and Peripheral Pressure-Taping Equipment. F.W. Hillnhutter et al (from Ger.) (International Iron and Steel Congress, Dusseldorf, 1974, Paper 2.1.2.2.) Equipment is described and experimental results are presented which allow changes in reactions and furnace working to be monitored, thus facilitating control. 669.162.26

An Investigation of Blast-Furnace Process Dynamics. L.S. Mkrtchan, A.F. Rebeko, Yu. V. Serov, and V.V. Besfamil'nyl. (Stal', Nov. 1975, (11), 981-986, (In Rus.); Steel in the USSR, Nov. 1975,) The relationships betweeen the parameters of the charges and blast operating regimes and those of the resultant pig iron and slag compositions are considered. The dynamics of the processes taking part are of long duration. A change of charge parameters takes 10-14, and that of blast parameters 7-10 h, to complete. A consideration of the dynamic characteristics enables a more effective control to be implemented, and defines the limits of the permissible magnitude and duration of input-parameter variations. 669.162.26

Laboratory experiments are described to determine the rate of gasification of various cokes in a manner simulating the conditions in the stack of a blast furnace. The coke used was impregnated with K_2CO_3, to modify the coke in a manner similar to that occuring in practice. Inconclusive results were reported, with the exception that the importance of the retention of high mechanical strength i the coke was confirmed.

Multi-Dimensional Regression Analysis of Blast-Furnace Operation. (Stal', 1973, (7), 660-663) (from Rus.) 669.162.26

MEDVEDEV, I.A. et al. From average monthly data on blast-furnace operation at four Ukranian works an analysis was carried out of the influence of the main production factors on the specific productivity (volumetric operating intensity in terms of coke burnt i) and coke rate k in blast furnaces of three size groups (2000-1719, 1386 and 1033 m^3) of incomplete second-degree polynomials. A factorial analysis was carried out of the variation of i, k and P (P = ik) for four Ukrainian works in 1966-1971, i.e. it was established which proportion of the change in i, k and P over the five-year period was due to the change in the corresponding production factors. (Price: £5)

669.162.26

42 0312 No. 3 Blast Furnace: Llanwern. C. R. Crellin. Ironmaking and Steelmaking, 1975, 2, (1), 14-23; and Appendix 23-24 [in English].

The background to the 5000 tons/day blast furnace is outlined, and basic furnace design parameters are given. The target productivities are 2.2 tons/m^3 (working volume) and 50 tons/m^2 (hearth area) per day. These factors determine the principal furnace dimensions of 2200 m^3 working volume and 11.2 m hearth dia. Detailed furnace dimensions are listed and discussed. Further important features are described and illustrated together with reasons for their selection. These include furnace linings, top gear, cast house, belt charging system, hot blast systems, gas cleaning plant, and control systems.—BA

Large Capacity Blast Furnace for the Rheinhausen Steel Mill. F. Lenger. (Tech. Mitt. Krupp. Werksber., Feb. 1975, 33, (1), 1-6) (in Ger.) A new high-capacity blast furnace is described with a hearth diam. of 11.5 m and a useful volume of 2,355 m^3. The furnace is designed for high-pressure operation and has double inlet seals, with bells of 6.1 and 2.2 m dia. and four gas-outlet valves; the working pressure may be up to 2.5 bar. Three tapping outlets, at 90° to each other, lead into three casting shops. Both fuel oil and oxygen can be introduced into the blast. 669.162.26

Increases in Blast Furnace Productivity. G. Ramirez and R.Blanco. (Rev. Latinoam. Sider., Oct. 1974, (174) 89-95, 103) (In Span.) The production capacity of the blast furnce at Acerias Paz del Rio (Colombia) was increased over a 20 year period from a nominal 500 tons/day to 840 tons/day by increasing the working volume of the furnace, improving the conditions of the blow and adopting measures to reduce the coke rate. The measures taken to achieve these improvements are discussed, with special emphasis on changes in the lining cooling system of the bosh. 669.162.26

D

Evolution of the Productivity of the Blast Furnaces at Usiminas. L.C. de Abreu, A.J.da Silva Neto and V.A.Guimaraes. (29th Annual Cong. of ABM, Porto Alegre, July, 1974, pp33) (in Port. Over a four-year period (Jan.1970-Dec.1973) Usiminas raised the productivity of its two blast furnaces from about 1.2 to 2 tons/day/m^3 of furnace capacity. The principal factors in this increase were: regularization of the working of the furnaces through improved charge preparation, elimination of crust from furnace walls and adoption of a method of controlling their internal profile; reduction of fuel consumption by increasing the temp. of the blow, minimizing the consumption of unroasted carbonates, reducing slag volume and improving the quality of the charge; introduction of a new gas mixing system for the regenerators and systmes for injection of oil and O; improvements in existing equipment. 669.162.26

Improving Blast Furnace Performance. J.J.Quigley and N.Sayles. (Iron Steelmaker, Feb.1975, 2,(2), 23-28) The study investigated new blast furnace operating parameters which would allow further efficiency of the process. Production data were obtained from Inland Steel's operation and the following conclusions were noticed. When the stability of coke was increased by improvement of coal grind, lengthening the coke time and greater bulk density, production increased in proportion. The purer the coke was chemically, with less ash and volatile matter, the more efficient and of better quality was the Fe produced. For every 10% increase in wind rate there was a 7% increase in production. Multivariate models using regression analysis techniques were applied. The slag production variable, oil usage, slag chemistry, Mn in hot metal were factors taken into consideration. A theoretical coke rate was calculated from equations. 669.162.26

Information, Instrumentation, and Quality Monitoring in Ironmaking. J.M. van Langen and G.A. Flierman. Metals Society Pub, 1975, 78-80) A blast furnace, based on an extrapolation of the situation at IJmuiden, The Netherlands, operating under optimum conditions and producing pig iron of the desired level of consistency is described. As far as control strategy is concerned, previous work has shown that close control of the quantity and quality of the input variables is all that can be realized in practice. Min requirements can be formulated for the consistency of burden materials. Bin-level probes will be necessary, and other control features of a blast-furnace charging system are described. The operator will need to have information on furnace permeability, iron level in the hearth, and water leakage. Instrument performance and furnace production must be checked weekly. 669.162.26

Developments in Blast Furnace Practice and Design. (UN-IDO Third Interreg. Symposium Iron Steel Ind. Brazil, Preprint, Oct. 1973, [ID/WG. 146/25], 29 pp) HASEGAWA T., and SATOH T. Lump ores have been crushed to provide optimum sizes for charging; in some plants sizing is maintained in the narrow range of 8 - 25 mm. The fires have been sintered, and the production of self-fluxing sinter has become more widely adopted. The improved permeability of the burden in the blast furnace, by careful control of the charges, has increased metal temp. by 100 deg.C, combined with a coke saving of about 20 kg/ton. BOF steelmaking demands increased hot metal temp. and this has resulted in the construction of larger blast furnaces, one of which produces over 10,000 tons/day. 669.162.26

Consistent Iron Quality. J. Dartnell. (Ironmaking and Steel-making, 1975, 2, (2), 95-101). To supply steelmaking plants with iron of consistent quality, stable blast-furnace operation must be achieved. The blast furnace must be charged with raw materials of consistent chemical and physical quality, and thermal stability must be maintained. Slag chemistry exerts major effect on iron analysis. The control of coke, sinter, other raw materials, burden: coke ratio, and blast-furnace conditions are discussed. The production of iron of consistent quality will require considerable capital expenditure, particuarly in the area of materials preparation. 669.162.26

Non-Linearities and Methods for Their Elimination to Blast Furnace Operations. V.A. Zavidonsky and A.A. Il'yashov. (Stal, 'Jan.1975, (1), 14-17 (in Rus); BLL M 25133). Means of determining the degree of non-linearity between the input and output parameters of a blast furnace are indicated. A model for linearizing non-linearities is proposed.

669.162.26

42 0142 The Operation of Large Blast Furnaces. Y. Ishikawa. Rev. Métall., Mar. 1976, 73, (3), 283-314; discussion, 315-317 [in French and English].

669.162.26

The construction and operation of large blast furnaces of ~4000 m³ volume is considered. Problems experienced with large blast furnaces and their solutions are discussed, including increase in throat dia. and distribution of burden; increase in hearth dia. and maintenance of tuyere gas velocity and the increase of theoretical flame temp. in the raceway; permeability of the burden and; circumferential uniformity of the burden. The operating results of a large furnace and property requirements for raw materials are described. 11 ref.—P.C.K.

42 0056 Operating Results of Blast Furnaces at Solmer. N. Jusseau. Cent. Doc. Sidér. Cir. Inf. Tech., 1976, 33, (4), 847-860 [in French].

669.162.26

The results of the first months of operation of two blast furnaces are presented. After a starting-up period, all the operating parameters developed to reach conditions conforming to initial forecasts. The quality of the agglomerate and coke is traced over this period. Operational results are considered including energy consumption, productivity, and composition of the pig iron and slag. Gaseous distribution in the furnace, and levels of elements and as S, P, and Mn in furnace additions and products are given.—J.M.S.

42 0057 Blowing-In and Starting-Up Blast Furnaces at Solmer. A. Annichini and C. Thirion. Cent. Doc. Sidér. Cir. Inf. Tech., 1976, 33, (4), 831-846 [in French].

669.162.26

The starting-up of two blast furnaces is described. Planning of the work before firing is outlined. Operations considered include heating and drying the Cowper stoves, drying of the blast-furnace refractories with warm air (200 °C), filling the hearth with cross-bars, wood fuel, and charcoal, and charging the boshes with coke and ore materials. The development of different parameters during the initial operation of the furnace is traced.—J.M.S.

Operation of a Model Blast Furnace. C.Allain. (Centre Document.Siderurgique Circul.Inform. Techn.,1975, 32, (2), 291-303; (in Fr.) Using a model, conditions for simulating the charging of materials into a blast furnace were established. Variables examined included the geometry of the model, the trajectory, impact, the sliding and segregation of materials, and the effects of the ascending currents of hot gases. A method for examing granulometric segregation was developed, and variations in the resistance to the flow of gases and in the pearmeability of the charge within the furnace were investigated.

669.162.26.

42 0430 **Investigating the Operation of a Blast Furnace of 2000 m^3 Useful Volume after a Major Overhaul.** V.A.Shatlov, R.D.Kamenev, E.G.Donskov, Yu.S.D'Yachenko, and V.I. Bondarenko. Stal', Mar.1974, (3), 197-201 [in Russian]. Following theoretical investigation, particularly concerning the relationship between the ratio of the throat cross-sectional area, to the furnace useful volume, and the volumetric coke-combustion intensity, the throat dia. of a blast furnace, 2000 m^3 in volume, was increased by 200 mm, and the gap between the edge of bell and the throat wall from 950 to 1050 mm. A second iron notch was also added, the tuyere dia. increased, and modifications were made to the method of delivering natural gas to the tuyeres. These changes resulted in an increased productivity of 56.8 tons/day, allied with a coke saving of 6.36 kg/ton. of pig iron. Redistribution of the gas flow, resulting from the design modifications necessitated changes in furnace control, and the optimum operating regime of the furnace has yet to be established.

669.162.26

Evolution of the Productivity of the Blast Furnaces at Usiminas. L.C. de Abreu, A.J.da Silva Neto and V.A.Guimaraes. (29th Annual Cong. of ABM, Porto Alegre, July, 1974, pp33) (in Port. Over a four-year period (Jan.1970-Dec.1973) Usiminas raised the productivity of its two blast furnaces from about 1.2 to 2 tons/day/m^3 of furnace capacity. The principal factors in this increase were: regularization of the working of the furnaces through improved charge preparation, elimination of crust from furnace walls and adoption of a method of controlling their internal profile; reduction of fuel consumption by increasing the temp. of the blow, minimizing the consumption of unroasted carbonates, reducing slag volume and improving the quality of the charge; introduction of a new gas mixing system for the regenerators and systmes for injection of oil and O; improvements in existing equipment.

669.162.26 (469)

Improving Blast Furnace Technology at the Karaganda Combine. B.N.Zherebin, P.P. Mishin, A.E.Paren'kov, A.A.Nikitin, and V.V.Volkov. (Stal,'Dec.1974, (12), 1068-1073, (in Rus.); BISI 13126). Experiences in operating a blast furnace of 2700 m^3 useful volume are described, and the reasons for increasing the tuyere dia. from 180 to 200 mm, and modifying the charging system are reviewed. It is intended to increase the number of tuyeres to 24, and of Fe-notches to three. Improved operating indices are planned by increasing the consumption of heavy fuel oil to 60-80 kg/ton of pig iron, and of the concentration of O in the blast to 30% and above. 669.162.26 (47)

42 0534 Prospects for the Development of Blast-Furnace Practice in the USSR. Yu.I.Gokhman and A.V.Marchenko. Stal', Jan.1976,(1),17-18 [in Russian]. 669.162.26 (47)

The planned development of blast-furnace design is briefly reviewed. It includes the construction of furnaces 5000 m^3 and above in useful volume, increasing blast temp. to 1250-1300 °C, and top pressures to 1.8-2 atm. The practice of injecting hot reducing gases enriched with cold O should diminish coke consumption to 250-270 kg/tonne pig iron. Heavy fuel oil and pulverized fuel will be used widely during cold weather periods, when normal fuel supplies may be interrupted. The advantages of metalized feed and the consequent 20% saving in coke with a simultaneous increase of 28% in productivity are considered.—J.W.

The Present State of Blast-Furnace Technology In North America. H. Hille. (Stahl Eisen, 23 Oct. 1975, 95, (22), 1017-1023) (In Ger.) 669.162.26(7)

Blast-furnace practice in North America is reviewed with ref. to furnace size, the age of stack, and hearth linings, and the correlation between effective volume and hearth dia. Blast temp. and O additions are considered and a description is given of charge compositions, sinter basicities, burden weights, and specific slags volumes. Coke consumption and pig-iron production as a function of hearth dia. are discussed, and details are given of the use of additional reducing agents.

Optimization of Blast-Furnace Processes. R. Therman. (Jernkontorets Ann., 1974, 158, (4), 145-154 (In Sw.) 669.162.26.001.5

A math. model for the processes involved in the (Finnish) Koverhar iron-and steelworks is described, with particular ref. to blast-furnace operations. The model covers sintering, blast-furnace and LD-converter processes, casting, O production, slag treatment, and power plant. Material balances are computed, and the relationship between various process parameters are illustrated graphically.

669.162.26.001.5

'A Mathematical model for blast furnace operation with inclined layers of burdens. M. Kuwabara and I. Muchi. (from Jap.) (Tetsu-to-Hagane, 1975, 61, (6), 787-796) Layer structure in the burden, heat distribution and gas flows are carefully mapped and a mathematical model is developed using only readily measurable parameters. The top, middle and lower part of the furnace, above the meeting zone are treated separately. Radial distributions of process variables are found to be remarkably uneven. (Price: £23)

669.162.26.004

Plant and Process Technological Problems of large-Scale Blast Furnaces. H. Wysocki. (Stahl Eisen, 26 Feb 1976, 96, (4), 141-145) (In Ger.) The further development of large-scale blast furnaces and the associated problems are considered. These problems arise in the peripheral areas of materials transport, maintenance, and pollution control, for example. The high throughputs of bulk materials, cooling water, air blast, and blast-furnace gas, and the high energy output bring about new requirements for furnace construction and maintenance. Refractory linings, cooling systems, top-closing devices, computer control of material flow, granulation of slag for easier transport, and operation of blast furnace stoves at high temp. and pressure are discussed.

669.162.26:
622.341.1-188

Burghardt, O.P. and Kortmann, H.A.

Possibilities of Influencing the Quality of Iron Ore Pellets.

Paper 75-B-19. Society of Mining Engineers, AIME, New York. 1975 Pp 22 [Pamphlet-English]

Teststo determine the properties of pellets for blast furnace use, consisting of cold compression strength, tumble index, reducibility, reduction-softening behaviour under load, swelling and grain disintegration are described. Data are given on the influence of silica and calcium oxide on the quality of iron ore pellets, and on the effect of cooling conditions on pellet properties.

42 0323 High Quality Pellets for Blast Furnaces. P. Barnaba and S. Palella. Boll. Tecn. Finsider, Dec. 1974, (334), 873-523 [in Italian].

The behaviour of haematite ore pellets was studied with special ref. to their compressive strength, porosity, low temp. degradation, swelling, reducibility, and softening under load. The SiO_2 levels were between 1 and 8%, and the $CaO:SiO_2$ ratio varied between 0.05 and 2.0%. The marked degradation of pellets at high basicity levels, the mechanism of the abnormal softening of pellets at <1.0 basicity, and the causes of high swelling of pellets at basicities of 0.1–0.5 are discussed.—H. S.

669.162.26:
622.341–188

Improved Blast Furnace Operation. P.L. Woolf. (Efficient Use of Fuels in the Metallurgical Industries, 1975, 263-296 (Symposium, Chicago Dec. 1974)

Several tests conducted in the Bureau of Mines experimental blast furances are discussed briefly. They are related to the remarkable improvements in blast furnace performance which the industry has achieved over the past 20 years. The tests selected from the many which had been conducted were those which resulted in coke economy, and which it is believed were significant contributions to the blast furnace industry. They include burden benefication, substitute cokes, high top pressure and the combination of fuel injection with high blast temp. Three proposals are made which offer potential for substantial coke saving-injection of coal pellets made by the spherical agglomeration process-use of prereduced burdens and injection of hot gases into the lower stack. A brief discussion of how these proposals might be implemented is presented.

669.162.26:
662.749.2

Investigation Of Some Coke Properties Affecting Blast Furnace Operations. L. Crovella et al (from Ital.) (Boll. Tech. Finsider., 1974, (329), 532-540)

Changes in the coal mixture led to a decline in blast furnace efficiency not shown in the routine tests on the coke. Ash content and reactivity are shown to be correlated with the effects and a test of the decrease of particle size in passing from the throat to the tuyere level was shown to be a good indicator for the coke quality. (Price:- £ 7.00)

669.162.26
662.749.2

42 0023 **Instrumentation and Automation for Blast-Furnace Operations.** Gerhard Bock and Horst Schwarz. Siemens Rev., July 1973, 40, (7), 308-313 [in English].
The basic instrumentation and control devices for a high-pressure blast furnace and its hot-blast stoves are described, the overall system of automation being illustrated schematically. Extension of the system to include a process computer is discussed with ref. to charging and burden control, and the metallurgical and automation control submodels, the co-ordination of which allows manipulative variables, i.e. blast temp. and humidity and burden variables (Fe-coke ratio) to be modified whenever deviations from the specified parameters occur.

669.162.26:
651.011.56

Determination of Blast Furnace Dynamics. V.A. Ulakhovich, E.I.Raikh, V.M.Sholeninov, and V.V.Gaikov. (Stal,'Jan.1975, (1), 9-14) (in Rus.) The effect of changes in the input variables on the output of a large, 2000 m^3, blast furnace was studied by statistical analysis. The factors considered include; ore: ratio; Fe content of sinter; blast temp; blast humidity; and natural gas consumption. The output parameters are gauged by fluctuations in the Si content of the pig iron or by a complex based on the heat used in the lower portion of the furnace. The most rapid effect of the blast furnace operation is achieved by varying blast temp or humidity. The complex index, derived from the heat blalance, allows more precise monitoring, and prediction of the thermal state of the blast furnace than does the control of the Si content of the pig iron.

669.162.26
669.012.34

Improving blast-furnace performance with HIB—experimental blast furnace results. (Proceedings of the 32nd Ironmaking Conference AIME, 1973, 228-234; discussion, 235) WHITE, D. G., STUBBS, P. B., RYGIEL, R. J., HARRIS, M. M., U.S. Steel Corp.'s new iron-ore agglomeration plant in Venezuela is designed to produce 75% reduced iron-ore briquettes, called High-Iron Briquettes (HIB), having an ore content of about 85%. A study was conducted with an experimental blast furnace to evaluate HIB as a blast-furnace burden material. For each 100 lb of metallic Fe/ton of hot metal added to the burden with HIB, the coke rate was decreased 30 lb/ton of hot metal, and the hot metal production rate was increased 4.1%. The additional production can be provided without capital investment in new blast-furnace facilities. The high resistance of HIB to reoxidation and degradation will permit their shipment over long distances.

669.162.26 (?)
669.162.1

42 0105 **A Road to Highly Efficient Hot Blasting: [Effect of Improved Efficiency in Hot Blast Production on Blast Furnace Operations].** S. Kobayashi. Internat. Iron Steel Cong., Düsseldorf, 1974, Preprints, 1974, (Vol. I), 2.1.2.1 1-15 (Met. A., 7501-72 0017) [in English].
Experiences with a blast furnace operating at a blast inlet temp. in excess of 1300 °C are described, and particulars are given of suitable hot stoves, and blast equipment. Operational efficiency of the hot stoves, is improved by their staggered parallel operation, with computer control of heat storage, and switching by fixed operature butterfly valves. The use of such a high temp. blast improves the combustibility of injected heavy oil. Dehumidification of the blast was studied, and a decrease in humidity of 10 g/m^3, at S.T.P. corresponds to an increase in hot blast temp. of ~70 degC.—P. C. K.

669.162.26;
669.162.232.2

669.162.262

Dynamic planning of the blast-furnace charge

I. E. POSTEMSKII and D. V. GULYGA

At the Azovstal' works linear programming methods are used for achieving the optimum distribution of available resources of charge materials between the blast furnaces with allowance for requirements as regards pig-iron chemical composition, the metallurgical quality of the raw materials, and various limitations. Operational planning is carried out for three periods (by shifts I–III) so that the resources additionally arriving by the start of shifts II and III can also be taken into account. Examples are given of the simplex matrices of static and dynamic models; calculated results are explained with a numerical example.

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669.162.262

42 0569 **The Effect of the Quality of the Burden on the Operation of the Blast Furnace.** V. G. Pyzhov. Izv. V.U.Z. Chernaya Metall., 1976, 36-40 [in Russian].
An increase in iron content in the burden leads to an improvement in the working parameters of a blast furnace despite the decrease in the coke consumption of 100% fluxed sinter. Pig iron can be successfully made from a rich burden without incorporating scrap. 11 ref.—C.C.

669.162.262

Intensification of the blast furnace smelting process with normal blast by charging burden materials in separate size fractions. *(Izvest. V. U. Z. Chernaya Met., 1973, (10 28-32) (in Rus.)* PYZHOV, V. G., ADMAKIN, F. K., SLEPTSOV, Zh. E., The influence of charging burden materials in separate size fractions (coke + 60 mm, sinter + 50 mm; coke 60-40 mm, 50-30 mm and above 40 mm; sinter 15-50 mm) on the intensity of operation of a blast furnace 2000 m^3 in volume is investigated. When using coke screened into 60-40 mm and sinter 50-15 mm fractions, the intensity of smelting increased by 3.6 and 5.4% resp., and the coke consumption decreased by 4.7 and 4.6% resp. in comparison with the operation on coke screened at + 40 mm. Operation of the furnace with coarse coke and sinter was less economical than with a narrower sized burden.

669.162.262.001.5

'A Mathematical model for blast furnace operation with inclined layers of burdens. M. Kuwabara and I. Muchi (from Jap.) (Tetsu-to-Hagane, 1975, 61, (6), 787-796) Layer structure in the burden, heat distribution and gas flows are carefully mapped and a mathematical model is developed using only readily measurable parameters. The top, middle and lower part of the furnace, above the meeting zone are treated separately. Radial distributions of process variables are found to be remarkably uneven. (Price: £23)

669.162.262.001.5

Mathematical Model for Blast Furnace Operation With Horizontal Layers of Burdens. M.Kuwabara and I.Muchi. (Tesu-to-Hagane (J.Iron Steel Inst. Jap.) Mar.1975, 61, (3), 301-311) (in Jap).

In the pratical operation of blast furnaces, ore and coke burdens charged alternately to the top of the furnace descend layer by layer and contact the ascending gas. To clarify the operating characteristics of the furnace with horizontal burden layers, a comparatively simple model has been developed by taking account of the indirect reduction of iron ores, the decomposition of limestone and the solution loss in the model building. With the aid of this model, the longitudinal distribution of process variables, such as the temp.of gas and solid particles, the fractional conversions of iron ore, limestone and coke, the volume flow rate of gas the composition of gas, the gas density and the bulk densities of ore and coke layers, have been calculated numerically over the region from the top to the melting zone of the furnace. The characteristic features in the furnace with the horizontal burden layers are discussed on the

669.162.262

42 0112 The Role of Burden on Fluid Dynamic Phenomena Affecting Blast Furnace Performance. S. Paiella, M. Giuli, P. Barnaba, R. Sacerdote and F. Tammaro. Symposium on Blast-Furnace Aerodynamics, University of New South Wales, Wollongong, Australia. 1975, 75-85 [Preprint-English].

Following a theoretical consideration of the effect of flooding, fluidization and softening on blast furnace blowing limits, results are presented which show the effect of these parameters on operation. It is shown that in these trials the furnace operated at levels of fluidization very much (60-90%) below those theoretically calculated whereas in some cases (high proportion of sinter) actual hot metal output was near the calculated flooding limit. However, it was observed that as the sinter percentage decreases actual productivity becomes lower than the one caused by flooding. This gap, which increases as other ferrous components (essentially acidic) replace the basic sinter was explained by the softening of the burden under bosh conditions. Softening indices measured on the individual materials yield support to this explanation. Coke rates data show that for ~ every 1% increase in the basic sinter in place of blended sized ore, a coke rate decrease of 1.1 kg/thm results. For acidic pellets this value is 0.6 kg/thm. Results of breakdown and reduction characteristics are also given and their indices compared with actual production. Measures to improve operations are proposed. 24 ref.--AA

669.162.262
539.217

42 0118 Investigations of Material Distribution and Permeability—Improvement of the Permeability of No. 7 Blast Furnace. W. Koen, G. A. Fleerman and C. H. Van Toor. Symposium on Blast-Furnace Aerodynamics, University of New South Wales, Wollongong, Australia. 1975, 122-123 [Preprint-English].

Investigations were carried out of burden distribution using a full-scale model of the furnace top. Various charging sequences were used and large differences were found between ore charged as sinter-pellets and as pellets-sinter. These were attributed to the differences in the angle of repose between the two materials. A permeability index was defined which was independent of the driving rate from which a furnace resistance index was obtained for use in weekly reports. Results are summarized as a single expression between blast rates and pressures and the values of Q_{η} and $Q_{max.}$ are continuously measured to aid the operators in controlling the wind rate in the safe ΔP region. Results also indicate a reserve in capacity of No. 7 BF.--AA

669.162.262
622.341.1-188

42 0143 *The Production of Self-Fluxing Pellets and Their Utilization in the Blast Furnace.* K. Taguchi, K. Aketa, and T. Matsumoto. Rev. Métall., Mar. 1976, 73, (3), 247-258 [in French and English].

The production of self-fluxing pellets from ore and limestone and operating experiences at a Japanese steelworks are described. Thorough quality control is required to ensure consistent pellets. Up to 30-35% of self-fluxing pellets in the blast furnace burden has been achieved, but thin smooth shape causes problems in burden stability. Experiments have been made in which 'jumbo pellets' of 25 mm dia. were produced and crushed to give angular particles and this appears to overcome the problem.—P. C. K.

669.162.262
622.341.1-188

Coal Use Down, Productivity Up, With Better Blast-Furnace Practice. J. E. Ludberg, W. H. Becken and R. C. Stanlake. (33 Mag. Met. Prod., Mar. 1976, 14, (3), 50-52)

The effects of the pellet burden, oil injection and other changes on the coal consumption in blast furnaces are described. The use of pellets has provided increased burden permeability, more uniform reduction-gas distribution, improved reproducibility of burden, smoother flowing stock and lower slag volumes. Oil injection and the use of pellets increased the hot blast temp. from 1200 to 1650°F (650-900°C). Use of homogenized oil has allowed a 30% increase over previous oil rates with a corresponding coke rate. External desulphurization of the hot metal permits the use of high oil rates without an increase in slag basicity. Other changes include the use of steelmaking slag, increased wind rate and recycling of the coke breeze.

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665.69

42 0088 *Effectiveness of Using Natural Gas in the Blast Furnace for Smelting Burdens of Varying Reducibility.* A. A. Gimmel'farb, A. M. Zhak, V. S. Tereshchenko, I. I. Dyshlevich, and I. T. Tkach. Stal', July 1974, (7), 580-584 [in Russian].

The effectiveness of using natural gas in blast furnaces is dependent upon the type of charge (sinter or pellets), the state of oxidation, the permeability of the burden, and the amount of the charge that is difficult to reduce. Pellets are reduced faster than sinter. In the middle of the stack the degree of sinter reduction is 34.2%; that of pellets 43.2%. At the bottom of the stack comparable reductions are 45.6 and 62.7%. These differing reduction rates determine the degree of utilization of H as a reducing agent in the bosh-parallel, and bosh zones. 12 ref.—J. W.

Distribution and Build-Up of Burden in Blast Furnaces and Their Effect on Dry-Charge Gas Permeability. K. Berner. (Thesis Tech. Univ. Clausthal, Dec. 1974, 104, + Diagrams) (In Ger.) 669.162.262 669.162.215

In a series of five charging experiments, the distribution of burden consisting of coke, graded and ungraded singer, and pellets to a stock line depth of 0.5-3.5 m in a model furnace shaft of 1.1 scale, under different charging orders, was examined with ref. to the gas permeability of the burden. The effects of altering shaft design parameters were also investigated. The application of the results to real situations in which the burden layers intermingle is discussed. Comparison of experimental permeability and practical results from industrial operations is satisfactory.

Investigation of Blast-Furnace Operation with Pulsating Top Pressure. E. G. Donskov, V. A. Shartlov, B. A. Lozovoi, and I. T. Khomich. (Stal, Feb. 1976, (2), 109-112), (In Rus.); Steel in the USSR, Feb. 1976) 669.162.262.229

Pulsating top-gas pressure in a blast furnace is an effective method of improving operating rate. Trials completed on blast furnaces of 1300-1719 m^3 effective volume suggest the method can be recommeded for larger installations, and raise furnace productivity and reduce the rate of coke consumption.

Some Questions of CO Utilization in Blast Furnaces, by O. Farkas, *Bany es Koh, Lapok (Kohaszat)*, (Hungarian), 1975, Vol. 108, No. 9, pp 389-392. Degree of reduction by carbon monoxide in the blast furnace under Hungarian conditions is determined for a range of values of blast and top gas temperatures. The max theoretical degree of CO utilization is determined and the great possibilities for further development are demonstrated. (BISI 14174-about $17.00) 669.162.262.232

669.162.263.232:
669.784

ndirect Reduction and Carbon Consumption in Blast-urnace Operation. N.N.Babarykin (from Russ.) (tal', 1975,(5),395-401.). This method of calcula-ing carbon consumption is based on a comparison of arbon consumption as a reducing agent or a heat ource under conditions of direct (R_i = 0) or indirect reduction (R_i = 1). All reducing-process indices re closely related and are definitely determined y the operating conditions (composition of raw aterials and pig iron, heat consumption, blast temp.and composition). The value of R_i or R_i cannot e taken as an independent index.CO The lowest tech-ically possible consumptions of gasified carbon C_t, (standard reducing agent C_o, coke k) in operation

669.162.262.[illegible]

Intensification of the blast furnace smelting process with normal blast by charging burden materials in separate size fractions. (Izvest. V. U. Z. Chernaya Met., 1973, (10, 28-32) (in Rus.) PYZHOV, V. G., ADVAKIN, F. K., SLEPTSOV, Zh. E., The influence of charging burden materials in separate size fractions (coke + 60 mm, sinter + 50 mm; coke 60-40 mm, 50-30 mm and above 40 mm; sinter 15-50 mm) on the intensity of operation of a blast furnace 2000 m^3 in volume is investigated. When using coke screened into 60-40 mm and sinter 50-15 mm fractions, the intensity of smelting increased by 3.6 and 5.4% resp., and the coke consumption decreased by 4.7 and 4.6% resp. in comparison with the operation on coke screened at + 40 mm. Operation of the furnace with coarse coke and sinter was less economical than with a narrower sized burden.

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622.341.1-7[illegible]

Quality control of self-fluxed pellet in Kakogawa No. 1. Pelletizing plant. (Proceedings of the 32nd Ironmaking Conference AIME, 1973, 248-259). TAGUCHI, K., AKETA K., KOIZUMI, H., The plant has an annual capacity of 2 500 000 tons and produces self-fluxed pellets with a lime: silica ratio of 1.25. In the blast furnace they are used as 85% of the burden. The effect of pellet quality on blast-furnace performance, quality control practices and operating conditions in the pelletizing plant are described. The pellet quality is based on chemical composition, cold crushing strength porosity, size distribution, softening property, reducibility and swelling index. Softening property and reducibility are thought to be the most important criteria. Porosity is an effective means of evaluating these two properties.

V

Improving blast-furnace performance with HIB—experimental blast furnace results. (Proceedings of the 32nd Ironmaking Conference AIME, 1973, 228-234; discussion, 235) WHITE, D. G., STUBBS, P. B., RYGIEL, R. J., HARRIS, M. M.,
U.S. Steel Corp.'s new iron-ore agglomeration plant in Venezuela is designed to produce 75% reduced iron-ore briquettes, called High-Iron Briquettes (HIB), having an ore content of about 86%. A study was conducted with an experimental blast furnace to evaluate HIB as a blast-furnace burden material. For each 100 lb of metallic Fe/ton of hot metal added to the burden with HIB, the coke rate was decreased 30 lb/ton of hot metal, and the hot metal production rate was increased 4.1%. The additional production can be provided without capital investment in new blast-furnace facilities. The high resistance of HIB to reoxidation and degradation will permit their shipment over long distances.

Introductory Paper: Consistent Iron Quality. J.Dartnell. (Consistent Iron, 1975, 7-13 Metals Society Pub.). The blast furnace must be charged with raw materials of consistent chemical and physical quality, and thermal stability must be maintained. Slag chemistry has a major effect on iron analysis. Features of the control of coke, sinter, other raw materials, burden/coke ratio, and blast-furnace conditions are discussed.

Use of Iron-Wustite Compacts in Blast-Furnace Smelting. (Metallurg, Apr. 1974, (4), 10-13) (in Rus.) POKHVISNEV A. et al. Compacts of Fe-FeO were substituted for 33% of the charge in a blast furnace of 700 m^3 volume, and resulted in a coke saving of 7%. Although the proportion of fines in the charge increased by 14.6%, the loss during smelting was unaffected. This was attributed to the high resistance of the Fe-FeO compacts to crushing.

42 0573 The Use of Carburized Non-Roasted Pellets [in Blast-Furnace Smelting]. A. M. Chernyshev et al. Metallurg, Dec. 1975, (12), 9-12 [in Russian]. 669.162.262.4: 622.341. —188

An investigation into the smelting of carburized non-roasted pellets contg. Fe 34.4% and having a $CaO:SiO_2$ ratio of 0.8 was carried out in a 125 m^3 blast furnace. On using 50% of carburized pellets in the blast-furnace charge, the productivity of the furnace increased by 8.7%, the specific coke consumption was reduced by 8.3%, the content of non-metallic inclusions in the pig iron was reduced by an order of magnitude, and the relative amount of pig iron without inclusions increased by a factor of 2.36 as compared with ordinary practice.—L.

Burden Level Measurement in Blast Furnace. (Steel Times September, 1974, 202, (9), 617-620) LENGER, F. and KNOOP, J. The importance of the stock level and its location and control in blast-furnace operation is indicated, and rod- and chain-type methods for its determination are illustrated and described. Ultrasonic, radioisotope, and radar techniques are outlined and assessed. 669.162.262.

A Study of Ore-Char Briquettes and Their Reduction Kinetics. R.S. Ghosh, N. G. De, J. Singh, and A. Lahiri. (Iron Steel Int., Dec. 1975, 48, (6), 459-461, 464-465, 468-469, 471) 669.162.26

A process for the production of pre-reduced briquettes at comparatively low temp., from a mixture of iron ore and non-coking coal char (prepared by carbonizing non-coking coal) is described. Studies carried out to determine the suitability of these briquettes as blast-furnace feed are reported, and their reduction kinetics discussed.

The Relationship Between the Indices of Reduction and Coke Rate in the Blast Furnace. (*Izvest. VUZ Chernaya Met., 1974, (1), 21 - 25 [In Rus.]; Steel in the USSR, Jan. 1974*) POKHVISNEV A.N., and YUSFIN Yu. S. The relationships between indices of direct (and indirect) reduction, degree of utilization of reducing capacity of blast furnace gas, and coke rate are discussed. 669.162.263.

The Reducing Processes in a 2700 m^3 Blast Furnace. (*Stal', 1973, (12), 1068 - 1074 [In Rus.]; Steel in the USSR, Dec.1973*) BYALYI L.A., KAILOV V.D., KOSTROV V.A., KOTOV A.P., and POTANICHEV N.A. Sampling and analysis of burden materials and gas, and measurements of temp. and pressure at three levels in the stack and at a number of points along the furnace dia. were made. The burden consisted of sinter and pellets and sampling was carried out during three individual operating periods: one with ordinary blast and 100% sinter burden and two with O enrichment and natural-gas injection, differing in the proportion of pellets. The results were compared with the results of a previous similar investigation on a 1007 m^3 furnace. It is established that the degree of reduction of sinter attained in the stack of the larger furnace is lower than at the corresponding levels in the smaller furnace. The difference is explained by an increased furnace volume and a lower amount of reducing gas per unit of burden. 669.162.263.23

Analysis of Reduction Processes in Blast Furnaces on a Metallized and Oxidized Burden. (Stal', Sept.1974, (9), 780- 785 (in Rus); Steel in the U.S.S.R.Sept.1974).. POKHVISNEV, A.N. YUSFIN, S.Yu PAREN'KOV, A.E. and KLEMPERT. V.M. A comparative assessment is presented of the development of reduction processes in a blast furnace in smelting a standard oxidized fee (sinter, pellets), or a metallized burden. The metallized feed is reduced quite rapidly down the furnace stack, and the extent to which indirect reduction occurs, increases on changing from an oxided to a metallized charge. Reduction processes in a blast furnaces should be assessed by the equation of Pokhvisnev and Yusfin(ibid., 1968, 1077) which takes account of the inter-relationship of the three furnace characteristics coke consumption rate, the degree of gas utilization, and the direct reduction rate. 669.162.263.23

The Relationship Between the Indices of Reduction and Coke Rate in the Blast Furnace. (*Izvest. VUZ Chernaya Met., 1974, (1), 21 - 25 [In Rus.]; Steel in the USSR, Jan.1974*) POKHVISNEV A.N., and YUSFIN Yu. S. The relationships between indices of direct (and indirect) reduction, degree of utilization of reducing capacity of blast furnace gas, and coke rate are discussed. 669.162.263.2 / 669.162.18

Indirect Reduction of Iron is the Result of Separating the Thermo-Dynamics of the Blast-Furnace Process from the Kinetics. (Izv. VUZ Chern. Met., 1974, (8), 19-22) (from Rus.) Chernyatin, A.N. The reasons for the contradictory nature of ideas on the role of indirect reduction of iron are clarified. This contradiction is explained by the use of a different volume of primary information, the insufficient weight given to role of kinetic laws in formulating the ideas on bottlenecks, the exaggeration of the possibilities of thermodynamics in operating schemes of partial heat balances, and also by the artificial separation of investigations of this particular problem, from the investigation of the mechanism of thermal transformations as a whole. 669.162.263.232

Indirect Reduction and Carbon Consumption in Blast-Furnace Operation. N.N.Babarykin (from Russ.) (Stal', 1975,(5),395-401.). This method of calculating carbon consumption is based on a comparison of carbon consumption as a reducing agent or a heat source under conditions of direct ($R_i = 0$) or indirect reduction ($R_i = 1$). All reducing-process indices are closely related and are definitely determined by the operating condit ions (composition of raw materials and pig iron, heat consumption, blast temp.and composition).The value of R_i or R_i cannot be taken as an independent index.CO The lowest technically possible consumptions of gasified carbon C_t (standard reducing agent C_o, coke k) in operation without hydrocarbon injection were analysed as applied to blast-furnace operating indices at the Magnitogorsk combine and other works over several years. Calculation results agrees well with experimental data. A low specific carbon consumption, contrary to theoretical ideas of 'ideal' furnace working, is obtained by decreasing R_{iCO} . An increase in the oxidation state of the raw material with a simultaneous rise in its reducibility acts in the same directions. 669.162.263.232

Indirect Reduction of Iron is the Result of Separating the Thermo-Dynamics of the Blast-Furnace Process from the Kinetics. (Izv. VUZ Chern. Met., 1974, (8), 19-22) (from Rus.) Chernyatin, A.N.. The reasons for the contradictory nature of ideas on the role of indirect reduction of iron are clarified. This contradiction is explained by the use of a different volume of primary information, the insufficient weight given to role of kinetic laws in formulating the ideas on bottlenecks, the exaggeration of the possibilities of thermodynamics in operating schemes of partial heat balances, and also by the artificial separation of investigations of this particular problem, from the investigation of the mechanism of thermal transformations as a whole. (Price: £4) 669.162.263.232 / 669.412.34

Inter-Relation Between the Course of the Reduction Process and Coke Consumption in a Blast Furnace. A.N.Ramm, V.G.Manchinsky, K.K.Shkodin, and Ya.B.Karpilovsky. (Stal,'Feb. 1975, (2), 109-113, (in Rus.); BLL M 25156). Errors are alleged in the conclusions reached by N.N.Barberykin (ibid.,1973,973) in his analysis of the reduction processes in blast furnaces. The values of the degree of indirect reduction, R_{ico}, when carbonates are present in the charge, were calculated incorrectly: the insertion of the necessary corrections changes the relationships indicated between R_{ico} and the $O_{ch}:C_o$ ratio. The assertion that coke consumption under constant operating conditions falls with decreasing degree of indirect reduction was also based on unreliable data, and is directly refuted. 669.162.263.234

(55)

Investigation Of Some Coke Properties Affecting Blast Furnace Operations. L. Crovella et al (from Ital.) (Boll. Tech. Finsider., 1974, (329), 532-540) 669.162.263.4

Changes in the coal mixture led to a decline in blast furnace efficiency not shown in the routine tests on the coke. Ash content and reactivity are shown to be correlated with the effects and a test of the decrease of particle size in passing from the throat to the tuyere level was shown to be a good indicator for the coke quality. (Price:- £ 7.00)

Injection of reducing gas into blast furnace (FTG process). (Proceedings of the 32nd Ironmaking Conference AIME, 1973, 288-294; discussion, 295-305) YATSUZUKA, T., OHMORI, K., HARA, Y., IGUCHI, M., SCHLINGER, W. G., Full-scale tests were conducted using a commercial blast furnace with hearth dia. of 29 ft. 10 in. The reducing gas was produced by the 'Fuji-Texaco' (FTG) process, and was injected into the lower section of the blast-furnace stack at ~1000 °C. The test results showed that the coke rate was reduced ~30kg/ton by injecting the gas at a rate of ~Nm³/ton. The economic advantage obtained was 1% in hot metal production per 100 m^3/ton of hot reducing gas injected. There were no adverse effects on the smooth operation of the gas generator, injection equipment or blast furnace. 669.162.263.

Effect of coke reactivity on its consumption in blast furnace. (Hutnicke Listy, Dec. 1973, 28, (12), 833-839) MALY, J. Coke consumption in a blast furnace is not directly related to its reactivity. Although a high reactivity decreased coke consumption, the total effect of coke reactivity can be considerably influenced by other coke properties. The values of coke reactivity were not sufficient alone to evaluate coke properties in the blast furnace. At 1100°C coke reactivity increased probably as a result of the etching of the coke surface by CO_2. 669.162.263.4; 669.162.16

Transient Behaviour of the Blast Furnace after Changes in Operating Variables at Tuyere Level. E.Schurmann, K.Mattheis, and D.Bulter. (Arch.Eisenhuttenwesen, Mar.1975, 46, (3), 195-200) (in Ger.) A formula is derived allowing the position of the smelting zone in the blast furnace to be calculated on the basis of the reduction and temp. profiles. Shifts in the smelting zone brought about by changes in conditions can be determined. The theoretical considerations are confirmed by a practical example based on typical conditions. 669.162.263.42

Investigation of the Transitional Behaviour of the Blast Furnace on Making Adjustments at Tuyere Level. 669.162.263.42
K.Mattheis, D.Bulter, and E.Schurmann. (Stahl Eisen, 7 Nov, 1974, 94, (23), 1100-1108) (in Ger.)
The effects of changes in blast temp., fuel quantity, blast humidity and mixed blast O content on the operational data of blast furnaces, particularly during the transitional periods have been studied. The most immediate effect on slag and hot metal values is caused by blast humidity, followed by O content, blast temp. and fuel level. The effect of adjusting these variables on the extent of Mn and Si reduction is shown.

Investigating The Coke Raceway-Zone at the Tuyeres of the Blast Furnace. N.G. Makhnek, O.P. Onorin, K. D. Konovalov, V.P. Papenov, and V. Kh. Vakulenko. (Stal', July 1975, (7), 588-590 (In Rus.); Steel in the USSR, July 1975) 669.162.263.42

The density of packing of the bed coke in the vicinity of the tuyeres in a blast furnace is reduced as a result of combustion taking place. The reduction in density increases with blast volume and rises sharply as raceway zones are created. The extent of such zones varies with the level of the molten products, slag and iron, in the extent of the raceway zones and enables the furnace to be worked at a higher rate by increasing the blast volume. Too frequent tapping should accordingly be avoided.

42 0090 Combustion of Coal-Dust in the Blast Furnace Hearth. V.N. Andronov and Z. Sh. Plotkin. Stal', July 1974, (7), 587-589 [In Russian]. 669.162.263.42; 662.87
Coal-dust at the rate of 55 g/m^3 of blast is injected into the blast furnace. To ensure complete combustion the particle size of the coal or anthracite should not exceed 35 μm. The optimum coal-dust consumption depends primarily upon the uniformity with which the dust is metered to each tuyere zone. 9 ref.—J. W.

Silicon Reduction in the Blast Furnace Melting Zone and the Hearth. T.Kootz et al. (from Ger.) (Thyssenforschung, 1973, 5, (1) 17-27). Further evidence is produced that reduction of silica in the blast furnace to a silicon takes place by two different mechanisms in two different zones, thus accounting for the anomaly between the behaviour of silicon, manganese and sulphur in the process. Silicon formed in the upper part of the furnace and that formed in the hearth in contact with slag are differentiated and the former is related to the gangue in the ore and the latter to slag basicity which is in turn affected by the silica reduction process itself. (Price:£11.) 669.162.263.42; 669.046.558.5

669.162.263.43

42 0110 **Theoretical Analysis of Blast Furnace Operation Based on the Gas Flow Through Layered Ore and Coke Burdens.** M. Kuwabara and I. Muchi. *Symposium on Blast-Furnace Aerodynamics*, University of New South Wales, Wollongong, Australia. 1975, 61-67 [Preprint-English].

To clarify the characteristics of nonuniform flow of gas through layered burdens of ore and coke, flow equations of continuity and motion were solved numerically taking account of the geometrical effect of a bed. The results are compared with that predicted by an approx. solution. A mathematical-kinetic model for determining the distributions of process variables over the region from the top to the melting level of blast furnace with the horizontal or the inclined layers of burdens is developed in consideration of the uneven gas flow. By the use of this model, the longitudinal and the radial distributions of process variables in an existing blast furnace in Japan were calculated with the aid of a digital computer. Computed results show that the process variables and the melting level change remarkably over the cross-section of the furnace and that the patterns of these distributions are similar to the results observed by other investigators.

669.162.263.45

42 0055 **Softening Behaviour of Blast-Furnace Burden Materials.** P. Barnaba, M. Ceccarini, and R. Fontana. Boll. Tec. Finsider, Feb. 1976, (348), 69-85 [in Italian].

Isothermal tests were carried out in the temp. range 950–1100 °C with reducing gases of various compositions in order to study the softening behaviour of basic and acid sinters and commercial pellets in the blast-furnace burden during reduction under load. Softening is associated with the Wüstite → Fe transformation in particular, and is caused by the non-topochemical formation of Fe. A study was made of the Fe formation mechanism with the aid of structural analysis with the optical and scanning electron microscopes. 16 ref.—H. S.

669.162.263.45
622.341.1—188

42 0141 **The Manufacture of Basic Pellets and Their Behaviour in the Blast Furnace.** N. A. Hasenack, R. B. Vogel, and F. Homminga. Rev. Métall., Mar. 1976, 73, (3), 259-280; discussion, 280-282 [in French and English].

Trials were undertaken in connection with a new integrated steel plant project in the Netherlands to determine the relative merits of acid-fluxed and self-fluxed pellets for use in sinter/pellet mixtures in blast-furnace burdens. Pilot plant pelletizing experiments and blast-furnace trials are described, and detailed cost comparisons made. Fluxing with dolomite has a detrimental effect on sinter quality but the use of limestone raises quality to Japanese levels. 9 ref.—P. C. K.

669.162.263.45
622.341.1—782

42 0141 **The Manufacture of Basic Pellets and Their Behaviour in the Blast Furnace.** N. A. Hasenack, R. B. Vogel, and F. Homminga. Rev. Métall., Mar. 1976, 73, (3), 259-280; discussion, 280-282 [in French and English].

Trials were undertaken in connection with a new integrated steel plant project in the Netherlands to determine the relative merits of acid-fluxed and self-fluxed pellets for use in sinter/pellet mixtures in blast-furnace burdens. Pilot plant pelletizing experiments and blast-furnace trials are described, and detailed cost comparisons made. Fluxing with dolomite has a detrimental effect on sinter quality but the use of limestone raises quality to Japanese levels. 9 ref.—P. C. K.

Investigations on Some Coke Properties Affecting Blast Furnace Operation. (Bell.Tecn.Finsider, July 1974, (329), 532-540) (In It) CROVELLA, L. DI POGGIO, E., IURILLI, G. and VERCELLI, S. The effects of coke, produced in emergency conditions, on blast furnace behaviour are discussed. The relationship between coke ratio and ash content, reactivity, strength after the CO_2 reaction, and the degradation in size from throat to tuyere level are considered.

669.162.263.45
669.749.2

An alkali problem and its solution. (Proceedings of the 32 nd Ironmaking Conference AIME, 1973, 40-59). GEORGE, D. W. R., PEART, J. A., A general deterioration in blast furnace performance over a period of several months was characterized by a gradual build-up of pressure at a constant wind rate until hanging occurred; slipping and peeling, followed by a chilled hearth (low metal temp., low Si and high S in the hot metal, and cold slag that would not run clear of the furnace runner but had to be dug out); and many casts with small coke discharged through the Fe notch during casting. After a long investigation the problem was indentified as being an alkali content in the charge too high for the quality of coke being used. The investigation is detailed and the remedial actions taken are given.

669.162.263.45
669.271

The Alkali Problem in the Blast Furnace. K.P. Abraham and L.I. Staffanesson. (Scand.J.Metall., 1975, 4, (5), 193-204) A survey is made of the alkali problem in the blast furnace. Standard free-energy-of-formation diagrams of alkali compounds that can occur in the blast furnace are modified with the latest literature data. The thermodynamic stability of the alkali compounds during the blast-furnace process is discussed.

669.162.263.45;
669.28

42 0197 **Alkali Control at Dofasco.** **J. D. Ashton, C. V. Gladysz, J. Holditch and G. H. Walker.** Proceedings of the 32nd Ironmaking Conference AIME, 1973, 60-72 (Met. A., 7407-72 0060) [in English].

Under certain conditions of high slag basicities and high hearth temp., the alkali oxides, K_2O and Na_2O, even in relatively low concentrations in the burden, can rapidly accumulate in a blast furnace and result in two major effects: operating problems such as high blast pressures, hanging, scab formation and coke deterioration; reduced lining life caused by refractory wear from both physical abrasion and chemical attack. In a study of the problem in a particular furnace, it was found that ~6lb K_2O + Na_2O/net ton of hot metal was the max. that the furnace could handle. Alkali control methods were developed, and a comprehensive monitoring programme is now in effect. Some empirical relationships describing K_2O removal in the blast furnace were developed.—M. M. R.

669.162.263.45;
669.28

The Contribution of Alkalies to Crust Formation and Setting Up and Alkali Balance for Blast Furnaces. H.Masuda. (Metal.ABM, Sept.1974, 30, (202), 631-636) (in Prt.) A rough alkali balance covering 90 consecutive days of operation for each of two blast furnaces was prepared by considering the amounts of K_2O put into the furnaces each day in the solid charge and the amounts that were removed by way of slag and by the portion of dust captured by the cyclone dust collector. The work showed that the amount of accumulated alkalies in a blast furnace is not necessarily the amount that will be found in the crust formed on the furnace walls. The results support the assumption of a process of recirculation of alkalies in the interior of the furnace. Means of eliminating these nevertheless harmful substances include increasing slag volume and working with an acid slag. 669.162.263.45: 669.88

Solving Scab Problems in CSN's Blast Furnaces. (Rev. Latinoam. Sider., Mar. 1974, (7), 8-13, 28) (in Port.) MASUDA, H. The burning of cleaning charges composed largely of coke on alternate days, the use of flame temp. on the low side in the furnaces and the elimination of excess alkalis from normal melting charges keep Cia. Siderurgica Nacional, Volta Redonda, Brazil, blast furnaces scab-free. When attempts to remove scabs by cleaning charges plus periodic dynamiting were not entirely successful, attention was focused on prevention rather than cure. The successful strategy was developed after discovery of the high alkali content (chiefly K_2O) of the scabs. Stress is laid on the evolution of the solution, which included investigation of the crackling of the unsintered haematite ores frequently used in the furnaces and the related irregularities in the speed and composition of the reducing gases in different parts of the furnace, the correlation between the basicity and the permeability of the charge, the effect of the resistance to hot degradation of the sinter on residual C, phenomena of recycling of alkalis and the effect of condensed alkalis on solid charges. The approaches used to attack the problem are offered as useful to the solution of scab problems in any blast furnace. 669.162.264

42 0195 Blast Furnace Operating Experience With High Oil Injection Rates and Oxygen Enrichment. J. J. Quigley, R. L. Troup and G. H. Craig. Proceedings of the 32nd Ironmaking Conference AIME, 1973, 25-33 (Met. A., 7407-72 0069) [in English]. 669.162.265.6; 662.753.325

Development of fuel injection lances and the design of the fuel oil and O transport system are detailed, and operating results are given. Atomization of oil was found to be essential for high injection rates. By keeping O utilization <60%, high rates of oil were injected with min. problems from C carry-over. A higher replacement ratio (pounds of coke saved per pound of oil injected) was found with high blast temp. operations than with O injection. The relationship between percent O enrichment and production rate was found to be linear up to at least 27% O. Hot metal quality was maintained although slag basicity increased. 8 ref.—M. M. R.

669.162.266

Use of the No.1 Blast-Furnace Cast House at Nippon-KoKan, Fukuyama. (Centre Document. Siderurgique Circul.Inform.Techn., 1974, 31, (10), 2099-2107) (in Fr) ANNICHINI, A. and THIRION, C. The blast furnace has a useful volume of 1920 m^3, 27 tuyeres, and a production of 5500 tons/day. The layout and dimensions of the cast-house runners are outlined, and details of, inter alia, the blast-furnace tapping techniques are given.

669.162.266.2

Consistent Iron: The Steelmaker's Viewpoint. M.D.Ward. (Ironmaking and Steelmaking, 1975, 2, 89-94) The economic and practical steelmaking considerations arising from variations in blast furnace iron analysis are discussed with particular ref. to the tapping constraints imposed by customer and quality control considerations.

669.162.266.2
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Effect of the Size of Tap on the Chemical Composition of Pig Iron. A.M.Lapa, V.T.Il'in, A.I.Vasyuchenko, and I.I.Dyshlevich (Metallurgiya i Koksokhimiya, 1975, (43), 95-98) (in Rus.) Processes taking place in the lower part of the blast furnace stack during the tapping of pig iron were studied with special regard to the relationship between the amount of each tap and the thermal characteristics of the furnace. Too large a tap in some cases led to unacceptable fluctations in temp. which inhibited optimal working and inter alia adversely affected the composition of the pig iron. A correct tap size was vital in ensuring chemical stability of the product and the safety and working life of the whole installation. Careful choice of slag mass and composition was also essential to prevent deviations from the norm.

669.162.266.2
669.015.9

Ways of Reducing Metal Loss when Tapping The Blast Furnace. L. Ya. Shparber and Yu. P. Trunilov. (Metallurg, Nov. 1975, (11), 9-12) (In Rus.) The effect of (i) technology of blast-furnace smelting, (ii) preparation of iron notches and iron runners and (iii) tapping regime, on the loss of pig iron was examined. The metal loss in the form of waste and also with slag depended on both the quality of hearth team work and the design of the main hearth spout and distribution system. Measures are described which can improve separation of iron from slag and reduce metal loss when tapping the blast furnace.

Tapping Pig Iron from the Blast Furnace. N.G. Makhanek, L.M.Kostyrev, and L.Ya.Shparber. (Izvest V.U.Z.Chernaya Met. 1974, (12), 23-27 (in Rus.); Steel in the USSR, Dec.1974). Experiments were made under laboratory conditions to study the relationships involved in the tapping of metal from the blast-furnace. The results of these investigations make it possible to determine the correct conditions for dealing with the molten pig iron. 669.162.266.44

Experimental Studies of Slag Flow in the Furnace Hearth During Tapping Operation. T. Fukutake and K. Okabe. (Trans. Iron Steel Inst. Jpn., 1976, 16, (6), 309-316) 669.162.266. 669.046.58

The slag flow in a blast furnace hearth was studied by means of a model experiment to determine the reasons for a large amount of molten products remaining in the hearth even at the end of tapping. The flow equations as well as the initial and boundary conditions for the slag flow in the hearth are given in terms of dimensionless variables.

42 0262 The Injection of Mazut into the Hearth of Large Blast Furnaces. B.I. Ashpin *et al.* Metallurg, Aug. 1975, (8), 11-14 [in Russian]. 669.162.267.4

A system for injecting mazut into the hearth of blast furnaces of capacity 2000-3000 m^3 is described. The use of mazut partially replacing the coke, improved the effectiveness of the operation of blast furnaces when working with slags contg. magnesia and alumina.

Blast-Furnace Operation on a Cold Blast Enriched with 30% Oxygen. N.N. Babarykin, N.M. Kryukov, L. Ya. Levin, V.S. Novikov, and Yu. V. Yakovlev. (Stal' Sept. 1975 (9), 784- 790 (In Rus.); Steel in the USSR, Sept. 1975,) 669.162.267.4

Experiences in running a blast furnace of 1370 m^3 volume during a period when the hot-blast stoves were being reconstructed are described. A reduction in blast temp. from 1050 to 80°C, and an increase in blast O concentration to 30% secured a good hearth heat, but furnace productivity was reduced by 18.4% and total fuel consumption increased by 33.4%. Such operating schedules are justified only in exceptional circumstances, such as during hot-blast-stove reconstruction.

Diversification of Energy Sources for the Blast Furnace: the Double Injection Process. (Ironmaking and Steelmaking, 1974, 1, (2), 85-89) COHEUR, P. and DECKER, A. The best blast furnace in the world are at present working with about 380 kg coke/ton hot metal and 100 kg fuel oil/ton hot metal. The double injection process makes it possible to reduce this coke rate, so long as the effects of the injections are additive. Trials were carried out on a furnace of 4.6 m hearth dia. (450 tons hot metal/day) With 615 kg/ton hot metal without injection, the coke rate dropped to 436 kg/ton with the injection of 428 Nm^3 reducing gas/ton hot metal in the bosh (mainly H_2 + CO) and 78 kg fuel oil/ton hot metal. The repalcement ratio of the reducing gas was about 0.25 kg coke/Nm^3 reformed gas. 600 m^3 reformed gas and 150 kg fuel oil/ton hot

669.162.267.4

Diversification of Blast-Furnace Fuels. R.Capelani, M.Schneider, and C.Staib. (Centre Document. Siderurgique Circul.Inform.Techn.1975, 32, (5), 1189-1222; 1219) (in Fr.) The partial replacement of coke in blast furnace fuel by gas, fuel oil, and C injected with air is discussed. These processes only replace 10-20% of the coke. Systems, aimed at ensuring good fuel combustion are being tested industrially on an experimental scale, and should result in a doubling of the quantities injected. Other experimental techniques include the charging of pre-reduced products or different forms of coke, and the injection of reducing gas into the hearth. By combining several of these methods it is theoretically possible that coke will represent only 40-50% of the fuel.

669.162.267.4

Improving Blast Furnace Technology at the Karaganda Combine. B.N.Zherebin, P.P. Mishin, A.E.Paren'kov, A.A.Nikitin, and V.V.Volkov. (Stal,'Dec.1974, (12), 1068-1073, (in Rus.); BISI 13126). Experiences in operating a blast furnace of 2700 m^3 useful volume are described, and the reasons for increasing the tuyere dia. from 180 to 200 mm, and modifying the charging system are reviewed. It is intended to increase the number of tuyeres to 24, and of Fe-notches to three. Improved operating indices are planned by increasing the consumption of heavy fuel oil to 60-80 kg/ton of pig iron, and of the concentration of O in the blast to 30% and above.

669.162.267

The Progress Achieved in the Blast Furnace Process. (Prace Inst.Hutniczych 1973,25, (1/2/3), 25-32) [In Pol.] RADOMINSKI Z. The use of fuel enrichment through the tuyeres of a blast furnace has shown a saving of 2.8 x 10^6 tons of coke over the last decade, and in 1972, about 10% of the coke was replaced by substitute fuels. The fuels found to be effective were powdered coal and natural gas with powdered coal showing the most promise. Also discussed are some improvements to furnace design and construction, as well as problems associated with blast furnace slags and their utilisation. 669.162.267.4

Injection of reducing gas into blast furnace (FTG process). (Proceedings of the 32nd Ironmaking Conference AIME, 1973, 288-294; discussion, 295-305) YATSUZUKA, T., OHMORI, K., HARA, Y., IGUCHI, M., SCHLINGER, W. G., Full-scale tests were conducted using a commercial blast furnace with hearth dia. of 29 ft. 10 in. The reducing gas was produced by the 'Fuji-Texaco' (FTG) process, and was injected into the lower section of the blast-furnace stack at ~1000 °C. The test results showed that the coke rate was reduced ~30kg/ton by injecting the gas at a rate of ~Nm³/ton. The economic advantage obtained was 1% in hot metal production per 100 m³/ton of hot reducing gas injected. There were no adverse effects on the smooth operation of the gas generator, injection equipment or blast furnace. 669.162.267.4

669.162.267.4

Coal Use Down, Productivity Up, With Better Blast-Furnace Practice. J. E. Ludberg, W. H. Becken and R. C. Stanlake. (33 Mag. Met. Prod., Mar. 1976, 14, (3), 50-52)
The effects of the pellet burden, oil injection and other changes on the coal consumption in blast furnaces are described. The use of pellets has provided increased burden permeability, more uniform reduction-gas distribution, improved reproducibility of burden, smoother flowing stock and lower slag volumes. Oil injection and the use of pellets increased the hot blast temp. from 1200 to 1650 °F (650-900 °C). Use of homogenized oil has allowed a 30% increase over previous oil rates with a corresponding coke rate. External desulphurization of the hot metal permits the use of high oil rates without an increase in slag basicity. Other changes include the use of steelmaking slag, increased wind rate and recycling of the coke breeze.

Reducing fuel costs

669.162.267.4.

W. R. Laws*

Research has been carried out for many years on reducing the cost of fuel in steelmaking. This article briefly describes where energy is used in integrated works and highlights some of the past and present engineering research undertaken by the CEL of Battersea aimed at reducing fuel consumption.

Iron and Steel International, April 1974
pp 10? - 115

Coal Injection Replaces 13% of Blast Furnace Coke

669.162.267.4;
662.66

By G. J. McManus

Armco has used coal to replace 13 % of the coke normally required in the Amanda furnace, which is equipped with a generation of pulverizing and injecting systems. On the basis of coke at $ 80.- a net ton and $ 40.- a ton, 13 % replacement rate saves $ 2.85 a ton of hot metal or $ 285 over a month, whereas the use of oil or gas if reformed outside is expensive.

IRON AGE: Metalworking International, Feb' 1977 pp 34

669.162.267.4;
662.69

42 0126 Starting-Up a Blast Furnace Using Natural Gas. G.G. Galiev *et al.* Metallurg, Feb. 1976, (2), 15-17 [in Russian]. During the starting up of a 1386 m^3 blast furnace following general maintenance, natural gas was injected through all the tuyeres immediately after coke firing. This allowed stabilization of the S content of the pig iron and reduced the time required for the operating characteristics of the furnace to be attained.—L. G.

669.162.267.4;
662.69

Estimating the Optimum Proportion of Natural Gas To Be Mixed with the Air Blast in the Blast Furnace. (Metallurg, Mar. 1974, (3), 9-10) (in Rus.) BYALYI, L.A. and KOTOV, A.P. A method of calculating the ratio D of the volume of natural gas to that of the air blast, at various circular zones of a blast furnace of 2700 m^3 volume, is presented. The H content in the gas samples, taken from various positions in the blast furnace stack, was indicative of the value of D.

669.162.267.4
662.69

Technological Assessment of Various Regimes of Blast Furnace Operation under Conditions Existing at a New Works. Yu.I. Gokhman. (Stal', Aug. 1975, (8), 679-683 (In Rus.); BISI 13916)
The performance of blast furnaces of 3200 m^3 capacity are compared under the following regimes: (i) injection of cold natural gas into a blast at 1400°C enriched to 35% O; (ii) natural gas at 500°C introduce into the blast; (iii) as (i) and (ii), resp., but with coke-oven gas substituted for the natural gas; and (iv) a blast composed of hot-reducing gases at

Progress Achieved In The Blast-Furnace Process. Z. Radominski (from Pol.) (Prace Inst. Hutn., 1973, 25, (1-3), 25-32)
Reduction of coke rate by injection of natural gas and of non-coking coals as lumps or as powder has been studied in Poland; the equipment for coal grinding and injection is shown. (Price:- £ 9.00)

669.162.267.4
662.69:

Influence of Injection of Hot Decomposed Hydrocarbons and Technological Oxygen on the Metallurgical Conditions in the Blast Furnace. J. Horvath. (Banyasz. Kohasz. Lapok (Kohasz.), May 1975, 108, (5), 193-197) (In Hung.)
The effect of a combined injection of hot decomposed hydrocarbons (natural gas) and technological O on the metallurgical conditions in the blast furnace was studied. For a constant theroretical temp. of combustion and O concentration the temp. of the blast which gives a min. coke consumption is calculated. The value is 50 kg per ton of pig iron. In this case indirect reduction is practically 100% and no coke is consumed for the direct reduction.

669.162.267.4
662.69

The Operation of a Blast Furnace Simulator with Gases Rich in H_2/H_2O. (Aufbereitungs - Technik, 1974, (5), 260-265) (from Ger.) WENZEL, W. et al. When blowing large amounts of hydrocarbon gas into the hearth, or a hydrogen-rich gas into the shaft, there is a change in working data. A blast furnace simulator can be used to study the behaviour of ores, pellets, sintered material and coke, either simply, or as mixtures, under varying conditions of temperature, gas composition, burden and gas pressure.

669.162.267.4;
662.69

Combined Use of Heavy Fuel Oil and Natural Gas in Blast-Furnace Operation. (Stal', June 1974, (6), 481-488) (in Rus.) TKACHENKO, A.A. et al. A technology for the combined use of heavy fuel oil and natural gas is described, in which the fuel oil is introduced into the natural gas supply line to each tuyere of a blast furnace of 1386 m^3 capacity, operating with an O enriched blast. The oil can be used as a substitute for natural gas when this is in short supply, or in a balanced reducing mixture to achieve a reduced consumption of coke. Maintaining furnace productivity, a coke saving of 26 kg/ton pig iron (5.2%) was attained when party the natural gas was replaced by the fuel oil. When the fuel oil was supplied at a rate of 31 kg/ton (or 58 m^3/ton in terms of natural gas, in addition to the max. amount of natural gas injected (102 m^3/ton) the coke saving in ceased to 45 kg/ton pig iron.

669.162.267.4
662.69;
662.753.325

669.162.267.4;
662.753.3;

42 0203 Industrial-Scale Use of High Sulphur Heavy Oil in the Blast Furnace. Whodyslaw Wozniacki and Wiktor Matlinski. Wiadomosci Hutnicze, Jan. 1974, 30, (1), 2-7 [in Polish].
Heavy fuel oil with a high S content, was considered as an alternative fuel for blast furnaces. With a calorific value of 9700 kcal/kg, the oil contained C 86.17, H 10.97, N. 0.28, O 0.17, and S 2.36%. The flash point of the oil was 100-124 °C and the viscosity at 80 °C was 12-15 Engler degrees. The S content of the pig iron was increased by a significance amount, and if introduced in amounts >50 kg/ton of pig iron, rubsequent desulphurization of the metal would be necessary.

669.162.267.4;
662.753.3;
662.87

Use of Heavy Fuel Oil and Pulverized-Coal Fuel in Blast-Furnace Practice. L.G.Salamatov (from Russ). (Stal', 1975, (1), 18-19) Natural gas is generally in short supply in winter and is not available at all works. A conference was held in March 1974 to consider the use of pulverized coal and heavy fuel oil instead of or in combination with natural gas, with and without oxygen enrichment of the blast. (Price: £3.00)

669.162.267.4;
662.753.3;
669.162.221.2

42 0196 Special Tuyeres for the Injection of Large Quantities of Full Oil into the Blast Furnace. D. Borgnat, H. Della Casa, M. Schneider, and C. Staib. Internat. Iron Steel Cong., Düsseldorf, 1974, Preprints, 1974, (Vol. 1), 2.1.2.3 1-16 (Met. A., 7501-72 0017) [in French].
To study the limitation of fuel oil injection through combustion difficulties, a high power combustion chamber was constructed capable of a blast rate of 10000 m³/h at 1100 °C, with pressures up to 2.5 bar and oil injection of 2000 l./h max. Three types of tuyere were compared: (i) a conventional three hole tuyere giving peak performance at 65 g oil/m³ air; (ii) a subsonic converging-diverging tuyere, with a corresponding value 100g oil, and (iii) a supersonic shock wave tuyere, in which oil injection can be increased to a corresponding value of 160 g.—P. C. K.

669.162.267.4;
662.753.3
669.162.224.

Blast furnace operating experience with high oil injection rates and oxygen Enrichment. (Proceedings of the 32nd Ironmaking Conference AIME, 1973, 25-39).
QUIGLEY, J. J. TROUP, R. L., CRAIG, G. H., Development of fuel injection lances and the design of the fuel oil and O transport system ate detailed, and operating results are given. Atomization of oil was found to be essential for high injection rates. By keeping O utilization below 80%, high rates of oil were injected with min. problems from C carry-over. A higher replacement ratio (pounds of coke saved per pound of oil injected) was found with high blast temp. operations than with O injection. The relationship between percent O enrichment and production rate was found to be linear up to at least 27% O. Hot metal quality was maintained although slag basicity increased.

669.162.267.4
662.753.325

Fuel oil treatment

The amount of coal tar or residual oil that can be added to a blast furnace to reduce coke rate is usually limited because of inefficient combustion; Nalco Chemical Co. has announced a product that can improve the situation. FIRE-PREP 8255 is an easy-to-handle liquid combination of an organic surfactant and a combustion catalyst.

Blast furnace operators often inject liquid fuels at the tuyeres to replace some of the expensive and scarce coke that is charged in at the top. However, because of insufficient air/fuel contact in the limited combustion zone, too high a fuel rate will cause smoking, and unburned carbon will cause problems in the scrubber water system.

The surfactant action of FIRE-PREP 8255 promotes better atomization of the fuel, yielding smaller droplets and improved combustion. The catalytic action lowers the ignition temperature of hydrocarbons and carbon, promoting more complete burning of the fuel. FIRE-PREP 8255 will usually allow the injection of more tar or oil with a resultant decrease in the coke requirement/ton of hot metal. Since it improves combustion efficiency, it also helps the blast furnace to get max Btu value out of the fuel that it does use. When added to the fuel before it enters storage, it will help to control sludge formation in storage tanks and transfer lines. Heavier hydrocarbon constituents will tend to remain dispersed, burning along with the lighter materials when they reach the combustion zone.

In addition to its use in blast furnace supplemental fuel, FIRE-PREP 8255 can improve the efficiency of other steel mill processes fired with residual fuel oil, such as reheat furnaces and boilers. The expected effect in these operations is reduced visible stack discharges due to more complete combustion and improved heat transfer due to cleaner surfaces.

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669.162.267.4;
662.753.325

42 0142 Conditions for High Fuel-Oil Additions to Blast Furnaces During Pig-Iron Manufacture. Werner Hoffmann. Thesis, Tech. Univ. Aachen, 1974, 62 pp [in German].
Fuel-oil input for pig-iron production can be doubled by controlling the size of oil droplet produced in the blast. Blast temp. and velocity when too high tend to reduce oil combustion so that the oil input should be arranged perpendicular to the blast. Complete combustion of small droplets overcomes the temp.-lowering effect of high fuel-oil additions. Cooling the lance is necessary to prevent cracking of the oil before combustion. 41 ref.—P.V.

669.162.267.4;
662.753.325

Appropriate Operational Range for Simultaneous Injection of Oxygen and Oil in Large Quantities in the Blast Furnace. (Tetsu-to-Hagane (J. Iron Steel Inst. Jap.), July 1974, 60, (8), 1078-1083) (in Jap.) HIGUCHI, M. IIZUKA, M., KURODA, K. and SUMIGAMA, T. Simultaneous injection of O and oil in large quantities is likely to cuase slipping and other irregularities in the blast furnace if the choice of each quantity is inappropriate. For this reason, it is necessary to treat this problem both from theoretical and operational points of view. To solve this problem the idea of an appropriate operational range is introduced which takes into account the limitation of heat exchange of gas and burden, theoretical temp. at tuyeres and full combustion of oil. Fukuyama No. 2 BF has been operated applying these considerations. The operational results of 380 kg/tHM coke ratio and 78 kg/tHM oil ratio have been obtained by O enrichment of 2.5%. The furnace is operated under good conditions with 3.8% O enrichment, which proves that the idea of an appropriate operational range is very beneficial in injecting O and oil in large quantities.

669.162.267.4
662.753.325

42 0032 New Developments in Blast-Furnace Oil Injection. Friedrich Lüth. Klepzig Fachber., July 1973, 81, (7), 301-302 [in German].
Some of the methods for injecting oil in blast furnaces are appraised. Adding water to the oil to form an emulsion requires subsequent O enrichment, with an increase in the cost. The use of a radial nozzle enables a greater rate of injection, up to 150 kg/ton of molten metal to be achieved, without O enrichment.—BA

669.162.267.4
662.753.325

Conditions for High Fuel-Oil Additions to Blast Furnaces During Pig-Iron Manufacture. W. Hoffmann. (Thesis, Tech. Univ. Aachen, 1974, 62 pp) (In Ger.)
Fuel-oil input for pig-iron production can be doubled by controlling the size of oil droplet produced in the blast. Blast temp. and velocity when too high tend to reduce oil combustion so that the oil input should be arranged prependicular to the blast. Complete combustion of small droplets overcomes the temp. lowering effect of high fuel-oil additions. Cooling the lance is necessary to prevent cracking of the oil before combustion.

669.162.267.41
662.753.325

42 0073 Fuel-Oil Injection into Blast Furnaces: A Literature Review. H.G. Lunn and G.W. Waterhouse. J. Inst. Fuel, June 1976, 49, (399), 70-78 [in English].
The use of auxiliary fuel injection in blast furnaces is reviewed. It is suggested that auxiliary injection, although expensive, will continue to be used because of the operating flexibility it introduces into the melting operation. Injection rates can be increased above those currently used by adjustment of current operating procedures. The economics of fuel injection are discussed and the main competitors to oil are natural gas, coke-oven gas and non-coking coal. However, it is concluded that on economical grounds the latter is the only competitor to oil. 59 ref.—R.E.

669.162.267.41
662.753.325

Combustion of Heavy Oil In Blowpipe And Tuyere. T. Inatani et al (from Jap.) (Tetsu-to-Hagane, 1976, 62, (5), 514-524)
Experiments on models and on a blast-furnace tuyere showed conditions under which the injection of heavy oil could be intensified without the formation of soot, ad also, by means of probes, the reactions occurring and where they occurred, were determined, making some assumptions. Two types of blowpipe were developed and their effects on blast injection were observed. (Price:- £ 19.00)

Operation of a 3000 m^3 Blast Furnace Using Heavy Fuel Oil. (Stal', Oct. 1974, (10), 886) (in Rus.) ASHPIN, B.I., STEPTSOV, Zh. E., ADMAKIN, F.K. and GUSAROV, A.K. Plant and equipment installed for injecting heavy fuel oil into the hearths of a 3000 and 2000 m^3 blast furnace are described. With an injection rate of 21.3 kg/ton of pig iron, a corrected coke saving of 28 kg/ton pig iron was obtained.

669.162.267.4; 662.753.325

Use of Heavy Fuel Oil and Pulverized-Coal Fuel in Blast-Furnace Practice. L.G. Salamatov (from Russ). (Stal', 1975, (1), 18-19) Natural gas is generally in short supply in winter and is not available at all works. A conference was held in March 1974 to consider the use of pulverized coal and heavy fuel oil instead of or in combination with natural gas, with and without oxygen enrichment of the blast. (Price: £3.00)

669.162.267.4; 662.753.325 662.87

A2 0019 Recent Progress and Future Prospects in Blast Furnace Fuel Injection in Japan. Heiji Ikegami. Trans. Iron Steel Inst. Jap., 1974, 14, (1), 54-60 [in English]. Recent progress of fuel injection with comments on future problems related with energy (coking coals and nuclear) are discussed. Blast furnace metallurgists must make efforts so that the max. blast furnace efficiency may be achieved through the careful use of petrochemical fuels by the effective use of the other alternative fuels. Some of the difficulties have been overcome and successful results obtained by fuel injection technologies. 27 ref.—F. G. N.

669.162.267.4(52) 662.753.325

Slurry injection in the blast furnace. (Congress, 'Coke and Iron in the Steel Industry, 1966, 509-514). [from Fr.] LIMPACH, R., et al. Blast Furnace No. 5 of the Seraing Works of Cockerill-Ougree was equipped with a slurry injection plant based on the system developed by C.N.R.M. A coalfuel oil slurry, containing 62 wt.-% of moist coal (9.5% H_2O, grain size range: 0-12 mm) and 38 wt.-% extra-heavy fuel oil was injected through the 8 hearth tuyeres of BF No. 5. The first test was run at an injection rate of 102.5 lbs of slurry/NTHM. During this test, the furnace was running very regularly and the pig iron was of very good quality. The comparison of the corrected coke rates for the base period and for the test period gave the replacement ratio coke/slurry; this ration was verified by theoretical calculations. The injection tests, which had to be stopped for a relining job of BF No. 5, were resumed soon after.

669.162.267.[illegible] 662.753.3[illegible]

Special Tuyeres for the Injection of Large Quantities of Fuel Oil into the Blast Furnace. (Centre Document. Siderurgique Circul. Inform. Techn., 1974, 31, (11), 2445-2455) (in Fr) BORGNAT, D. DELLA CASA, H. SCHNEIDER, M. and STAIB, C. The injection of large amounts of fuel oil into blast furnaces is often limited by problems of combustion.

669.162.267.4; 662.753.325; 669.162.221.2

NKG Process. T. Miyashita, K.Sano, H.Nishio, S. Ohzeki and T.Nayuki. (Iron Steelmaker, Feb. 1975, 2, (2), 29-38) Due to the high cost of O and natural gas for Fe and steelmaking, Nippon Kokan KK started to produce cheap reducing gas by reforming some gaseous hydrocarbons, such as coke-oven gas, natural gas and gas obtained by cracking of coal, with CO_2 and H_2O contained in the reforming raw material formed by the blast furnace top gas. The top gas of the blast furnace is reformed to a reducing gas, which is injected in a recycle system into a blast furnace stack. Methods were developed to lower the N content in the injected gas, produce reducing bas without S interference and inject safely into blast furnace stack. Commercial furnaces and their operating techniques are described in detail. The economic advantages, such as using lower amounts of virgin material, or 3% energy cost saving, are calculated with the aid of mathematical models.

669.162.267.4
662.76

42 0198 Prospects for Higher Productions and Lower Coke Consumption [in the Blast Furnace] Through the Injection of Hot Reformed Gas. J.Horvath. Internat. Iron Steel Cong., Düsseldorf, 1974, Preprints, 1974, (Vol.I), 2.1.2.5 1-17 (Met. A., 7501-72 0017) [in English].
Tests were carried out on the combined injection into a blast furnace of hot reformed gas (CO and H) and O. The results indicated that (i) the benefits of O enrichment decrease rapidly when the hot gas and blast temp. exceed 1200 °C; (ii) increases in temp. of either the hot gas on the blast in 100 degC increments give similar reductions in coke consumption up to a max. of 25 kg/ton; (iii) the lowest specific coke consumption attainable is ~50 kg/ton.—P. C. K.

669.162.267.4
662.76

42 0095 The Injection of Hot Reducing Gas into Blast-Furnace Tuyeres. N. Ponghis, A. Poos, P. De Woot, J.-M. Masuy, and A. Thirion. Revista Met., May-June 1974, 10, (3), 161-164 [in Spanish].
A natural gas reformed with steam, contg. H 70-72, CO 16-18, CH_4 2-4, N 6-7, and H_2O+CO_2 3%, preheated to 950 °C was injected into an experimentally modified 4.6-m dia. blast furnace. Alternating periods of hot-gas injection, fuel-oil injection, and no fuel injection were compared. Results showed, *inter alia*, that gas and fuel oil could be injected simultaneously, their energy effects being additive, and the hot gas had no detrimental effect on furnace operation or iron quality.

669.162.267.4
662.762

42 0197 Bosch Injection of Reducing Gas [into a Blast Furnace]. A. Poos, N. Ponghis, R. Vidal, and P. De Woot. Internat. Iron Steel Cong., Düsseldorf, 1974, Preprints, 1974, (Vol. I), 2.1.2.4 1-19 (Met. A., 7501-72 0017) [in English]. 669.162.267.4; 662.764; 669.162.211.5

To overcome shortages of metallurgical coke the use of gas generated from low grade coals and lignites, or H produced by nuclear means is considered. Injection of hot gases into the bosch of the blast furnace, just above the melting zone is compared with injection through the main blast tuyeres and experimental work described. The quality requirement for reducing gas is less critical with main blast injection. 14 ref.—P.C.K.

42 0320 Injection of Pulverized Coal Into the Blast Furnace. J.R. Sexton and S. A. Bell. Boll. Tecn. Finsider, Mar. 1974, (325), 186-190 [in Italian]. 669.162.267.4; 662.87

The injection of pulverized coal into blast furnaces is described, and the experiences obtained using different systems on two furnaces are compared. The improvements carried out, as the result of experience and the main advantages desired are discussed.—H. S.

Armco Coal Injection. S.A. Bell, J.L. Pugh and J.R. Sexton. (Iron Steelmaker, Aug. 1975, 2, (8), 24-31) 669.162.267.4; 662.87

Production trials with pulverized coal injection in steelmaking at two Armco Steel Co. sites are described. The use of powdered coal as a fuel in blast furnaces was first attempted in early 1966 in Armco's Bellefonte blast furnace and leater in the Amanda blast furnace. Flow-sheets for both systems are shown. Over 700 000 tons of coal have been injected through tuyers of these two blast furnaces to date. The Amanda system is a second generation design and employs a low-pressure air system (2.0 lb/in² gauge max. against 35-45 lb/in² gauge in the Bellefonte system). Important problems that had to be solved during operations were explosion suppression and ash removal The former was solved by using halogenated hydrocarbon explosion suppressants and the latter by a combined cyclone and bag house filter subsystem.

42 0108 Some Concepts of Stack Injection. N. Standish and B.J. Collins. *Symposium on Blast-Furnace Aerodynamics*, University of New South Wales, Wollongong, Australia, 1975, 48-50 [Preprint-English]. 669.162.267.4; 669.162.211.4

Basic principles of stack injection are outlined and supported by calculations of thermal, chemical and aerodynamic requirements of an ideal 4000 tons/day furnace. Calculated results show that these requirements vary with conversion of FeO, and that best performance may be expected with $X_{FeO} = 1.0$ for which calculated production of 6910 tons/day and coke rate is only 211 kg/thm. Calculations are also presented for a cycled injection. Discussions show that stack injection is a good way of overcoming softening problems and meeting the demand for Fe in a fluctuating demand situation when it exceeds the max. capacity of a furnace. 8 ref.—AA

42 0109 Fluid-Dynamic Aspects in Blast Furnace With Gas Injection Into the Stack. A. Ghighone, V. Giordano, A. Milani and G. Quintiliani. Symposium on Blast-Furnace Aerodynamics, University of New South Wales, Wollongong, Australia. 1975, 51-60 [Preprint English].

A research field of interest and a topical subject with the aim to reduce a considerable amount of coke in ironmaking is the injection into blast furnace stack of hot reducing gas combined with use of auxiliary fuels at tuyeres. Some aspects are analysed on fluid dynamics of blast furnace process with two gas flows: the main flow coming from the bosh and cross-flow of the reducing gas injected in the lower shaft. A research on a blast furnace physical model was made to obtain information about the phenomena which occur in the full-scale blast furnace. This work was carried out on cold models (bi- and tridimensional) in which the radial gas distribution was experimentally measured. A mathematical model based on gas diffusion was implemented, aimed at simulating gas distribution inside the reactor and taking into account the number of injection tuyeres. A good agreement between experimental and theoretical data allows for extending results to industrial practice to determine operating conditions, assuring good performance of blast furnace with high amount of auxiliary fuels. 9 ref.—AA

669.162.267.6;
669.211.4;
620.163.1

669.162.267.4;
669.162.224.4

Blast furnace operating experience with high oil injection rates and oxygen Enrichment. (Proceedings of the 32nd Ironmaking Conference AIME, 1973, 26-39).
QUIGLEY, J. J. TROUP, R. L., CRAIG, G. H., Development of fuel injection lances and the design of the fuel oil and O transport system are detailed, and operating results are given. Atomization of oil was found to be essential for high injection rates. By keeping O utilization below 80%, high rates of oil were injected with min. problems from C carry-over. A higher replacement ratio (pounds of coke saved per pound of oil injected) was found with high blast temp. operations than with O injection. The relationship between percent O enrichment and production rate was found to be linear up to at least 27% O. Hot metal quality was maintained although slag basicity increased.

669.162.263.42

Transition Behaviour of the Blast Furnace Resulting from Changes in Blast Parameters. K.Mattheis. (Theis,Techn.Univ.Clausthal,1973 106 pp) (in Ger.) The effects on blast-furnace reaction of changes in the blast temp. ,oil content, blast moisture and O content of the blast gases were studied. Steady-state conditions were achieved 32, 12-14, 22-24, and 32h resp., after each of the above parameters had been altered. Parameter changes leading to a rise in temp. lead to increased Si and reduced Mn contents of the pig iron.

669.162.267.6

42 0034 'A New Continuous Desulphurization Process. Ryo Ando. Symposium on External Desulphurisation of Hot Metal, 1975, Pp 24 (Met. A., 7601-72 0003)(in English).

Experiments were carried out with water model and hot metal in an attempt to find out methods satisfying the conditions necessary for the continuous desulphurization process. The best method was one consisting of employing the stirring based on stirring rods in a convex-section vessel. 9 ref.—AA.

Desulphurization of Pig Iron. (C.Document, Siderurgique Circul. Inform. Techn., 1974, 31, (5), 1103-1139) (In Fr). ETIENNE.A. Different methods of desulphurization which can give S levels below 0.01% in steels are examined. Techniques described include injection of de-sulphurizing agents into the melt by means of a lance, mechanical agitation with addition of desulphurizing solid, and the use of coke impregnated with Mg. The cost of conventional desulphurization with Na_2CO_3 is compared with the cost of injecting CaC2 for irons of different S and P contents. The S levels attainable in LD and LD-AC processes by these two desulphurizing methods are discussed.

669.162 267.6

Desulphurizing Plants at Italsider Taranto Works. E. Cavallero and A. Cecere. (Boll. Tec. Finsider, Nov, 1975, (345), 602-611) (In It.)
Two new high efficiency desulphurizing plants for the production of very low-S steel are described. They are of the KR and "top blow" types resp., and they replace a method based on Mag-coke utilization. The results obtained and the operating costs of the three methods are compared.

669.162.267.6

Combating Sulfur in Pig Iron with Modern Blast Furnace Operating Technology, by G. A. Volovik, *Stal,* (Russian), 1975, No. 9, pp 791-794. The trends in the variation of steelmaking pig iron composition at a number of works from 1960 to the present are demonstrated, and the sulfur balance is analyzed. Comparisons of the sulfur balance and the investigations of the gas composition in the combustion zones of blast furnaces (with injection of natural gas) indicate that production of pig iron with a low sulfur content is possible only if it is efficiently slagged. Very little (2 to 3%) sulfur is transferred to the top gas. In operation with natural gas a considerable part of sulfur in hearth gas is in the form of H_2S, which favors its slagging. At many works the slag desulfurizing capacity is insufficiently utilized; a rise in the coefficient of sulfur distribution between slag and pig iron along with a further reduction in coke consumption remain the most substantial reserves for the further lowering of sulfur content in the metal. (BISI 14009-about $13.00)

669.162.267.6

42 0034 The Production of Low Sulphur Iron in the Blast Furnace. M. Vlădescu, P. Nicolae, and T. Popescu. Metalurgia, Aug. 1972, 24, (8), 525-529 [in Romanian].
A six month statistical study was made of the factors affecting desulphurization in a blast furnace with a working volume of 1700 m^3. The data collected comprised the blast furnace parameters, the quantity of iron produced and the chemical compositions of the iron, the slags and the blast furnace burdens. The S content of the iron depended upon slag compositions, and the CaO/SiO_2 and MnO/Mn ratios were determined, as were the relative coke consumptions. Daily variations of S in the iron between 0.07 and 0.023% were obtained.—C. T.

669.162.267.6

Desulphurizing: Sulphur Control Plus More Production. R.F. Potocic and K.G. Leewis. (3rd McMaster Symposium on external Desulphurisation of Hot Metals, Hamilton Ontario, 22-23 May 1975, Pp 23 ed.Lu). Lower flux blast furnace operation resulting in high S (0.045%) Fe was compared economically to the standard low-S (0.021%) practice. The excess hot metal S was controlled by external desulphurization, tapholes on the torpedo cars and torpedo car deslagging. A Combination of a lower blast furnace flux rate and magcoke desulphurization resulted in a 13% increase in Fe production. This additional tonnage came from a higher wind rate (4.3%) and the lower coke rate (8.8%). Desulphurizing costs amounted to 69% of the measurable blast furnace savings. 669.162.267.6

Operational Aspects of the Injection Process for Desulfurization of Hot Metal. H.P. Haastert, W. Meichsner, H. Rellermeyer and K-H. Peters. (Iron Steel Engineer, Oct. 1975, 52, (10), 71-77) Five years of operation at a large-scale experimental plant have confirmed the effectiveness of a hot metal desulphurization process in which powdered calcium carbide is injected pneumatically into the melt through a submerged lance coated with ceramic. The powder also contains gas-evolving components which stir the steel. A commercial installation using the process now treats about 300 000 tons of hot metal/month, reducing S content to 0.010%. Graphs show the relation between S content and the consumption of carbide reagent, the influence of the amount of fill in the torpedo ladle on the final S content and the relation of the initial S content to the calcium carbide efficiency. 669.162.267.6

42 0429 Desulphurization of Pig Iron Outside the Blast Furnace and Modification of Cast Iron with Magnesium. N.A. Voronova. Liteinoe Proizv., Feb. 1974, (2), 5-7 [in Russian].
Desulphurization of pig iron by injection of granulated Mg in transfer ladles is outlined. Some properties of the crude and desulphurized irons are compared: S content is decreased from 0.025 to 0.003-0.010%, the content of gases (O, H, N) is decreased from 0.0193 to 0.0070%, in addition desulphurized pig is free from kish. The consumption of Mg depends on the degree of desulphurization required and, for the modification of pig to obtain 0.04-0.07% residual Mg, amounts to 1.8 – 2 kg/tonne. The content of active Mg in the granulated metal amounts to ~90%. Desulphurized iron is used in the manufacture of crankshafts from spheroidal graphite. Equal parts of such iron and of scrap melted in an electric furnace produces metal which does not require desulphurization in the furnace, thus reducing the melting time by 20-25%. The consumption of Mg for inoculation was reduced by 30%. In addition, the quality of castings is improved considerably.—M.G. 669.162.267.6

12 0070 Effect of Sulphur Content of the Fuel Oil Injected into the Blast Furnace on the Sulphur Content of the Iron. C. Huguet and J.P. Richter. Rev. Mét., Apr. 1974, 71, (4), 321-332 [in French].

Some of the factors influencing the S content of slag and iron in the blast furnace were investigated. In particular, the use of a low-S (~1%) fuel oil, compared with the normal 3.3% S oil, reduce the S content of the iron from 0.04 to 0.025%. The efficacy of other desulphurization techniques, namely Na_2CO_3, CaC_2, or Mg, are also considered.—E.M.D.

669.162.267.6

Behaviour of Sulphur in a Blast Furnace Operating on Combined Blast. G.V. Volovik, V.Kh. Katsman, V.I. Kotov, and A.S. Kandiral. (Izv. V.U.Z. Chernaya. Met., 1975, (10), 26-29 (In Rus.); Steel in the USSR, Oct. 1975)

669.162.267.6

Natural gas injection leads to a radical change in the gaseous S-contg. components in the gas phase, with conversion of all the S of the hearth coke into H_2S. The most active S accumulator in the blast furnace is CaO. Thus this can ensure the transfer of gaseous coke S in the hearth directly into slag, instead of the formation of FeS.

Distribution of Sulphur in the Blast Furnace. I.D.Balon, V.I. Khavkin, B.V.Glovatsky, and A.N.Cherzer. (Stal,'Feb.1975, (2), 104-109, (in Rus.); Steel in the USSR, Feb. 1975)

669.162.267.6

The distribution of S between the charge materials, the smelted products during their passage down the stack of a blast furnace is analysed. As the charge descends, the S from the coke is partially vaporized and absorbed by the charge constituents, mainly by the Mn ore and $CaCO_3$. Factors controlling the stages of desulphurization and S absorption are indicated, and the mineralogical character of the sulphide phases formed is investigated.

Reducing the Sulphur Content of PIg Iron with Modern Blast-Furnace Operating Techniques. G.A. Volovik. (Stal', Sept. 1975, (9), 791-794, (In Rus.); BISI 14009)

669.162.267.6

A decrease in the coke consumption in blast furnaces has resulted in a reduction in the S content of the pig iron. In furnaces using natural gas, a considerable proportion of the S in the coke is converted to H_2S, which is readily assimilated in the slag. This is not the case when the S in the coke is converted to SO_2. Hence an increase in natural-gas consumption, associated with improved slag fluidity and increased slag temp., assists in reducing the S content of the pig iron. To attain max. advantages, a rational slag-handling schedule must be adopted and maintained.

42 0028 The Control of the S Content of Pig Iron at Hoogovens-Estel NV. Nick A. Hasenack and Kees H. van Toor. Symposium on External Desulphurisation of Hot Metal, 1975, Pp 19 (Met. A., 7601-72 0006) [in English]. The measures taken at Hoogoven-Estel to allow production of pig iron with relatively low Si, Mn and S contents are described. The experimental relationship between slag composition, slag quality and the degree of desulphurization is given as well as a description of the tests on which the relation is based. The importance of chemistry control of the burden material is illustrated by the improvement obtained by the installation of a bedding system ahead of the sintering plant. From all the experimental work done at Hoogovens-Estel it is concluded that stringent and consequent control of the burden may considerably increase the pig iron quality at reasonably low costs. 8 ref.—AA. 669.162.267.6

Desulphurizing: Sulphur Control Plus More Production. R.F. Potocic and K.G.Leewis. (3rd McMaster Symposium on external Desulphurisation of Hot Metals, Hamilton, Ontario, 22-23 May 1975, Pp 23 ed.Lu). Lower flux blast furnace operation resulting in high S (0.045%) Fe was compared economically to the standard low-S (0.021%) practice. The excess hot metal S was controlled by external desulphurization, tapholes on the torpedo cars and torpedo car deslagging. A Combination of a lower blast furnace flux rate and magcoke desulphurization resulted in a 13% increase in Fe production. This additional tonnage came from a higher wind rate (4.3%) and the lower coke rate 669.162.267.6

Desulphurizing Plants at Italsider Taranto Works. E. Cavallero and A. Cecere. (Boll. Tec. Finsider, Nov, 1975, (345), 602-611) (In It.) Two new high efficiency desulphurizing plants for the production of very low-S steel are described. They are of the KR and "top blow" types resp., and they replace a method based on Mag-coke utilization. The results obtained and the operating costs of the three methods are compared. 669.162.267.6

External Desulphurization of Iron by Injection. E. Campomanes, R.Goller and H.Y.Lee. (3rd McMaster Symposium on External Desulphurization of Hot Metals Hamilton, Ontario 22-23 May 1975, Pp 20 ed.Lu) The desulphurization reaction which takes place on the surface (the reaction interface) of the CaC_2 particles consists of three steps: the flow of S atoms toward the interface, the interface reaction and the solid-state diffusion within the particles. The effect of reaction interface area on the efficiency of desulphurization was studied by reducing the CaC_2 particle size in steps while maintaining a constant rate of injection. 669.162.267.6

Limit of Desulfurization in Blast Furnace, and External Desulfurization by Sintered CaO-CaF$_2$ Pellets. N.Tsuchiya, H.Ooi, A.Ejima and K.Sanbongi. (3rd McMaster Symposium on External Desulphurization of Hot Metals, Hamilton Ontario 22-23 May 1975, Pp 16 ed.Lu). The limit of desulphurization in a blast furnace under the deterioration of coke properties is discussed. The kinetic behaviour of desulphurization reaction of Fe by sintered CaO-CaF$_2$ is considered. Some experiences on external desulphurization of Fe by sintered CaO-CaF$_2$ pellets on a semi-industrial scale are given.

669.162.267.6

Desulphurizing Liquid Iron. M. Cavallini and G. Signorelli. (Fonderia Ital., Oct. 1975, 24, (10), 317-324) (In It.)
The thermodynamics of desulphurizing molten pig iron using Mg, Na_2CO_3, CaO, CaC_2 or $CaCN_2$ are considered, together with the kinetics of metal-slag transport by diffusion and the benefits of agitation in speeding-up the process. Various desulphurizing processes involving agitation by mechanical impellers or gas injection are compared. The effects of process parameters such as slag basicity on the efficiency of desulphurizing are noted.

669.162.267.6

On the Desulphurization of Molton Pig Iron by Means of 200 Ton-GMR (Gas-Lift Mixing Reactoar). K. Narita et al. (Kobe Res. Dev., July 1975, 25, (3), 82-86) (In Jap.) The techinique for desulphurization of molten pig iron is a mthod of treating molten metal by the gas-lift pump. The GMR equipment can desulphurize about 200tons of molten pig iron at a time. The circulation flow rate of pig iron for this equipment was about 100 tons/min and it was easy to desulphurize this molten metal to a low S level of under 200 ppm in 15 min treatment, using 5kg/ton calcium carbide as a desulphurizing agent.

669.162.267.6

The External Desulphurisation of Hot Metal-a Pneumatic Injection Technique. J.K.Wood, G.E.Schoeberle and R.W.Pugh. (3rd McMaster Sumposium on External Desulphurisation of Hot Metals, Hamilton Ontario 22-23 May 1975, Pp 14 ed.Lu)
Magnesium-aluminium and Mg-Ca alloys from a Canadian source have been injected via a pheumatic technique into hot metal in torpedo ladles. The desulphurizing efficiency of these alloys has been found to compare favourably with mag-coke. The method offers significant advantages over the plunging technique in terms of operating costs and results in lower ladle temp. losses during treatment.

669.162.267.6

Desulphurization of Hot Metal at Hoesch-Estel. U.Puckoff and H.Kister. (3rd Mc.Master Symposium on External Desulphurisation of Hot Metals, Hamilton, Ontario 22-23 May 1975, Pp 22 ed.Lu) To adjust the hot metal content to the requirements, Hoesch-Estel has chosen the following ways: accurate control of agglomerate quality, increase of agglomerate in blast furnace burden to 90%, careful control of blast furnace performance and lifting blast furnace slag basicity to about 1.15 to 1.20. By these measures it is expected to obtain a S level of about 0.020% in hot metal without external desulphurization. The external desulphurization of a smaller tonnage to below 0.010% S will be done by using the Hoesch process with calcined lime powder as desulphurizing agent or mag-coke.

669.162.267.6
661.242.62

The Desulfurization of Pig Iron Using the Rheinstahl-Stirrer for the Production of BOF-Steel Grades Low in Sulphur. K.D.Haverkamp, H.-P.Schulz and J.Mandel. (3rd McMaster Symposuim on External Desulphurisation of Hot Metals, Hamilton, Ontario 22-23 May 1975, Pp 15 ed.Lu) The advantages of desulphurization of hot metal and cast iron using the Rheinstahl-stirrer are explained. Some other cast iron mills and hot metal producers are also using this process including the Schalke works of Rheinstahl AG where a continuous desulphurization plant is operational in the blast furnace plant.

669.162.267.6

Desulfurization of hot metal by injection of calcium carbide based mixtures. (AIME Open Hearth Proc., 1973, 56, 113-119) MEICHSNER, W., PETERS, K.H., ULLRICH, W. and KNAHL, H. An injection process for external desulphurization of pig iron in the transport ladle was developed in Germany. The desulphurizing agent is a mixture of calcium carbide and gas-evolving components. This gas causes an intensive turbulence within the hot metal, leading to efficient utilization of the CaC_2. About 95% of the ladle capacity is utilized, leaving only sufficient room for the desulphurization slag. Hot metal is desulphurized to below 0.020% S, with a small portion to below 0.010% S. The relationship between the initial and final S content and the specific amount of

669.162.267.6;
661.842.62

Influence of Injection of Hot Decomposed Hydrocarbons and Technological Oxygen on the Metallurgical Conditions in the Blast Furnace. J. Horvath. (Banyasz. Kohasz. Lapok (Kohasz.), May 1975, 108, (5), 193-197) (In Hung.) 669.162.267.6 662.69

The effect of a combined injection of hot decomposed hydrocarbons (natural gas) and technological O on the metallurgical conditions in the blast furnace was studied. For a constant theroretical temp. of combustion and O concentration the temp. of the blast which gives a min. coke consumption is calculated. The value is 50 kg per ton of pig iron. In this case indirect reduction is practically 100% and no coke is consumed for the direct reduction.

Reducing the Sulphur Content of PIg Iron with Modern Blast-Furnace Operating Techniques. G.A. Volovik. (Stal', Sept. 1975, (9), 791-794, (In Rus.); BISI 14009) 669.162.267.6 662.749.2

A decrease in the coke consumption in blast furnaces has resulted in a reduction in the S content of the pig iron. In furnaces using natural gas, a considerable proportion of the S in the coke is converted to H_2S, which is readily assimilated in the slag. This is not the case when the S in the coke is converted to S0 SO_2. Hence an increase in natural-gas consumption, associated with improved slag fluidity and increased slag temp., assists in reducing the S content of the pig iron. To attain max. advantages, a rational slag-handling schedule must be adopted and maintained.

Appropritate Operational Range for Simultaneous Injection of Oxygen and Oil in Large Quantity in the Blast Furnace. M. Higuchi, M. Iizuka, K. Kuroda and T. Sumigama. (Trans. Iron Steel Inst. Jpn. 1975, 15, (10), 516-521) 669.162.267.6 662.753.25

Simultaneous injection of O and oil in a large quantity is likely to cause slipping and other irregularities in the blast if the choice of each quantity is inappropriate. To solve this problem the idea of the appropriate operational range is introduced, which takes account of the amount of heat exchange of gas and burden, the theoretical flame temp. at tuyeres and the perfect combustion of oil. The operational results of 380 kg/tHM in coke rate and 78 kg/tHM in oil rate have been obtained with 2.5% O enrichment. The furnace is, at present, in good condition with 3.8% O enrichment, which proves that the aforementioned idea is very beneficial in injecting O and oil in a large quantity.

Blast-furnace operating technology with injection into the hearth of natural gas and 100–200kg of coal-dust fuel per tonne pig iron

STEEL IN THE USSR
70 11 75 pp 298-301

S. L. YAROSHEVSKII, I. N. KRASAVTSEV, and Z. K. AFANAS'EVA

The influence of replacing a considerable part of coke by coal-dust fuel on the temperature distribution up the blast furnace, the utilization of the reduction energy of the hearth gases, and the aerodynamic regime of the blast furnace has been examined; calculations have been made of the effectiveness of increasing the consumption of coal-dust fuel to 200 kg/t pig iron. The results are presented of a lengthy trial on blast furnace no. 3 of the Donetsk works with the consumption of coal dust increased to 100 kg/t pig iron; these results have confirmed the great economic benefits of the technological regime developed.

Changes in ironmaking technology in relation to the availability of coking coals

E. W. Voice and J. M. Ridgion

Ironmaking and Steelmaking (Quarterly), 1974 No.1
pp1-7

The paper begins with a survey of the present and future supply position for coking coals in relation to overall resources of fossil fuels and other energy sources. This shows that optimum technology for ironmaking will change considerably during the next half-century. In relation to the near future, consideration is given to techniques of improving coke technology with the objects of maintaining quality standards whilst extending the range of usable coals. Classical prime coking coals can be replaced or supplemented by inferior grades with the application of sophisticated techniques of blending, and coke quality and performance can be improved by charge preheating. More basic solutions involve the manufacture of artificial or formed cokes. In the immediate future, the injection of gaseous and liquid hydrocarbons into the blast-furnace tuyeres can be economically advantageous, and wider possibilities are opened up by the injection of reducing gases in the bosh or shaft. Prospects for direct-reduction systems based on fossil fuels, eventually supplemented by the use of nuclear heat, are examined. Finally, consideration is given to the problem of iron-oxide reduction in the absence of all fossil fuels. IS/1

Injection of Hot Reformed Gas in the Bosh (1)

N. PONGHIS, C. VANOSMAEL, A. POOS (2)

Bosh injection of hot reformed gas into an experimental blast-furnace. — This technique made possible the replacement of about 150 kg of coke/t of hot metal. — Combined injection of fuel-oil at the tuyeres and bosh injection of reformed gas. — The effects of both techniques are additive and with combined injection 285 kg of coke/t of hot metal could be replaced.

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Dec 71 P7-15

Operational Aspects of the Injection Process for Desulphurization of Hot Metal. H.P. Haastert, W. Meichester, H. Rellermeyer and K.H. Peters. (3rd McMaster Symposium on External Desulphurization of Hot Metals, Hamilton, Ontario 22-23 May 1975, PP24 ed Lu) The mechanical properties and the quality of steel improve with decreasing S contents. It is concluded than an external desulphurization treatment of the mass of hot metal is advisable for iron- and steelmaking. Brief description is given of the injection process practiced at August Thyssen-Huette and of the new desulphurization installation at Bruckhausen. Metallurgical results and practical aspects related to the operation of this installation are discussed.

The Desulfurization of Pig Iron Using the Rheinstahl-Stirrer for the Production of BOF-Steel Grades Low in Sulphur. K.D.Haverkamp,H.-P.Schulz and J.Mandel. (3rd McMaster Symposuim on External Desulphurisation of Hot Metals, Hamilton, Ontario 22-23 May 1975, Pp 15 ed.Lu) The advantages of desulphurization of hot metal and cast iron using the Rheinstahl-stirrer are explained. Some other cast iron mills and hot metal producers are also using this process including the Schalke works of Rheinstahl AG where a continuous desulphurization plant is operational in the blast furnace plant.

The Use of Low-Sulphur Pig Iron in the Production of Basic Oxygen Converter Steel. N.A. Voronova et al. (Stal', July 1975, (7), 604-605 (In Rus.); Steel in the USSR,July 1975).
Desulphurizing pig iron after tapping from the blast furnace, with granulated Zn has facilitated the widespread production of grades 08 kp and 08 Yu steel contg. S less than 0.02%. The extent of desulphurization is dependent upon the quantity of Zn used and S contents in the steel of 0.009% have been attained. This is accompainied by an improved steel quality, with particular ref. to increased ductility characteristics and an improved YP.

The Desulphurization of Pig Iron in a Blast Furnace Operating with a Low Slag Volume. (Stal', Nov.1973, (II), 978 - 980 [In Rus.]; Steel in the USSR, Nov.1973) BABARYKIN N.N., GALATONOV A.L., and AGASHIN A. A. The influence of slag volume on the desulphurization process is investigated on an 3 m dia. blast furnace. By replacing fluxed sinter with fluxed pellets contg. Fe 53-58 and 62 - 63% resp. the slag volume was reduced in stages from 441 to 228 - 245 kg/tonne. It is established that with a decreasing slag volume, the desulphurizing ability of slag is utilised more fully. Nevertheless, for the production of a low S iron, a decrease in the slag volume should be accompanied by a reduction in the S load, increase in slag basicity, and smooth furnace operation.

669.162.267.62

Desulfurization in the Transer Ladle. M.A.Palmer and J.S.Becker. (3rd McMaster Symposium on External Desulphurisation of Hot Metals, Hamilton Ontario 22-23 May 1975, Pp 24 ed.Lu) During the project, 82 calcium carbide injections were completed using either N or natural gas as the carrier gas. Twenty-seven trials of lime injection were also completed utilizing various sizes of lime and either N or natural gas as the carrier gas. It was concluded that: calcium carbide injection into a transfer ladle is mechanically feasible and 10 lb.of fine carbide (50%-325 mesh)/Fe ton will approx.halve the initial S content.

669.162.267.642

Desulphurization of Pig Iron by Injecting Magnesium into Hot-Metal Ladles. (Stal', Apr., 1974, (4), 297-302, (in Rus.): Steel in the USSR, April, 1974) VORONOVA, N.A., PLISKANOVSKY, S.T., SHEVCHENKO, A.F., LAVRENT'EV, M.I. and EMEL'YANOV, I. Ya. Desulphurizing pig iron in the ladle using granulated Mg consisting of spheroidal particles 0.5-2 mm in dia. contg. Mg about 90% is described. The granular mixture is injected through a lance of special design immersed in the metal, before the addition is made. The Mg, evaporating in the expansion chamber of the lance, bubbles uniformly through the pig iron. This method of desulphurizing is more effective than injecting Mg mixed with lime or dolomite. The technique can produce, on a large production scale, low-S blast furnace pig iron with any desired S content down to 0.001%. Concurrently N and O contents are also reduced.

669.162.267.642

669.162.267.642

Mag-Coke Desulphurization of Hot Metal in the Ladle H.Sugita (3rd McMaster Symposium on External Desulphurisation of Hot Metals, Hamilton, Ontario 22-23 May 1975, PP1? ed.Lu) Regular operation of mag-coke desulphurization started for the first time in 1974. Comparative investigations on various desulphurization methods were made. It was found that desulphurization by soda ash brings about air pollution (emission of white fumes) and its slag substantially shortens the life of ladles. In the case of desulphurization by calcium carbide, handling of the calcium carbide dangerous and the malodour emitted from the slag after desulohurization pressure an environment problem. On the other hand, for mag-coke desulphurization, capital cost is less than for the described methods and there is no pollution problem.

669.162.267.642
661.966

Desulphurization of Pig Iron by Injecting Magnesium into Hot-Metal Ladles. (Stal', Apr., 1974, (4), 297-302, (in Rus.): Steel in the USSR, April, 1974) VORONOVA, N.A., PLISKANOVSKY, S.T., SHEVCHENKO, A.F., LAVRENT'EV, M.L. and EMEL'VANOV, I. Ya. Desulphurizing pig iron in the ladle using granulated Mg consisting of spheroidal particles 0.5-2 mm in dia. contg. Mg about 90% is described. The granular mixture is injected through a lance of special design immersed in the metal, before the addition is made. The Mg, evaporating in the expansion chamber of the lance, bubbles uniformly through the pig iron. This method of desulphurizing is more effective than injecting Mg mixed with lime or dolomite. The technique can produce, on a arge production scale, low-S blast furnace pig iron with any desired S content down to 0.001%. Concurrently N and O contents are also reduced.

669.162.267.646

Limit of Desulfurization in Blast Furnace, and External Desulfurization by Sintered $CaO-CaF_2$ Pellets N.Tsuchiya, H.Ooi, A.Ejima and K.Sanbongi. (3rd McMaster Symposium on External Desulphurization of Hot Metals, Hamilton Ontario 22-23 May 1975, Pp 16 ed.Lu). The limit of desulphurization in a blast furnace under the deterioration of coke properties is discussed. The kinetic behaviour of desulphurization reaction of Fe by sintered $CaO-CaF_2$ is considered. Some experiences on external desulphurization of Fe by sintered $CaO-CaF_2$ pellets on a semi-industrial scale are given.

669.162.267.646

42 0539 Lime-Slurry Injection in the Blast Furnace. Kikuo Tajima, Yoshiteru Jomoto, Yuji Kanayama, Yoshio Okuno, and Noboru Okamoto. Tetsu-to-Hagané (J. Iron Steel Inst. Jpn.), Sept. 1975, 61, (11), 2531-2543 [in Japanese].

The effects of the injection of a lime-oil slurry through the tuyeres of a blast furnace were studied with the aid of model experiments and full-scale tests. Results obtained from an experimental apparatus for measuring the rate of desulphurization of pig-iron droplets in a fluidized bed of lime fines showed that the S content of the pig iron was rapidly reduced. The lime fines reacted mostly in the molten zone so that the slag basicity increased. On replacing the lime in the burden materials of a furnace by an equivalent amount of injected lime fines, the temp. corresponding to a particular value of the rate of descent of the molten materials did not increase in proportion to the rate of injection. Trials in the blast furnace showed that lime injection may lead to a 25% reduction in the S content of pig iron and the permeability of the molten zone is improved without the formation of a viscous slag. 12 ref.—BA

Desulphurizing Liquid Iron. M. Cavallini and G. Signorelli. (Fonderia Ital., Oct. 1975, 24, (10), 317-324) (In It.) 669.162.267.646.4

The thermodynamics of desulphurizing molten pig iron using Mg, Na_2CO_3, CaO, CaC_2 or $CaCN_2$ are considered, together with the kinetics of metal-slag transport by diffusion and the benefits of agitation in speeding-up the process. Various desulphurizing processes involving agitation by mechanical impellers or gas injection are compared. The effects of process parameters such as slag basicity on the efficiency of desulphurizing are noted.

Use of Pre-Reduced Material in the Blast Furnace and Its Economic Influence in Iron and Steelmaking. J. Gomez Saenz-Messia. (Steel Furnace Monthly, Jan. 1975, 10, (1), 7-38) Historical developments in the size and capacity of the blast-furnace and in its ore, coal, and coke requirements are reviewed with ref. to fuel economy. Pre-reduction of the metallic charge is discussed, its effect on costs, productivity, energy distribution, and other factors are indicated, and details and locations of processes in present use are tabulated. Pre-reduction to 50% metallization could increase pig-iron production in Spain by 1.8 X 10^6 tons/year without additional blast-furnaces, or reduce the coke requirements by 780 000 tons.

669.162.275;
669.162.1;
669.094.22

669.162.275.1

42 0565 Pig-Iron Production in an Oxygen Tandem Process. Stanislava Jaklova, Jiri Vesely, and Vlastimil Tomis. Hutnik (Prague), Oct. 1975, 25, (10), 365-371 [in Czech].

Steps taken to obtain a relatively uniform blast-furnace charge, and to improve sampling of the pig iron during tapping, are, *inter alia*, described with ref. to a duplex steelmaking process. A relationship between the Si, S, and Mn content of the pig iron is presented. 13 ref.

669.162.275.1

42 0033 **Development Trends in Pig Iron Production in the Blast Furnace.** Miloslav Vranka. Hutnicke Listy, Feb. 1974, 20, (2), 80-91 [in Czech].
Trends in the development of pig iron production for the next 10-15 years are presented. The construction of blast furnaces with a cubic capacity >3000 m^3, the improvement of primary material treatment, and max. intensification of blast furnace processes is expected. The last factor includes increasing the O content of the blast >30%, and the air pressure >2.5 atm. The Fe content in the raw material is expected to be 67-68%, and the amount of O and the natural gas 130-150 Nm^3/ton of pig iron. The temp. of the hot-blast stove may be increased to 1500 °C. 48 ref.—M. L.

669.162.275.1.003.1

42 0043 Economic Production of Pig Iron. Richard Vesely, Karel Horak, Ludvik Tejzr, and Jan Mrazek. Hutnik (Prague), Mar. 1975, 25, (3), 84-89 [in Czech].
Lining wear was responsible for increasing the volume of a blast-furnace from 1082 to 1393 m^3. The useful stack volume increased by 60%, and the max. lining wear occurred in the bottom part of stack. Wear in the rammed hearth was very irregular and in the range of 8-50%. Measures necessary to decrease lining wear are briefly discussed.—M. L.

669.162.27[?]
546.22

The Control of the S Content of Pig Iron at Hoogovens-Estel NV. N.A. Hasenack and K.H. Van Toor. (3rd McMaster Symposium on External Desulphurisation of Hot Metals, Hamilton, Ontario 22-23 May 1975, Pp 19 ed. Lu)
The measures taken at Hoogoven-Estel to allow production of pig iron with relatively low Si, Mn and S contents are described. The experimental relationship between slag composition, slag quality and the degree of desulphurization is given as well as a description of the tests on which the relation is based. The importance of chemistry control of the burden material is illustrated by the improvement obtained by the installation of a bedding system ahead of the sintering plant.

669.162.275.1
621.365.22

42 0162 **Electric Smelting Furnaces in Southern Africa.** S.G. King. Proceedings of INFACON 74, 1975, 135-142 (Met. A., 7608-72 0150) [in English].
Electric smelters in Southern Africa are producing ferroalloy, pig iron, nonferrous mattes and nonmetals. Data are given on the types, electrodes, ratings, etc. Some features are described such as the electrode systems, furnace design parameters, furnace shell and refractories. 8 ref.—H. B. C.

669.162.275.1:
621.365.22

42 0139 **Some Experiences in the Smelting of Pig Iron in Electric Furnaces.** S.Y. Ghorpade. J. Electrochem. Soc. India, Oct. 1973, 22, (4), 291-302 [in English].
Smelting of foundry grade pig iron in a 15 MVA submerged arc furnace of capacity 1.7 tons/day. m^2 reactor area is discussed. The furnace resistance, predominantly governed by the coke bed has a marked effect on the power factor and operational loads, which are important in predicting furnace capacity. Raw materials and temp. are the controlling parameters to stabilize the grade of iron. Fines influence the permeability of the furnace charge, and slag boils lead to higher electrode consumption. Basic slags are more reducing than acid slags. The dependency of specific power on factors, including Si content, and slag volume permits a comparison between theoretical and practical limits. 10 ref.—E.S.D.

669.162.275.1:
658.152

1.22 million tons of hot metal produced in Blast furnace at Great Lakes, U.S.A. had capital investment cost of $90 million but per ton cost was $106.42.

Source: EPA-600/1-76-034c, December 1976, P. 63.

669.162.275.1:
658.152

Capital cost for 7 million to 3 million tons of iron produced in Blast furnace with hearth diameter from the range of 6 m. - 14 m. varies from 120 DM. 80 m. per ton.

Source: UNIDO/ICIS/25, 15 December 1976, P. 201

669.162.275.1
658.152

Capital cost of iron making in DM varies for Blast furnace with hearth diameters from the range of 6 m. - 14 m. in production capacity of 7 million to 3 million tons.

Source: UNIDO/ICIS/25, 15 December 1976, P. 201.

669.162.275.1:
658.152

In 3-million steelmaking mills, average operating cost of producing Blast furnace pig iron and Basic oxygen raw steel is $134.40 per ton.

Source: UNIDO/ICIS/15, December 15, 1976, P. 213.

42 0340 **Operation of a 2000 m^3 Blast Furnace on a Dry-Quenched Coke and Slags High in Magnesia and Alumina.** Zh. E. Sleptsov, D. I. Ashpin, F. K. Admakin, V. M. Dinel't, and N. A. Zhukov. Stal', Oct. 1974, (10), 876-880 [in Russian].

The comparative performances between dry, and wet-quenched coke were assessed by blast-furnace trials conducted in a 2000 m^3 capacity furnace, using slags of high MgO (up to 18%), and Al_2O_3 (up to 19%) content. The dry-quenched skip coke was stronger than wet-quenched, and had a smaller but more uniform lump size. Its gas permeability was greater than that of the wet-quenched coke, and its physico-mechanical properties were also superior. Smoother working of the blast furnace when charged with dry-quenched coke, resulted in an improved quality of pig iron. The S content decreased for the same slag basicity, and the distribution coeff. of S between slag and pig iron increased from 21.3 to 25.6.—J. W.

669.162.275.1
662.815

Reducing the Loss of Pig Iron with Blast-Furnace Slags. A.A.Deryabin, V.G. Baryshnikov, V.M. Antonov, G.V. Glov, and K.K. Slaby. (Metallurg, July 1975, (7), 12-13) (In Rus.) For reducing the loss of pig iron with blast-furnace slags specially-shaped channesl were used in blast furnaces and the results were compared with those of balst furnaces with ordinary channels. As a result of changing the shape of channels at furnaces of 256,1513, or 3200 m^3 volume, the loss of pig iron was reduced by 0.81, 0.92, and 3.65%, resp.

669.162.275.1;
669.015.9;
669.162.275.2

Contributions To The Control Of The Silicon Content In Pig Iron. T. Kootz (from Ger.) (Stahl Eisen, 1975, 95, (9), 403-408)
It is shown that the reason why silicon production is not directly related to manganese reduction and desulphurization is that this reduction takes place in three stages which may not be in equilibrium in all locations. Only the middle stage is directly related to Mn and S removal, and means for calculating, and so controlling, silicon in the finished pig iron are indicated. (Price:- £8.00)

669.162.275.1;
669.046.55[illegible]

Carburization and silicon reduction during pig iron production in the blast furnace (Stal', July 1973, (7), 583-589) (in Rus.) BUKLAN, I.Z., BALON, I.D., NIKULIN, Yu.F., MURAVEV, V.N., MISHCHENKO, N.M., Variations in the C and Si conte of iron samples taken from horizontal levels down the furnace stack of a N-cooled blast furnace have veen examined. The C content varies with the paticle size of the metal granules, and generally increases towards the tuyere level. In the region of rapid temp. rise at the tuyere zone level, where Si is rapidly reduced from gaseous SiO and silicates, 3-4% Si is obtained in the metal. The level of Si is reduced at the hearth level due to oxidation by reaction with the slag.

669.162.275.1
669.046.56

Use of Information Regarding the Temperature of Pig Iron for Estimating the Thermal State of a Furnace. D. Dikov, A. Siromyatnikov, N. Naidenov, N. Dzhambazov, and T. Georgiev. (Metallurgiya (Sofia), June 1975, 30, (6), 19-22) (In Bulg.) The possibility of using information relating to the temp. of the pig iron on release from a blast furnace in order to determine the thermal state of the furnace as a whole is discussed. Statistical data regarding the temp. of the pig iron, obtained by means of a specially developed remote-control system. are presented and analysed. Correlations are established between the proportions of Mn and Si in the pig iron and the thermal parameters of the furnace. Such information may be used in order to monitor any deviations of the furnace from its specified operating conditions and introduce corrections either manually or automatically.

669.162.275.1; 669.162.238.4

669.162.275.1; 669.162.261.5

Vishnyakova, E.N., Starshinov, B.N., Popova, N.I., Lukashov, G.G. and Vyazovsky, Yu.V.

The Effect of Blast-Furnace Charging Conditions on the Properties of Pig Iron for Steel Manufacture.

Metallurg. Apr. 1975, (4), 14-17 in Russian.

The properties of pig irons for steelmaking smelted with coke, contg.. various amounts of S (0.63-1. 37%) and sinter of various quality were investigated. Halving the S-content in the coke led to an improvement in the macro- and microstructure surface quality and tensile and bending strength of the pig iron.

Smelting of Pig Iron for Open Hearth (Steelmaking) with an Increased Consumption of Natural Gas (in the Blast Furnace). (Metallurg, Sept. 1974, (9), 10-13) (in Rus) ANTONOV, V.M. Experimental investigations were carried out on: (i) increasing the consumption of natural gas, up to 80-90 m^3/ton pig iron, and (ii) improving the effectiveness of its use in a balst furnace of 2700 m^3 volume. The blast furnace operated efficiently and economically during the investigation, and a considerable saving in coke consumption was achieved. Data, characterizing the operation of the blast furnace during the trials, are presented.

669.162.275.; 669.162.267.4; 669.69.

669.162.275.1
669.162.21

Smelting of Pig Iron for Open Hearth (Steelmaking) with an Increased Consumption of Natural Gas (in the Blast Furnace). (Metallurg, Sept.1974, (9), 10-13) (in Rus) ANTONOV, V.M. Experimental investigations were carried out on: (i) increasing the consumption of natural gas, up to 80-90 m^3/ ton pig iron, and (ii) improving the effectiveness of its use in a balst furnace of 2700 m^3 volume. The blast furnace operated efficiently and economically during the investigation, and a considerable saving in coke consumption was achieved. Data, characterizing the operation of the blast furnace during the trials, are presented.

669.162.275.12

Pig Iron Production (VDI-Z., Oct.1973, 115, (15), 1200 - 1204) [In Ger.] REINFELD H. Progress since Oct.1971 is reviewed, covering ore output, preparation for the blast furnace, coke production, the use of supplementary fuels in the blast furnace, iron output, the growth of high top pressure and high blast temp. practice, and direct reduction processes.

669.162.275.12
669.046.541/542

Carburization and silicon reduction during pig iron production in the blast furnace (Stal', July 1973, (7), 583-589) [in Rus.] BUKLAN, I.Z., BALON, I.D., NIKULIN, Yu.F., MURAVEV, V.N., MISHCHENKO, N.M., Variations in the C and Si content of iron samples taken from horizontal levels down the furnace stack of a N-cooled blast furnace have veen examined. The C content varies with the paticle size of the metal granules, and generally increases towards the tuyere level. In the region of rapid temp. rise at the tuyere zone level, where Si is rapidly reduced from gaseous SiO and silicates, 3-4% Si is obtained in the metal. The level of Si is reduced at the hearth level due to oxidation by reaction with the slag.

669.162.275.

Cyclic Phenomena in Blast Furnaces. (Centre Document Siderurgique. Circul.Inform.Techn., 1974, 31, (9), 1859 - 1872., dis.1871,1872) (in Fr). MORE., G. DELACHARLERIE, R. VIDAL, R. COLIN, R. and PONGHIS, N. Cyclic phenomena occurring in a blast furnace were studied. They are associated with discontinuity in pouring the cast iron and slag. Two methods of investigating the phenomena are considered: ii) sampling of the iron and slag for chemical analysis and temp. of the iron., and (ii) rapdi scrutinization of the working parameters of the furnace. Two types of transitory phenomena were observed: during pouring, either Si and Mn contents increase while S decreases or Si and S contents decrease while Mn increases.

The Control of the S Content of Pig Iron at Hoogovens-Estel NV. N.A. Hasenack and K.H.Van Toor.(3rd McMaster Symposium on External Desulphurisation of Hot Metals, Hamilton, Ontario 22-23 May 1975,Pp 19 ed. Lu) The measures taken at Hoogoven-Estel to allow production of pig iron with relatively low Si,Mn and S contents are described. The experimental relationship between slag composition, slag quality and the degree of desulphurization is given as well as a description of the tests on which the relation is based. The importance of chemistry control of the burden material is illustrated by the improvement obtained by the installation of a bedding system ahead of the sintering plant. 669.162.275.2 669.162.267.6

669.162.275.3

The use of measured quantities of blast and blast furnace gas yield in calculations of direct reduction indices. (Izvest. V. U. Z. Chernaya Met., 1973, (12), 35-38) [in Rus.] STEFANOVICH, M. A., VAGANOV, A. I., Calculating the degree of direct reduction on the blast volume and the yield of blast furnace gas instead of, or additionally to, the usual method based on the gas composition and coke rate, is advocated. It is suggested that the proposed method is particularly suitable for calculating current values of the direct reduction. The accuracy of the method can be improved by placing the measuring points for the blast and gas closer to the blast furnace.

NKG Process. T. Miyashita, K.Sano,H.Nishio, S. Ohzeki and T.Nayuki.(Iron Steelmaker, Feb. 1975, 2, (2), 29-38) Due to the high cost of O and natural gas for Fe and steelmaking, Nippon Kokan KK started to produce cheap reducing gas by reforming some gaseous hydrocarbons, such as coke-oven gas, natural gas and gas obtained by cracking of coal, with CO_2 and H_2O contained in the reforming raw material formed by the blast furnace top gas. The top gas of the blast furnace is reformed to a reducing gas, which is injected in a recycle system into a blast furnace stack. Methods were developed to lower the N content in the injected gas, produce reducing bas without S interference and inject safely into blast furnace stack. Commercial furnaces and their operating techniques are described in detail. The economic advantages, such as using lower amounts of virgin material, or 3% energy cost saving, are calculated with the aid of mathematical models. 669.162.275.33

Improving the control of gas-distribution in small-volume blast furnaces. (Metallurg, Dec. 1973, (12), 12-13). (in Rus) EGOROV, N.D., KOSTROV, V.A., SHOLENINOV, V.M. and SOLODKOV, V.I. A description is given of apparatus for the control of gas-distribution below the level of the charge in small-volume (1007 and 1033m^3) blast furnaces. For a further mechanization of the gas-distribution control a remote-control apparatus was designed and is briefly described. 669.162.275.54

42 0480 The Heat Consumption of Blast Furnaces. E.Lingner. Metalurgia, May 1975, 27, (5), 225-229 [in Romanian]. 669.162.275.28; 669.162.16

A statistical analysis of the Si content of the pig iron produced in two months was made and correlated with the total amount of heat (i.e. coke) consumed for SiO_2 reduction. The results suggested that a decrease of Si content from 0.76 – 0.78% to 0.68 – 0.72% would allow a lowering of the specific consumption of the metallurgical coke by ~6.4 kg coke/tonne of iron without affecting the iron quality. 9 ref.–C.T.

The Operation of a Blast Furnace Simulator with Gases Rich in H_2/H_2O. (Aufbereitungs - Technik, 1974, (5), 260-265) (From Ger.) WENZEL, W. et al. When blowing large amounts of hydrocarbon gas into the hearth, or a hydrogen-rich gas into the shaft, there is a change in working data. A blast furnace simulator can be used to study the behaviour of ores, pellets, sintered material and coke, either simply, or as mixtures, under varying conditions of temperature, gas composition, burden and gas pressure. (Price: £4) 669.162.28

Determination of Blast Furnace Dynamics. V.A. Ulakhovich, E.I.Raikh, V.M.Sholeninov, and V.V.Gaikov. (Stal, Jan.1975, (1), 9-14) (in Rus.) The effect of changes in the input variables on the output of a large, 2000 m^3, blast furnace was studied by statistical analysis. The factors considered include; ore: ratio; Fe content of sinter; blast temp; blast humidity; and natural gas consumption. The output parameters are gauged by fluctuations in the Si content of the pig iron or by a complex based on the heat used in the lower portion of the furnace. The most rapid effect of the blast furnace operation is achieved by varying blast temp or humidity. The complex index, derived from the heat blalance, allows more precise monitoring, and prediction of the thermal state of the blast furnace than does the control of the Si content of the pig iron. 669.162.28

669.162.283;
622.341.1-785

42 0143 Simulation of Blast-Furnace-Shaft Processes in Laboratory Studies of the Reduction Behaviour of Various Types of Iron-Ore Pellets and Sinters. Behzad Samadi. Thesis, Tech. Univ. Aachen, 1974, 169 pp [in German].
In a laboratory simulation of two blast-furnace shafts, a series of four reduction-condition programmes was used to evaluate the action of the reductive process on a variety of iron-ore pellets, cement-bound pellets, and sinters. The shaft systems simulated were the conventional and the more modern supplemented reduction-gas system. Reduction characteristics were generally improved in the modern system. Significant differences were noted between tests with these systems and isothermal reduction tests. 76 ref.—P.V.

669.162.3

42 0423 Ironmaking with Charcoal. A.T. Barnaba. Met. Ital., Feb. 1974, 66, (2), 91-94 [in Italian].
The manufacture of iron in blast furnaces using charcoal in place of coke is practised in Brazil, certain other countries, and in a few specialized plants. The modern charcoal blast furnace is described, together with the manufacture of wood charcoal and recovery of by-products.--P.C.K.

669.162.3

The Manufacture of Charcoal and Experience With Its Use in a Blast Furnace. A. Constantine. (SEAISI Q., Oct. 1975, 4-4 (665), 13-21)
Under certain circumstances, charcoal from destructive wood distillation can be a competitive and regenerative fuel for blast furnaces, thereby utilizing wood unsuitable for other purposes, resulting in better forest management and cheaper land development. The chemical and physical properties of wood and the effect of wood type and distillation temp. on the yield of C and by-products are described. Four carbonization processes are compared. The dependence of charcoal quality on the density of the wood and process used is described. Wood drying is detailed. Blast furnaces used with charcoal and their operation are discussed.

669.162.3

Rubberwood Charcoal for Iron-Making. L.S. Chai and H. Iso. (SEAISI Q., Apr. 1975, 4-2, (665), 33-40) A brief history is given of rubberwood charcoal making in Malayawata. The properties of rubberwood and replantation of rubber tress; charcoal making from rubberwood; supply and consumption of rubberwood charcoal; quality of charcoal; and the economic effect of charcoal production from wasted rubberwood, are discussed.

12 0507 Increasing the Production of Charcoal-Fired Blast Furnaces by Partial Substitution of Coal for Charcoal. Marco A. L. Melo and Paulo A. Gomes. Metal. ABM, Nov. 1974, 30, (204), 781-787 [in Portuguese].

669.162.3

The aerodynamic and hydrodynamic flow of materials in blast furnaces is discussed with reference to the IRSID mathematical model of the operation of a blast furnace. An analysis of the changes in flow phenomena resulting from substitution of coke for part of the charcoal in charcoal-fired furnaces concludes that the substitution makes possible an increase in furnace productivity by improving the conditions of gas flow both in the dry zone of the furnace and in the zone of formation of the first slag, is even more beneficial when operating with a high-Si content in the melt and promotes the elimination of counterflow conditions. 10 ref.—S.M.

669.162.46

Mysore India Operates New Electric Pig Iron Furnaces

G. RATH and H. ROTH

In 1970, within the scope of an expansion programme carried out by the Mysore Iron and Steel Works Limited, Bhadravati, the electric reduction plant was supplemented by two modern Demag furnaces for pig iron, each of them being rated at 24 MVA. The new furnaces produce steelmaking pig and foundry pig.

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Table I Raw materials employed

Raw Materials	Mean Composition	Size Range
Iron ore (hæmatite Kamangundi ore)	67% Fe, 3% SiO_2, 0.3% CaO, 1% Al_2O_3, 0.1% MgO, 0.02% P very low in sulphur	10 – 30 mm
Coke (high-temp.)	70 – 75% C fixed, 1% moisture (Ash: 56% SiO_2, 4% CaO, 28% Al_2O_3, 8% Fe_2O_3, 1.5% P_2O_5, 2.4% S)	25 – 50 mm (coarse coke) 10 – 25 mm (coke nuts) 3 – 10 mm (coke fines)
Limestone	36 – 45% CaO, 3 – 6% SiO_2, 4 – 10% MgO, 1% MnO, 1 – 3% Al_2O_3 approx. 40% ignition loss	40 – 50 mm
Quartz	99% SiO_2	30 – 50 mm
Manganese ore	29% Mn, 20% Fe, 15% SiO_2, 1% CaO, 0.6% MgO, 0.05% P	30 – 50 mm

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Economics of the Manufacture of Pig Iron in the Blast Furnace and the Electric Reduction Furnace. (Metal ABM, Feb. 1974, 30, (195), 99-103; 106-108) (in Port.) SILVEIRA, R.C. and FONSECA, D.M. Costs of production per ton of pig iron in Brazil were calculated for different production capacities with blast furnaces and electric reduction furnaces. The usual items of

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42 0107 **Control of Blast Furnace Hot-Metal Quality Using and Computer-Based System.** B. I. Wood. [Conf. on] Developments in Ironmaking Practice, London, Nov. 1972, 1972, 146-151 (Met. A., 7502-72 0034) [in English] [Received 1974].

A process control computer system for blast-furnace hot-metal quality control is described. The first phase of control is the proportioning and charging of the burden, while cast-to-cast control is achieved by adjustments at tuyere level, calculated using a simulation, which can follow and predict the transients following disturbances. In this way the process inputs are held steady from cast to cast. 10 ref.—BA

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42 0194 **Blast Furnace Computer Operations at Burns Harbor.** Jerome Hess and Edward Auslander. Proceedings of the 32nd Ironmaking Conference AIME, 1973, 15-25 (Met. A., 7407-72 0069) [in English].

Each blast furnace has one minicomputer with 16 000 words of core and 64 000 words of disc storage. The basic functions are: refilling and discharging of all stockhouse weigh hoppers; weight correction; moisture correction on coke weighments; tracking of material to furnace top; sequencing of furnace top; data logging of all major points around the furnace; computation of hourly material and heat balances; summary logging hourly and daily; and provision of input data for the blast furnace data processing system. A tabulation of hot metal quality shows the success of the feed-forward approach to blast furnace control.—M. M. R.

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42 0192 **The Blast Furnace Operator and the Computer—Partners in Ironmaking.** Douglas K. Bessellevre. Proceedings of the 32nd Ironmaking Conference AIME, 1973, 2-8 (Met. A., 7407-72 0069) [in English].

Input data requirements for a working computer system can include: facility information (furnace size, etc.); material information (chemical and physical composition of available charge materials); operating information (tuyere level, wind rate, blast moisture, blast temp., etc.); production requirements (hot metal chemistry, max. or min. acceptable limits on hot metal or slag chemistry); and actual results attained. Indirect or off-line systems are used to compile and evaluate historical data, for economic evaluation, forecasting and costing systems. Direct or on-line applications are described for burden control, stockhouse control, tuyere level control and a process control package. General items that should be considered in choice of an appropriate computer system are listed.—M. M. R.

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42 0042 **The Control and Regulation of Blast-Furnace Processes by Means of a Computer.** Ryszard Benesch, Jan Janowski, Marek Jaworski, Roman Kopec, and Andrzej Wilkosz. Polska Akad. Nauk. Prace Kom. Metalurgia, 1974, 22, 129-154 [in French].

The regulation of blast-furnace processes by means of a computer is described. The mathematical models of the processes on which the computer control is based, are discussed. The method facilitates the standardization of the chemical composition (Si + S content) of the cast iron. The economic aspects of the regulation of blast-furnace processes are examined.—N. M.

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42 0689 **Planning the Optimum Blast-Furnace Burden with the Use of Linear-Programming Methods.** S. T. Pliskanovsky, D. V. Gulyga, and I. E. Postemsky. Stal', July 1974, (7), 585-587 [in Russian].

An algorithm was developed, and is being used to calculate the proportion of charge components from three forms of sinter, pellets, Fe and Mn ore, and limestone, to feed each of six blast furnaces to make pig iron of the desired grade. The results of calculations made on a computer are presented.—J. W.

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42 0563 **Optimization of Pig Iron Production Technology Using Mathematical Statistics and an Electronic Digital Computer.** *S. L. Yaroshevsky, V. N. Andronov, N. I. Velsky, I. N. Krasav[illegible]* and V. M. Strelets. Stal', Mar. 1975, (3), 205-209 [in Russian].

A system is presented whereby the main operating parameters of a blast furnace can be computed, to ensure its operation with the lowest possible coke consumption under given technological conditions. Maintaining such parameters a coke reduction of up to 50 kg/ton of pig iron is theoretically possible. Experience with a blast furnace [illegible] 1033 m^3 useful volume confirms these findings. The stable nature of the extremal relationships is demonstrated.—J. W.

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42 0011 **Pilot-Plant Smelting Campaign of Iron Ores From Tete.** D. D. Howat *et al.* *NIM Rep. No. 1546*, National Institute for Metallurgy, 1 Yale Rd., Milner Park, Johannesburg, South Africa, 1976, Pp 27 [Pamphlet--English].

Smelting tests were made on V-bearing titaniferous Fe ore from the Tete area of Mocambique in a 3.6 MVA furnace to produce a pig iron and a titaniferous slag under conditions that would favour the partitioning of the V to the slag. This slag would then be amenable to pyrometallurgical or hydrometallurgical treatment for the recovery of TiO_2 and V. A low-C pig iron having a low Si content and a high S content was produced. However, it was shown that the furnace could be operated in such a way that the V would partition to the slag. A pyrometallurgical treatment for the recovery of the V could not be attempted during these tests, but a hydrometallurgical treatment was initiated.—AA

INFORMATION PROFILE ON STEELMAKING

This profile on steelmaking, spread over seventy pages, covering some 291 abstract items, is roughly divided onto 11 sections. The time span of the data coverage is about seven years starting from 1970. Although most of the items selected were published during the three years 1974-1977, the information not only reflect the status and trend of technology and economic thinking during this limited period and scope, but also give an insight into the problem areas that were agitating the minds of technologists and administrators connected with steel plants during this particular period.

The collection of data - here the abstracts - being dependent on the availability of material from in-house sources - the sections or aspects selected here for highlighting are uneven in treatment. Of the eleven sections, the first has 32, second 21, third 6 and the eleventh 104 items. This uneven strength hampers an equal in-depth understanding of the different sections, which are merely indicative of some among many possible areas of interest within a broad category. However, the intelligent reader would not fail to see that with the enrichment of the information sources and the proper organisation of the available data, each section may be further strengthened in coverage, provided, of course, the area has been able to claim the interest of technologists, economists and administrators leading to study and research and, hence, the publication of their results.

The first section deals with general trends, and among others, draws attention to the scope and prospect of using nuclear energy in steelmaking - in view of its contribution to a cheap direct reduction process and to the operation of a pollution free steel plant. Eight out of 32 items of this section (pp.5-7) are devoted to this interesting possibility.

Section two deals with the cost of steel plants and of steelmaking. Though the figures are rough and ready and merely give order of magnitude estimates - they provide a valuable clue to the investment cost in about 18 countries of the world, 8 of which are developed (UK, USA, France, Germany, Italy, Australia, Canada and Sweden) and the remaining 10 developing, which give a reasonably good idea of the investment cost per ton of steel in the various countries and provides a basis of comparison.

The small section 3 (in fact the smallest of the eleven sections) gives six items of information, which gives a clear indication of the emphasis laid on the consumption of energy in steel plants including their availability, alternative sources, costs, pollution factor, etc. Most of the items, published in 1975, were a response to the world oil and energy crisis. They are a pointer to the sure crop of further work in this area which followed the escalation of the energy problems and the longterm policy response of US and European governments to this problem.

Sections 4 to 11 deal with the different process routes to steelmaking. As new processes and technological possibilities come to light and are investigated for eventual industrial production, the old and new processes have to co-exist for varying periods of time. Such co-existence offers a welcome opportunity to review and reasses the existing and new processes against each other so that after the inevitable period of co-existence dictated by investment constraints, the process most suitable for a particular country and set of conditions may be selected with complete confidence.

Section 11, the last and the longest section of the profile (26 p. - pp.45-70 - and 104 items) covers the electric furnace steel-making process. Apart from the easy availability of this material from the in-house journals used for the purpose of this profile, such emphasis seems more than warranted by the interest in electric steelmaking in developing countries, which do not have either the capital needed for investment in integrated steelplants or the material resources for the operational viability of such plants, and which want to curtail the gestation period between an investment decision and operation of a plant. Its obvious advantage as regard pollution is added attraction of this process. The detailed discussions try to do justice to all these aspects of this process.

C o n t e n t s

669 18

J.C. GROVES

Changing World Steel Industry

The doubling of world steel production since 1960 has been accompanied by many changes in the technology and geography of the industry, and even more drastic changes are in sight.

Developments in raw materials mining and transportation have introduced a new location pattern for integrated steelworks.

Ever increasing economies of scale have led to much larger but less flexible integrated steelmaking complexes, which require capital investment running into $ billions. Increasingly strict pollution control requirements impose an escalating capital and operating cost burden.

This has encouraged the widespread introduction of scrap-based semi-integrated mills, based on the economies of specilisation.

This trend will be reinforced by the expected rapid growth of direct reduction, which will help reduce electric arc furnace operators' dependence on the volatile international scrap market.

In areas with access to cheap natural gas, the DR/EF route is already becoming a serious competitor to the medium-scale BF/LD route.

The conventional route, however, is highly efficient, is capable of further improvements, and is expected to provide the main stream for large scale operations for many years to come.

In the very long term, with the gradual depletion of fossil fuel reserves, nuclear reactors could become the dominant energy source for the steel industry.

SEAISI Quarterly April '76 P4

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The Current State of Iron and Steel Technology. Robert S. Barnes. Stahl Eisen, 7 Nov. 1974, 94, (23), 1077-1084 [in German]. (Received 1975)

Process developments leading to reductions in investment and operational costs are discussed. Energy consumption rates and source flexibility are detailed for the various steelmaking processes. Coke production and alternative tuyere blown fuels are discussed, emphasizing the reductions in coke rate possible. Ladle metallurgy and a fully continuous casting system assist in reducing steel production costs. The effect of more efficient scrap utilization and the use of low grade scrap are discussed. Sankey diagrams are presented for the energy consumption rates in the various steelmaking processes. 16 ref.--P. V.

669.18

Recent Developments in Steelmaking Processes. P. Anant and P. Mehta. Trans. Indian Inst. Met. Oct. 1975, 28, (5), 429-448 [in English].

A review. The main features of the contemporary steelmaking scene are discussed with particular ref. to the replacement of the o.h., Bessemer, and basic Bessemer processes by the newer O steelmaking and the electric-furnace steelmaking processes. 29 ref.--BA

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Steel plant of the future

Iron and Steel International, October 1976

S. Eketorp* T341

Accurately predicting what steel plants will be like 20-30 years hence is an impossible task. However, from experience and known criteria, it is possible to work out in what direction future development work should be directed. In this article the author examines the important determining factors and on the basis of these puts forward two proposals for metallurgical process routes – high temperature reduction with coal to raw iron and with hydrogen to raw steel. He goes on to describe his proposals for the ideal steel plant of the future and finally discusses what is required if such a plant is to become a practical reality.

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Chaparral Steel--Newest U.S. Mini Mill. John A. Kotsch. Iron Steel Eng., Apr. 1976, 53, (4), 33-37 [in English].

This plant has its own scrap shredder and storage yard and uses scrap as all of its raw material, most of which consists of recycled auto bodies. Steelmaking is accomplished in one 18 ft dia. split shell ultra-high power (65 000 kva) electric arc furnace. Energy consumption for the furnace averages 460 kWh/ton. Heat times average 2 h when using 300 cfm of O_2/ton of steel. After tapping the steel is transferred to a four-stand low-head Concast caster. A 15 stand straightaway mill receives billets from the reheat furnace through two horizontal stands and one vertical stand, followed by three horizontal stands and a second vertical stand, then to a flying crop shear for the roughing process. Eight finishing stands complete the processing to a walking beam 300 ft. cooling bed. The expected production rate is 1000 tons/year/employee. R.C.D.

669.18

Developments in the Iron and Steel Industry. John A. Kotsch and Charles J. Labee. Iron Steel Eng., Jan. 1975, 52, (1), D1-D46 [in English].

Both U.S. (146 million tons) and world (estimate 785 million tons) steel production operated at near record levels in 1974--and it is expected that demand will continue to exceed supply. Through 1974, the world steel industry was faced with fuel and raw materials shortages, high prices of scrap and environmental regulations. Large expansion plans are underway, with world raw steel needs by 1980 estimated to be 1155 million tons. U.S. mills face an annual expenditure in excess of $2.5 billion through 1980. It is expected that for the first time in free-world steel production, electric furnace output will exceed that of openhearth.--D.J.A.

'B

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The Steel Industry—It Is Old but Rejuvenated Constantly. Eiji Umene. SEAISI Q., Apr. 1975, 4-2, (665), 9-13 [in English]. Technological changes and innovations in steelmaking processes from the 14th century to the present are surveyed and the current research being conducted to widen the choice of fuel and energy is discussed. It is predicted that fume emission will be completely eliminated with the special 'formed coke' methods by which coke can be produced by means of calcining coal briquettes or pellets.-

669.18

Steelmaking – modern processes and plant. (Techn. Mitt. Essen, 1972, 65, Oct., 454-457) [in Ger.] BRANDI, H.T., HOFFKEN, E., RELLERMEYER, H.
The dominant feature in steelmaking during the last 10 years has been the emergence of the oxygen refining process. The authors describe the present status of oxygen blowing, trends towards larger capacity converters, introduction of the torpedo ladle and developments in dust control methods. Other topics discussed are preliminary desulphurisation of pig iron before its inclusion in the converter charge, inert gas rinising of steel in the ladle, lance desulphurization of molten pig iron while in transit from blast furnace to steelworks and vacuum degassing of steel. Brief notes are given on the proprietary BISRA, IRSID and OBM processes and possible advantages of the last-named over the LD process. Some likely future developments are indicated. (10 refs.)

669.18

Steelmaking and Processing. K. J. Smith. SEAISI Q., Oct. 1974, 3-4, 33-40 [in English].
In the making and shaping of steel, the pouring of liquid steel into ingots is the first conventional step taken before subsequent reduction and shaping in primary rolling mills. The continuous casting of steel made possible the elimination of the costly stages of ingot manufacture and the subsequent heating and rolling in bloom mills to produce blooms, billets and slabs for rolling to final sections. The essentials of both processes are briefly surveyed, with greater emphasis on established practice than the theoretical aspects of steel casting.—AA

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Challenge to High Productivity in a Steelmaking Complex—Muroran Works. Seiki Tsuzuki. Iron Steel Eng., Aug. 1975, 52, (8), 29-34 [in English].
Successively higher goals in monthly steel production were achieved by modifications in plant facilities and by worker motivation. When steel demand dropped, emphasis was changed to reducing ingot cost. When demand again increased, earlier targets were quickly reattained. Plant facility and operation improvements are described, with primary attention to use of a sublance for end-point temp. control and reduced cycle time. Operational data are presented.—J.W.S.

669.18

Steelmaking at Rotherham Works [U.K.]: Then and Now. C. Cox. Ironmaking Steelmaking, 1976, 3, (4), 175-180 [in English].
A description of the integration of the two plants at the Rotherham Works into one works structure is presented. Details are given of the present steelmaking facilities and of each plant and the reasons for their installation.—BA

(2)

The rise of the Spanish steel industry

R.A.C. Richards

Since the mid-sixties, Spanish steel production has virtually trebled with output growing from 3.8Mt in 1966 to 11.1Mt in 1975, a figure which makes Spain the world's thirteenth largest steelmaking nation. Of the 1975 total, 55% was made in oxygen converters, 35% in electric furnaces and the remainder by the open-hearth process. This article looks at the modern growth of the Spanish steel industry and examines the course of future development, paying particular attention to the new 6 Mt/y integrated works presently under construction at Sagunto.

Iron and Steel International, October 1976

P 353

Steelmaking in the Land of the Midnight Sun—Raahe Plant. C. J. Labee. Iron Steel Eng., Nov. 1974, 51, (11), 37-41 [in English].

The integrated steel plant at Raahe, Finland, started in 1961 and having a capacity of 800 000 tons/year, is described. Most of the iron ore is obtained by sea from northern Finland; coke is supplied in unit trains from the USSR. Two 75-tons basic O furnaces feed three single-strand continuous slab casters with C steel. The slabs are heated in two pusher-type, three-zone reheating furnaces serving a plate mill and a hot strip mill. Of the 350 000 tons of hot rolled strip, ~250 000 tons annually are shipped by rail to the cold rolling facility 400 km south. Research and development into new grades and improved operational techniques are carried on. Future plans involve an increase in capacity to 1.7 million tons by the installation of a new plate mill served by a new 75 tons BOF vessel and two additional casting machines.—M. R.

Progress of Japanese Steelmaking Technology. S. Toyoda. SEAISI Q., July 1974, 3, (3), 55-67 [in English].

The history of Japanese steelmaking technology is presented from the middle of the 19th century to the present, from the primitive 'Tatara Method' to modern processes such as reverberatory furnaces blast furnaces of large capacity, electric furnaces, cold and hot strip mills, pure-O LD converters and direct Fe reduction processes. The per capita steel production increased from 5 kg (11 lb.) at the beginning of this century to 600 kg (1320 lb.) at present, with low production during and immediately after the second world war. The advances in steelmaking took place by both government and private industry. Around 1930 steel production based on the scrap iron method by private industry surpassed that of government steelworks. Steelmaking has shifted from sites near raw materials sources to locations near the principal steel consuming markets. The beneficial influence of the Iron and Steel Institute of Japan is pointed out as the research centre for technological innovations.—D. R.

Production and Technology of Iron and Steel in Japan During 1974. Tsuneyo Iki. Trans. Iron Steel Inst. Jap., 1975, 15, (4), 212-230 [in English].

The output, developments, technological exchanges and other activities of the Japanese steel industry are reviewed for the year 1974. The total steel production for the year is expected to about the same as in 1973, ~12 million tons. The energy and time necessary for steel production have been decreased. Continuous cast steel reached 21% of the total steel production. The technological exchanges with various countries are described and tabulated. The activities of various research societies are discussed.—H. A. D.

Projections Regarding Steelmaking Technology in Latin America. Eduardo Oscar Fraccina. Present and Future Technology of Steel Fabrication in Latin America. 1974, 293, 295-318 + 2 plates (Met. A., 7505-72 0081) [in Spanish].
Expansion of the steel industry is a preoccupation in each of the producing countries in Latin America. The search for prereduced pellets with a high degree of metallization is a must for the area. Studies of the continuous charging of sponge Fe offer hope for a continuous process of steelmaking based on this material. The blast furnace-B.O.F. steelmaking route is seen as being increasingly adopted for use in integrated plants, electric steelmaking combined with continuous casting for semi-integrated plants. In view of the ever-changing technology of the developed countries, care must be exercised that future plants in Latin America do not turn out to be obsolete before start-up. Information on the structure, production capacity (including projections to 1980) and other facets of the industry in Brazil, Mexico, Argentina, Venezuela, Colombia, Peru, Chile and Uruguay is presented, plus tables showing the location, equipment, products, expansion plans, nature of ownership (private or government) and sources of capital of plants in Argentina and Brazil. 23 ref.–S.M.

A Report on the Iron and Steel Industry of the Philippines. Antonio V. Arizabal. SEAISI Q., July 1974, 3, (3), 9-21 [in English].
The Philippines has deposits of iron ores and other mineral raw materials, such as $FeCr_2O_4$, $MgCO_3$, $(Ca, Mg)CO_3$, SiO_2 and Mn, for sustaining iron and steel industries. There are melting and rolling plants, sheet cold and hot rolling mills, sheet galvanizing plants, tinning plants, as well as tube and pipe mills. The fluctuation between imported and domestically produced steel products, and variation in prices and tariffs, are reported in detail. The country is striving to a competitive position with imports and eventual self-sufficiency in cold rolled products, tinplate, galvanized iron sheet, pipe, tubes, billets, merchant bars and wire rods.–D.R.

Steelmaking in the Seventies. John R. Stubbles. Iron Steel Eng., Nov. 1974, 51, (11), 64-69 [in English].
The U.S. needs more and better steel to develop domestic energy resources, and thus sustain economic growth. While the technology to do this is available, the capital required for new and replacement facilities is becoming increasingly difficult to generate. Despite the introduction of the BOF and significant advances in blast furnace technology that have substantially increased productivity, there has been no increase in capacity. The continuous casting of slabs will be a dominant steelmaking method in the 1970's. Multimillion-ton plants already exist in Japan and the USSR that are based exclusively on slab casting, a process which offers major advantages in energy efficiency, yield, quality and productivity. The two major problems facing both the domestic and world steel industry in the 1970's are the availability and cost of raw materials and the lack of capital necessary for the expansion of facilities. Steel shortages in the U.S. will be very severe in the 1970's. The demand for steel will be such that the market must be able to bear significant price increases. 48 ref.–M.R.

Comparison of steelmaking processes from the technical and economic point of view, and consideration of future trends. (Thyssen Forschung, 1973, 5, (2), 59-77) (in Ger.) KOOTZ, T., LENZMANN, K. and ALTGELD, A. Steelmaking processes, and the ways in which these have changed and developed, are reviewed. Economic aspects of the industry are considered, with ref. to costs and sources of materials, including iron, scrap, ores, slagging materials, various fuels, electrodes, and water. Future trends (to 2100 A.D.) are considered in the light of world population growth and steel demand.

4A

SVEN EKETORP

A Proposal for a future Steel Plant and Reseach Program

The evolution of our steel industry has not occurred due to results of metallurgical research or by careful consideration of all possible factors. Instead, the usual way has been that capital has been invested, inventors and development engineers have found new ways of production and scientists have come many years behind explaining how everything worked. This will all be changed in the future.

In this lecture a proposal for a steel plant 20 to 30 years ahead will be discussed. The ideas for this plant are based on well defined scientific, technical, human and economical conditions and the end result is an integration of all these factors.

Main chapters will be:

(i) *Discussion of determining factors*
(ii) *Two possible metallurgical process routes*
(iii) *Description of plant*
(iv) *How to realize the ideas*
(v) *Summary of advantages obtained.*

Only process metallurgy from ore to solidifed steel will be considered in this discussion.

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New Economics of Steel–More Steel With Less Capacity. William T. Hogan. Iron Steel Eng., Dec. 1975, 52, (12), 57-60 [in English].
Through the application of large amounts of O_2, combined with a C brick lining, which includes a water jacket inside the Electric furnace for cooling purposes, heats have been produced on a regular basis in ~70 min. The furnace with its present technology has been in operation for almost two years, and the results over this period have been consistent. The 70 min. tap-to-tap time represents a sharp reduction from that recorded by most furnaces in the U.S. A survey of a number of shops in the U.S. indicates that an average of more than 3 h is required for a heat. Thus, there is a possibility that the application of this Japanese technology to existing furnaces in the U.S. could increase steelmaking capacity substantially for a relatively modest capital investment.–R. C. D.

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45 0626 Factors Influencing the Creation of Integrated Midi or Mini Steel Plants in Developing Countries. J. Astier and C. Roederer. SEAISI Q., July 1974, 3, (3), 22-30 [in English].
Factors to be considered in designing plants are: size of proposed plant, i.e. consideration of the market of total consumption in the given area, the type of products and corresponding rolling mills to be built; energy requirements, with the two main different cases of possible use of coal, especially coking coal and gas or liquid fuel and iron ore resources, with the comparative situation of high-grade ores or concentrates on one side, and medium or low-grade ores on the other. Included are comparisons between the classical flowsheet, i.e. production of pig iron in blast furnace or eventually in electric smelting unit followed by O steelmaking, and prereduction followed by electric arc steelmaking. 8 ref.–AA.

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Mini-Steel Plants. Alan Gough Shakespeare and Igor de Abreu e Lima. Metal. ABM, Sept. 1974, 30, (202), 643-647 [in Portuguese].
The technological developments and economic factors that have contributed to the proliferation of mini-steel plants in a number of countries are reviewed. Brazil has a number of such plants based on direct reduction processes and more will probably be built, but integrated mills are also expected to flourish.–S. M.

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Nuclear Steelmaking in Europe. Robert S. Barnes. Iron Steel Eng., May 1976, 53, (5), 53-58 [in English].
The steel industry by itself is unlikely to require sufficient reducing gas to justify the construction of a reactor/reformer complex supplying only steelworks. If large-scale industrial development of the high-temp. reactor (HTR) is to take place, its principal role will probably be electricity generation. An HTR can therefore be envisioned as using part of its high-temp. He output to steam-reform a hydrocarbon feedstock to produce a gas, e.g. 96% H_2. This gas would be available for distribution cold to steelworks and other industrial users. With the nonintegrated approach and the lower temp. that now

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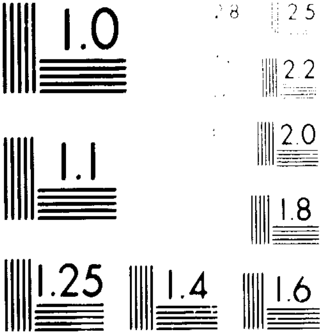
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Perspectives Offered by Nuclear Energy in Steelmaking. J. Astier. Cent. Doc. Sidér. Cir. Inf. Tech., 1976, 33, (2), 341-365 [in French].

The two basic processes for manufacturing steel (the classical method and the use of prereduced ore) are reviewed, and the possibilities of applying nuclear energy to these processes are discussed. Various schemes are envisaged for a steelworks based on prereduction with or without integration with a high-temp. nuclear reactor, and the energy costs for the different processes are compared. 9 ref.—J.M.S.

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Nuclear Steelmaking in the U.S.—Prospects and Plans. Donald J. Blickwede. Iron Steel Eng., Apr. 1976, 53, (4), 38-44 [in English].

A steelmaking system using a nuclear-heated coal gasification process to produce a gas for direct reduction of ore could be competitive or even provide a slight economic advantage over the present coke-oven/blast furnace/BOF system. Moreover, the system could use nonmetallurgical coal, and the amount of coal used could be less by ~40% than that used in the present steelmaking route. The system could also furnish a gas suitable for methanol and ammonia production. Addition of the chemical processes to the system and ownership of the gasification/reactor reformer part of the system by a group of industrial firms or by a quasigovernmental utility may be needed to keep investment in the system manageable.—R. C. D.

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Technology Assessment on Nuclear Steelmaking.—I. ——. Technocrat, May 1975, 8, (5), 6-17 [in English].

Pollution-free nuclear steelmaking using a high-temp. gas cooled reactor is expected to require a small construction cost and (if reducing agents and heat sources are available at a sufficiently low cost) a lower processing cost compared with the blast furnace. In developing countries a nuclear steelmaking plant proportional to the demand for steel could be a part of technological development assistance. Iron is reduced from ore containing Fe 65–67% and gangue 4% in either a shaft-type or fluidized bed using reducing gas $(CO + H_2)$ *from crude oil, thus being completely independent of coal.*

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Technology Assessment on Nuclear Steelmaking.—II. ——. Technocrat, June 1975, 8, (6), 21-31 [in English].

A nuclear unit which is a combined type of a gas-cooled reactor capable of producing high-temp. energy (1000 °C or higher) and a light-water type power reactor, can supply economical heat, electricity, process steam and fresh water for the Fe industry or the like where there is a demand for such energy. Although a comparison of nuclear and conventional steelmaking shows that the nuclear system has many economic advantages, the direct and secondary influences of radio-activity indicate that considerable development investment will be required in this area.—R. C. D.

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621.039.8

The Use of Nuclear Energy in Steelmaking—Prospects and Problems. Donald J. Blickwede. Nucl. News, Oct. 1974, 17, (13), 65-69 [in English].

A study is made of available systems for applying nuclear energy in steelmaking. In the high-temp. nuclear reactor, He is heated to ~1400 °F, high enough to make steam in a separate boiler for electric power generation and to provide heat for an endothermic chemical process. The system of reforming a hydrocarbon gas for direct reduction of iron oxide involves use of heat from the HTGR to provide heat for an endothermic chemical process. The gas produced is composed of CO and H, by steam reforming of a light hydrocarbon. This reaction takes place best at temp. >1600 °F (871 °C). This hot CO/H mixture produced by the reforming reaction reduces iron oxide to sponge iron, which can then be refined to steel in an electric furnace. Hydrogen for direct reduction of iron ore is based on the production of H through the dissociation of water into its elements, H and O. Hydrogen from the electrolysis unit passes through the HTGR to pick up enough heat (1200 °C) (649 °C) for the direct reduction of iron ore. The iron is then refined to steel in an electric furnace. Schematic drawings illustrate the process sequence for both HTGR processes, reduction processes and for the HTGR heat source operation.—L. H. S.

669.18 (520)
621.039.8

Japan Warms to Nuclear Steelmaking. Phil Hicks and Nicolas Consant. New Sci., 15 Apr. 1976, 70, (996), 124-125 [in English].

The bases of preliminary Japanese approaches towards nuclear steelmaking from directly reduced iron are outlined and the system under consideration is schematically presented. Reduced-pressure residue oil is favoured as the parent reducing-gas material, and the reactor output temp. (1000 °C) visualized is higher than in U.S. and European concepts. Geographical and other influences on the location of the sites are discussed. An experimental prototype is expected to be in production by 1990.—J. R.

669.18;
621.365;
533.9

Plasma-Arc Steelmaking: Literature Survey. (Bany.Koh.Lapok(Kohaszat), Apr.1974, 107, (4), 156-160) (in Hung) HEDAI L. The production of various steels in plasma-arc furnaces is discussed The construction and performance of the furnaces are, inter alia, described, and data are given on inclusions and oxides in steels produced by this process.

669.18;
65.012.3

Steel Capacity Rises; Will it be on Schedule? ——. 33 Mag. Met. Prod., Jan. 1976, 14, (1), 33-37 [in English].

Increased steel capacity planned to meet a projected demand of 25 million tons/year in 1980 over 1973 are threatened by currently lower profits but plans under way are expected to meet the need at least a few years later. An analysis of expansion plans and activities shows new plast furnaces, Q-BOP's, BOF's, electrics, concast facilities and rolling mills. Improvements to existing equipment cover increased furnace productivity, new coke ovens and improved materials handling, storage, scrap handling and charging and preparations for rolling. —J. V. R.

Construction costs for individual processes.

BF + LD

	0.5 million tons/year	1 million tons/year	3 million tons/year	6 million tons/year
Steelmaking	29.2	52.0	116.7	175.0

UNIT: Million dollars

Source: ID/WG/146/29, P.18, Table 3

The report No. ID/WG./146/29 indicates that production cost per ton of finished steel is $167.20 in integrated steel plant and $171.03 in mini plants.

Source: ID/CG/146/29, P.14. Table 2.

Construction costs for individual processes.

BF + LD

	0.5 million tons/year	1 million tons/year	3 million tons/year	6 million tons/year
Crude Steel per ton	$188	$162	$120	$97.4

UNIT: Million dollars

Source: ID/WG/146/29 P.18, Table 3

Capital Investment Requirements for steelmaking

GROVER, J.C 669.18 : 658.152

Changing World Steel industry

SEAISI Quarterly January '77 P14

Although increased scale of operations has certainly increased efficiency, the industry has suffered a major upscaling in capital investment requirements. This has been caused by rapid inflation of equipment costs, increased technological complexity and the increasing burden of pollution control expenditure.

In the early 1960's, a new integrated steelworks could be built for perhaps $100 to $200 per tonne of annual capacity. A greenfield works today would probably cost at least $500 to $600 per tonne in Japan, $600 to $800 in Europe and possibly $800 to $1000 in the U.S.A. Table II provides examples of major Japanese U.S. and European works built in recent years, compared to the possible cost of duplicating them today.

TABLE 2

INVESTMENT COSTS OF SELECTED MAJOR STEELWORKS

Country	U.S.A.	Japan	France	Japan	Japan
Company	Bethlehem	Kobe	Usinor	NSC	NKK
Works	Burns Hbr.	Kakogawa	Dunkerque	Oita	Fukuyama
Cap. Mtpa	4.0	6.0	8.0	8.0	16.0
When Built	1964-75	1968-73	1960-74	1971-76	1963-73
Actual Cost	$1½ bill.	$1½ bill.	$1.1 bill.	$2 bill.	$2 bill.
Poss. 1976 Cost	$3½ bill.	$3½ bill.	$5½ bill.	$4 bill.	$8 bill.

(2f)

Estimated cost of steel plants in different countries.

ARGENTINA

Thyssen Stahlunion Technik, Germany, and Finsider, Italy, have submitted tenders on building a $1,000 stellworks with a capacity of 2,5 million tons/yr. The works would be located either in Ensenada, Quequén or Bahia Blanca in Buenos Aires, or Puerto Madryn in Chubut. Source: IAMI, December 1974

The government will request international tenders for the construction of a 3 million ton-a-year steel complex which will be run by a new company. The complex will have a capacity of 5 million tons annually eventually. Source: IAMI, July 1974, P. 22

AUSTRALIA

Feasibility studies for the projected integrated works with an annual capacity of 10 million tons in Western Australia will cost $1,3 million and are expected to be completed next may. Participants in the project include Nippon Steel, Nippon Kokan, Sumitomo, Kawasaki, Kobe, Broken Hill British Steel, and Jones and Laughlin. Source: IAMI, December 1974

BELGIUM

The steel industry plans to increase its crude steel capacity to 20 million tons annually by investing $1,1 billion. Of that, $330 million will be invested over the next year. Source: IAMI, July 1974, P. 17

BRAZIL

A consortium made up of Usiminas Mecânica S.A., USIMEC, Clesid and Concast AG, will supply a $50 million continuous casting plant with three slab casting machines to Cosipa, Sao Paulo. Scheduled to go into operation by the end of 1979, the 1,4 million ton a year plant will produce slabs 1000 to 1900 mm wide and 180 to 300 mm thick. Source: IAMI, September 1976, P. 14

BRAZIL (cont'd)

Aco Minas Gerais will build an $1800 million integrated iron and steel works to make structural shapes and sections on a greenfield site near Belo Horizonte. The plant will have an initial annual capacity of 2 million tons and is scheduled to be operating by the end of 1979. Source: IAMI, July 1976, P. 21

Açominas has completed studies on a $2,2 billion plant which would produce 2 million tons of steel annually beginning in 1980. Source: IAMI, October 1976, P. 52

The BNDE has loaned Siderurgica Mendes Junior $20 million to build a steel mill at Juiz de Fora, Minas Gerais, with an annual capacity of 2 million tons.

The federal government has granted a $250 million credit to expand the Usiminas steel plant to an annual production rate of 3,5 million tons. CSN will build its second mill in early 1977 in Itaquai, Rio de Janeiro, spending $2,5 million. Engineering is by U.S. Steel Engineering Co. The plant will have a capacity of 3 million tons a year.

CVRD, with the Tunisian government and West German and Japanese interest, is participating in building a $55 million steel mill at Gabes, Tunisia, with an annual production capacity of 1 million tons.

CANADA

Steel Co. of Canada will build a $2 billion steelworks near Port Dover on Lake Ernie with an annual capacity of 6 million tons. Arthur G. McKee and Co., Cleveland, will design the blast furnace. The works will have two BOF's, a double-strand continuous casting unit and a 2030 mm strip mill. Source: IAMI, September 1974, P. 26

CHILE

Asociación de Industriales Metalúrgicos plans to build a 330 million steel mill with an initial capacity of 500,000 tons annually.
Source: IAMI, January 1975, P.13

FRANCE

Usinor will build a 50 million plant at Thionville using the OBM process. Eventual monthly output will be 110,000 tons a month.
Source: IAMI, September 1976

Sacilor-Sollac will build a 165 million steel mill in Lorraine. The plant will have two 220-ton converters and a continuous casting plant. Its second stage will include modernising a hot mill and building two more continuous casting plants.

GERMANY

Klöcker Werke A.G. will spend 57,2 million rationalising and expanding production. Most of that will be spent on its Bremen works, increasing crude steel capacity to 3,5 million tons annually from 2,65 million tons.

GREAT BRITAIN

A 20 million arc furnace will be installed at the Shelton works, giving the works an annual capacity of 350,000 tons.

BSC will spend 160 million on the South Teesside steelworks, which should double the Lackenby output within the next two years. The Lackenby BOS plant capacity will be increased from the present 2,2 million tons to 4,8 million tons by 1978.
Source: IAMI, March 1976, P. 35

GREAT BRITAIN (cont'd)

The British Steel Corp. will spend $34 million on developing the Shelton works and $374 million on the first phase development at Hunterston in Ayrshire. The Shelton works will have a Japanese-designed electric arc steelmaking plant with an annual capacity of 350,000 tons. Source: IAMI, March 1977, P. 9

Guaira S.A., Paran, will spend $90 million increasing steel production by 143,000 t/yr. Source: IAMI, March 1977, P. 9

Aconorte S.A., Pernambuco, will spend $30 million increasing steel production by 40,000 t/yr. Source: IAMI, January 1977, P. 9

ITALY

Italsider will spend $320 million at its Corrigliano plant. Most of this will go towards changing its Martin-Siemens plant into an OTM system. As well, a continuous casting plant will be installed and the existing cold sheet plant will be expanded. The plant will have an annual capacity of 2,4 million tons. Source: IAMI, Feb. 1976, P. 12

MEXICO

A total of $280 million will be spent in various steel expansion projects over the next few years, according to the Comisión Coordinadora Nacional de la Industria del Acero. Steel production is expected to reach 10 million tons annually by the end of this year, jumping to 12,3 million tons by 1980. Source: IAMI, March 1976, P. 37

[illegible] will borrow $150 million to raise the company's steel capacity from 2,4 million to 4,6 million tons/yr. Source: IAMI, February 1976, P. 14

8E

PERU

A $700 million steel mill will be built near the existing complex in Chimbote, bringing total annual steel production to 2,3 million tons. Source: IANI, January 1975, P. 34

PORTUGAL

Davy Ashmore, Britain and Demag, Germany, will design, supply, build and set to work a $35 million integrated steelworks at Oporto for Siderurgia Naciona . Siderurgia Nacional will also build a works in Maia with an eventual annual capacity of 500,000 tons. Source: IANI, January 1974, P. 16

SOUTH KOREA

The government has requested French participation in building a $2,800 million steelworks with an annual capacity of 7 million tons. Source: IANI, January 1975, P. 35

Nippon Steel has been asked for technical and financial aid and advice on the $2000 million third phase expansion of Pohang Steel Corp., which will raise annual capacity to 5,5 million tons by 1976 and 8,5 million tons by 1980. Source: IANI, January 1975, P. 35

SPAIN

A steel mill with an annual capacity of 280,000 to 300,000 tons will be built at Areijo, La Coruña, for Sodiga..... Source: IANI, February 1974, P. 13

A $40 million steelworks with an annual capacity of 700,000 tons annually is planned at Santander by a group of local steel makers, including Nueva Montana SA, Vitorio Luzuriaga SA, Hervacero, San Pedro and Tubacex. Source: IANI, December 1974, P. 15

SWEDEN

A $1 billion, state-owned steelworks, with an annual capacity of about 4 million tons of raw steel will be built at the NJA steelworks at Lulea. Source: IAMI, June 1974, P. 12

Gränges will spend $53 million on a new 180-ton LD furnace installation, together with a torpedo-ladle transport system, desulphurization unit and new lime kilns at the Gränges' Oxelösund steelworks. Source: IAMI, January 1975, P. 13

U.S.A.

National Steel has announced a $1000 million programme to add 2,3 million tons of capacity to its works. Source: IAMI, June 1976, P. 22

VENEZUELA

The government will build a $3,500 million steelmaking complex with an annual capacity of 5 million tons in the western oil-producing state of Zulia. Source: IAMI, April 1976, P. 23

Orinoco Steel Corp. will spend $2,700 million increasing steel output to 5 million tons in 1978 from 1 million tons.....
Source: IAMI, Februal 1976

669.18
662.69

The Possibilities of Using Natural Gas in Various Steelmaking Operations. H. Della Casa. Cent. Doc. Sidér. Inf. Tech., 1975, 32, (9), 1925-1945 [in French].
The role which natural gas could play in supplying the energy needs of steelmaking processes is considered. In the classical process based on agglomeration, blast furnace operation, and O steelmaking, <50% of the energy needs can be met, principally by the direct injection of gas at the tuyeres and by injection of reformed gas at the base of the stack. Processes based on the pre-reduction of ores and electric melting allow exclusive use of natural gas, which can also supply some of the energy needs of heating furnaces. 11 ref.—J.M.S.

669.18
669.012.37

Saving Energy in Steelmaking. Reinhold Friedel. Met. Eng. Q., May 1975, 15, (2), 2 [in English].
Methods for dealing with the energy shortage include the exploration of new sources, the adoption of substitute systems which allow adaptation to price shifts or scarcity situations and reductions in energy consumption. Increased use of coal in steelmaking is particularly important, as is improving the efficiency of power stations, coking plants, furnaces and ancillary equipment.—M.J.W.

669.18;
669.012.37

Energy Use in the Steel Industry. 1.—Current and Projected Use. J. K. Stone. Iron Steelmaker, Mar. 1975, 2, (3), 23-26 [in English].
The U.S. steel industry consumed in 1974 90 million tons of coal, 10 million tons of coal equivalent (TCE) of fuel oil, and 26 million TCE of natural gas. On a per ton basis, electric furnace melting is the biggest single user of power in a steel plant (500 kWh/ton). The next biggest users are wide strip mills and coating lines. Increasing energy costs are going to make byproduct heat recovery and recycled energy important in the future. The steel industry will also become increasingly dependent on cokable coal to fuel blast furnace production to support the shift to BOF steelmaking. 11 ref.—R.C.D.

The Effect of Raw Materials for Steelmaking on Energy Requirements. D. I. T. Williams and D. S. Thornton. Br. Steel Corp. Rep., May 1975, [illegible]. 14 pp. and Appendices 4 pp [in English].
Energy models for production of 1 tonne of steel by the electric-arc-furnace (EAF), blast-furnace (BF) and basic-O (BO) routes are presented. Consideration of these and major energy-affecting factors quantifies the lower energy requirement and greater conversion efficiency of the scrap-based EAF approach. The replacement of scrap by pre-reduced material and ore in the resp. processes increases the energy requirements in both cases. The use of formed coke in the BF can decrease the energy requirement by 2%, but replacement of the coke charge by hydrocarbon injection can increase it by 10%. Contaminants in the Fe and scrap can significantly increase thermal requirements.—J. R.

Energy Trends in the Iron and Steel Industry. ——. Inform. Latinoam., 1976, (188), 42-52 [in Spanish].
Trends in the production, consumption and efficient utilization of the various types of energy used in the manufacture of iron and steel are analysed on the basis of statistical data from the major producing countries and general tendencies in steelmaking technology. Electricity, coke, coal, fuel oil, natural gas, O and other sources of primary energy are considered, as well as the secondary energy resulting from melting, coking, rolling and other operations. Reductions in energy consumption made possible by the partial substitution of one fuel for another, innovative charge mixtures, matching the size of casting ladles to heats to require fewer lifts by ladle cranes and numerous other measures are examined. Two of several charts and tables analyse the yearly consumption of blast-furnace and coke-oven gases in each of 11 countries for the period 1960-1972 inclusive. Another presents the energy balances for the production of one ton of steel by the electric arc furnace with a 100% scrap charge and by the blast furnace-O converter and direct reduction-electric arc furnace methods.—S. M.

Energy in the Steel Industry. Shigeru Toyoda. Met. Eng. Q., May 1975, 15, (2), 1 [in English].
Coke rates in Japanese steel furnaces have been reduced by improving blast furnace burden properties, increasing sinter-plus-pellet ratios, increasing blast temp. and pressures, improving coke quality, injecting auxiliary fuel from tuyeres and improving charging and control methods. The L-D converter process and continuous casting have resulted in large energy savings. New techniques for utilizing noncoking coals are particularly important, as illustrated by methods for making formed coke and coke made with coal blended with briquetted coal.—M. J. R.

Raw materials for steelmaking

D.S. Thornton*

Recent changes in steelmaking technology and ferro-alloy production have increased the range of raw materials available to the steel producer. This article looks at these raw materials and discusses the various factors influencing their use. Particular attention is paid to choice of alloy grades, an area where rapidly increasing costs are proving a major consideration. Finally, the author briefly examines recycling and reclamation and the problems associated with increasing such practice.

Iron and Steel International, October 1976

669.12
669.012.37

The Effect of Raw Materials for Steelmaking on Energy Requirements. D. I. T. Williams and D. S. Thornton. Br. Steel Corp. Rep., May 1975, (CAPL/SM/A/14/75(SM/7588/-/75/A)), 14 pp; and Appendices 4 pp [in English].
Energy models for production of 1 tonne of steel by the electric-arc-furnace (EAF), blast-furnace (BF) and basic-O (BO) routes are presented. Consideration of these and major energy-affecting factors quantifies the lower energy requirement and greater conversion efficiency of the scrap-based EAF approach. The replacement of scrap by p... uced material and ore in the resp. processes increases the energy requirements in both cases. The use of formed coke in the BF can decrease the energy requirement by 22%, but replacement of the coke charge by hydrocarbon injection can increase it by 10%. Contaminants in the Fe and scrap can significantly increase thermal requirements. ... .R.

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669.012.37

Energy Trends in the Iron and Steel Industry. ——. Sider. Latinoam., 1976, (189), 42-52 [in Spanish].
Trends in the production, consumption and efficient utilization of the various types of energy used in the manufacture of iron and steel are analysed on the basis of statistical data from the major producing countries and general tendencies in steelmaking technology. Electricity, coke, coal, fuel oil, natural gas, O and other sources of primary energy are considered, as well as the secondary energy resulting from melting, coking, rolling and other operations. Reductions in energy consumption made possible by the partial substitution of one fuel for another, innovative charge mixtures, matching the size of casting ladles to heats to require fewer lifts by ladle cranes and numerous other measures are examined. Two of several charts and tables analyse the yearly consumption of blast-furnace and coke-oven gases in each of 11 countries for the period 1960-1972 inclusive. Another presents the energy balances for the production of one ton of steel by the electric arc furnace with a 100% scrap charge and by the blast furnace-O converter and direct reduction-electric arc furnace methods.—S. M.

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669.012.37

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(10)

669.183.21

Rise and Fall of the Open Hearth. A. Jackson. (Iron making Steelmaking, 1976, 3, (1), 1-9)
An historical account of the developement of the gas-fired, open-hearth furnace in the UK is given from its beginnings in the mid 1850s to its decline in the late 1960s. The replacement of the puddled-iron process by the acid open-hearth process, which was, in turn, replaced by the basic open-hearth process, is described. The melting procedures used in the basic open hearth in the 1920s with their dependence on the skills and experience of the melting-shop workers are described, followed by an account of the gradual introduction of control procedures, initially by simple analysis of melt and slag samples, and ending with the highly instrumented furnaces of the 1950s. The growth of managerial control of the steelmaking process and the co-operation within the steelmaking industry beginning in the 1930s are outlined. Brief descriptions of technical developments in the furnace ports, the manufacture of producer gas, regenerators, and refractories, are given together with accounts of model work, instrumentation, furnace charging, nad the use of tonnage O (in the 1960s). The effects on steel production of various developments during the life of the open-hearth process are described.

669.183.211.182

The Effect Of Positioning The Refining Oxygen Lance On The Progress Of Metallurgical Processes With Special Attention To Tandem Furnaces. J. Petros & B. Borsky (from Cz.) (Hutn. Listy, 1976, (4), 248-254)
The distance between the lance and the metal surface affects sulphur and phosphorus removal and also the transfer of manganese to the slag. Conditions are investigated including the oxygen content of the metal and the effect of the carbon content on the agitation of the bath during blowing. (Price:- £ 9.00)

669.183.211.182

Prospects of the Tandem Steelmaking Process. G. Schmidt. (Bany.Koh.Lapok (Kohaszat), Dec.1974, 107, (12), 541-545) The traditional o.h. process and the O injection process differ mainly in performance, in scrap consumption and in investment and production costs. A process combining the advantages of O blowing with the favourable characteristics of the traditional process would be desirable. The tandem process fulfils these conditions to some extent, without, however, being competitive with the LD-process.

669.184.211.152

Perspective on OUtput Rate in Tandem Steelmaking Furnaces (Hutnicke Listy, Apr. 1974, 29, (4), 239-247) (in Cz.) HAROK, M. and BOHM, Z. Relationships and factors determining the productive capacity of tandem steelmaking furnaces are considered. The output of such furnaces is affected by: (i) the heat capacity, (ii) the max. blowing intensity, and (iii) the quality of the charge. The production capacity both for one tandem furnace, and the whole tandem steel plant was theoretically computed. The optimum arrangement appears to comprise a configuration of five furnaces, four of which, at any one time, are in operation.

669.183.211.182

(Stal', Sept. 1975, (9) 795-797 (In Rus); BLL M 25281) Improving the Operational Factors of Tandem (Steelmaking) Furnaces: Report of a Conference in March 1975. L.M. Efimov and M.M. Privalov. Measures designed to improve the working time of tandem furnaces, reducing refractory consumption, and economizing on metal charges are discussed, on the basis of the operational performances of such furnaces at a number of plants. The advantages of preheated charges the control of O injection (at the rate of 0.4-0.5 m³/tonne.min), and the extended range of steels melted in tandem furnaces are considered. Means of increasing they yield of good steel, accelerating the rate of scrap charging, increasing the bath capacity and recommendations aimed at increasing roof life and improving technological parameters of the process receive special attention.

669.183.211.182

Development in the Tandem (Twin-Hearth) Steelmaking Furnace at the Krivoi Rog Plant. L.M. Efimov, D.A. Smolyarenko, E.A. Grekov, Yu.F. Voronov, and V.F. Isaenko, (Stal' Sept. 1975, (9), 802-805 (In Rus); BLL M 25282) The steelmaking practice developed for the produciton of low-C rimming and semi-killed steels in the tandem furnace is described and its recent development outlined. Yield is increased simultaneously with a reduction in the consumption of molten pig iron, and an increase in theproportion of scrap in the charge. A practice involving the addition of a second portion of molten metal into the twin-hearths (2 x 280 tonnes) of 25-35 tonnes has resulted in a marked reduction in the losses of Fe in the slag.

12

669.183.211.182

Melting Practice for the Producton of Steel in the Tandem Furnace at the Zaporozhstal Works. L.D. Yupko, K.M. Trubetskov, P.M. Shchastnyi, V.A. Mir'ko, and I.K. Borshchevskii. (Stal, Sept. 1975, (9), 768-800 (In Rus.); BISI 14010)

Improved operating schedules for a tandem steel-making furnace (each vessel with a capacity of 250 tonnes) are described. In semiproduction trials, a substantial reduction in metal losses was achieved by the addition of molten pig iron to each vessel in two portions. The quantity of molten metal added in the second stage (during refining, 15-20 min before tapping) was varied from 12.7-48.8 tonnes (7.2-26% of the entire molten metal charge). A steady improvement in operational performance was noted. Data relating to the trials are tabulated.

669.183.211.184

Prospects of the Tandem Steelmaking Process. Gyorgy Schmidt. Bany. Koh. Lapok (Kohaszat), Dec. 1971, 107, (12), 541-545 [in Hungarian].

The traditional o.h. process and the O injection process differ mainly in performance, in scrap consumption and in investment and production costs. A process combining the advantages of O blowing with the favourable characteristics of the traditional process would be desirable. The tandem process fulfils these conditions to some extent, without, however, being competitive with the LD-process. - BA

669.183.211.184

Metallurgy of the Tamden Furnace Steelmaking Process by L. Kodrle and J. Petros, *Hutn. Listy* (Czech.), 1972, No. 2, pp 100-110. Carbon removal, lance design and its effects and changes during the refining process are discussed. Lime quality and rate of slag formation and the changes in its composition and fluidity are then referred to, and their effects on sulfur removal. A comparison with oxygen converters is made. (BISI 10443 - £10)

669.183 212.217

Bottom-blown open hearths .... SIP takes shape at SYSCO. (33 Mag., 1972, 10' Aug., 30-1) HAYSOM, D.W.R. The development is described of the Submerged Injection Process (SIP) at the Sydney Steel Corp. of Canada (SYSCO). Results of development with Maxhütte have led to the conversion of open hearth furnaces using bottom-blowing tuyeres.

(13)

669.183.218.5
669.41

Experiences of preheating natural gas in open hearth furnaces. (*Stal', 1973, 5, 463-464*) (*from Russ.*) MAGIDSON, M.A. et al. Preheating natural gas to 350-400°C raises its velocity on leaving the nozzles, improves flame luminosity, and reduces the consumption of fuel oil, while melting and refining are accelerated. Natural gas preheaters with stainless steel tubes were installed in the flues of two 400 t open-hearth furnaces at the Orsk-Khalilovo combine, where the temperature of the products of combustion was 550-700°C. This appreciably improved the running particulars for the furnaces. Provision is made for the free deformation of the tubes during heating and for automatic control in the case of a tube burning out and the natural gas igniting in the flue. (Price: £3)

BISI 11699

669.183.23

Conditions of Realizing the Scrap-oxygen Process in a 100 Ton open Hearth Furnace. J.Miko et al (from Hung.) (Bany es Koh.Lapak (Koh.), 1973, 106, (4), 149-152.) An investigation is described into various parameters of the scrap-oxygen process developed in the Moscow Steel Institute with particular reference to its application in a 100t open hearth furnace. Relations were established between iron/scrap ratio, content of Si and Mn in the iron, variation in the quantity of heat received by the charge and the duration of the individual heating and melting periods, also that of the overall heating/melting period. (Price: £6).

BISI 13041

669.183.23

The Scrap-Oxygen Process - a new open hearth steelmaking technique. J.Miko (from Hung.) (Bany es Koh. Lapok (Kohi), 1973, 10, (1), 29-32.) The scrap oxygen process developed at the Moscow Steel Institute is described. Its advantages, as indicated from experimental melts in the USSR, are compared with the conventional scrap ore process, and its potential in Hungary is discussed. (Price: £5-50.)

BISI 13025.

669.183.214.23

Improved performance of open-hearth furnaces charged with scrap. (*Metallurg, Apr. 1973, (4), 23-24*) [*in Rus.*] KARPEL', M.Z., MARKOV, I.Kh., LAPITSKY, M.M., CHUVANOV, A.I., BUBLEVSKY, L.I. A statistical study was made of the operating characteristics of a number of open hearth furnaces, when charged with scrap. The influence of charging time, and scrap density, related to the hearth area, on output metal yield and specific fuel consumption were determined. Means of further improving the efficiency of operation of open hearth furnaces, charged with steel scrap, are indicated.

(15)

669.183.23

High Scrap Melt Practice. (AIME Open Hearth Proc., 1973, 56, 175-185) BETZOLD, W.C. and LONG, C.W. A programme was undertaken to reduce the ingot costs at an open-hearth shop by capitalizing on the differential cost between scrap and hot metal. Scrap use was ncreased to 60-63% compared to the former 45% level. Operating and metallurgical aspects are reviewed, including utilization of oxy-gas roof burners to maximize scrap melting and minimize oxidation; charging of carbonaceous material to ensure adequate melt-in condition; use of C-temp. control charts for optimum furnace operations; operating data such as O consumption, bottom making, charging and refining times; and the effect of varying the scrap percentage upon residual alloy contents and melt-in C and S levels.

669.183.214.25

The industrial development of the IRSID continuous steelmaking process. (I.S.I. of Japan, Proc. Int. Conf. on the Science and Technology of Iron and Steel, Tokyo, 7-11 Sept., 1970, Part 1, 272-277) BERTHET, A., KRUG, J.C., ROUANET, J., VAYSSIERE, P. In the IRSID continuous steelmaking process refining of hot metal takes place in a complex mixture of slag, metal droplets and gases, in which the interface areas are very large. This ensures high mass and thermal transfer rates, allowing high speed refining in a small volume. Refining is perfomed in one or two consecutive stages, the slag in the latter case being recirculated. Owing to this possibility, the process can be applied to various kinds of pig iron with the same productivyt and a good yield. After a first investigation on an experimental 10 tons/h plant, a semi-industrial pilot installation with a grading and holding furnace has been integrated in an existing steelwork. With a capacity of 20 to 30 tons/h, this new installation has produced, up to now, about 2000 tons of steel. The metallurical results presented – such as refractory consumption, metallic yield heat balance, regularity and quality of steel, grading possibilities – are better than those of conventional processes. Further studies are necessary to achieve full industrialization.

669.183.214.25

WORCRA steelmaking. (I.S.I. of Japan, Proc. Int. Conf. on the Science and Technology of Iron and Steel, Tokyo, 7-11 Sept., 1970, Part 1, 277-282) WORNER, H.K., BAKER, F.H. WORCRA continuous smelting and refining furnaces are zoned in a horizontal plane. A "central" more or less circular feed zone (called the "bowl") has two elongated braches connected therewith. One is used for refining with countercurrent slag flow and the other for the clean-up of slag. The slag in the bowl is caused to circulate generally concurrently with the metal blow. The slag necessary for refining is generated by lime additions near to the metal outlet end of the refiner branch. The continuous refining of hot metal by this approach has been tested in a 5 ton per h pilot at Cockle Creek, Australia and an electric WORCRA steelmaker has been commissioned at Jernkontoret's Research Station in Lulea, Sweden. This nominal 8,metric ton per h plant is designed to melt and refine continuously blends of pig iron, scrap and sponge iron, including pellets or briquetts containing carbon. The potential of both approaches to achieve very high Fe yields and high refining efficiency with economy with respect to lime and oxygen has been demonstrated.

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669.183.214.25

Studies of NRIM Continuous Steelmaking Process. (Trans Iron Steel Inst. Jap., 1973, 13, (5), 333-342) NAKAGAWA, R. et al. Basic concepts for the development of the NRIM continuous steelmaking process an the recent experimental results are reported. In a small-scale experimental plant and a short running time of about 100 min,, satisfactory results were obtained in the separation of reactions into each stage and the operational techniques. The characteristics of this multistage continuous steelmaking process have been confirmed, i.e. as for the dephosphorisation, steel of 0.005% P is produced (dephosphorisation rate 96%), and as for the decarburization, C level could be controlled mainly in the second stage. The NRIM multistage continuous steelmaking process has the characteristics of separating the complex steelmaking reactions into several simple ones, and results in easy control of reaction and mixing, proper selection of refractories and reduction of capital and maintenance cost.

669.183.214.25

Continuous Steelmaking. M. A. Glinkov. Izvest. V.U.Z. Chernaya Met., 1975, (3), 41-48 [in Russian]
An account of the theory, present state and future prospects for development of various modifications of the continuous steelmaking process, based on published data is presented.—M. L. T.

669.183.214.25

NAKAGAWA, R.
The NRIM Continuous Steelmaking Process. (V.D.Eh. Internat.Iron Steel Cong., Düsseldorf,1974, 1974, (Vol II), 3.3.2. 1 1-16) Details are given of the NRIM pilot plant in which molten iron is fed into three one-ton troughs in cascade, each equipped with four top blowing O lances, which also inject powdered fluxing materials into the molten metal. The throughput is 8 tons/h, and the process time is 100 min. Up to 96% P is removed , depending on slag basicity, whilst decarburization is proportional to the O blowing rate. Calculations indicating the feasibility of a 100 ton/h production plant are presented.

669.183.214.25

A Discussion on Development Trends in Continuous Steelmaking by V. A. Medvedev, *Stal* (Russian) 1974, No. 5, pp 414-415. A report on a discussion of the scientific and technical council of the USSR Ministry of Iron and Steel. Converter development of emulsion processes, flow-type units of hearth type and stream or jet methods of refining were reviewed. Contributions of various research institutes are briefly indicated. (BISI 11690 - £4)

669.183.214.25

Continuous Steelmaking in Rotary Reactor System.-1. (Ind. Heat., Feb. 1974, 41, (2), 17-20, 22,24-25) GOSS, N.P. and BLOUGH, A.K. Continuous system advantages in comparison with other melting methods are discussed. With ever increasing cost of handling equipement, its maintenance and increasing labour costs, the continuous steelmaking process becomes more and more attractive. A continuous steelmaking operation would have min. amount of material in the system; this would make it possible to change chemistry without difficulty. In continuous steelmaking, fuming (FeO dust) is greatly reduced. The use of cheaper fuls and a wider range of fuel type is possible. The discussion of a rotary reactor for mixing metal and slag is initiated and will be continued.

669.183.214.25

Melting of Metal Scrap in Continuous Steel-Melting Plant. Yu. S. Paniotov et al. (Metall. Koksokhim., 1975, (47), 36-38) (In Rus.)
The mechanisms underlying the melting of metal scrap in continuous steel-melting plant are discussed with ref. to thermodynamic analysis (making reasonable assumptions regarding scrap composition) and practical experience. The efficeincy of the scrap-melting process depends onthe rate of heat trnasfer between the melt and the solid scrap fragments. Hence a ratio al choice of the size and shape of the fragments is necessary. A method of determining the rate of heat transfer by means of a system of probes is described. An expression is also given for determining the optimum size of the fragments.

669.183.214.25

Continuous steelmaking in a rotary reactor system. (I.S.I. of Japan, Proc. Int. Conf. on the Science and Technology of Iron and Steel, Tokyo, 7-11 Sept., 1970, Part 1, 287-289) GOSS, N.P., BLOUGH, A.K. A method has been developed for reducing solid iron ore particles to hot metallic iron in a continuous system involving a rotary kiln, a flash heater and a rotary reactor in series. The operation is performed in such a way that the iron oxide is reduced step by step, as it passes through a series of apparatus elements. The hot metal thus produced (2-4% carbon) is made into steel in one or more rotary reactors. The compacting of these operations into small units will reduce investiments and operating costs. A group of such units would give the flexibility required by the market as to total tonnage and size of order. Steel would be produced to the exact quantity to fill orders. All the elements of this process are proven to make steel directly from ore, or cupola scrap. High cost refractory problems found in other continuous processes have been overcome. Prehaps the greatest advantage of the system proposed is the use of fuels, (coal fines, etc.) and ores not suited for blast furnace operations. These fuels are much cheaper than metallurgical coke, and a wider range of fuel can be used -- gas, oil, or coals can be fully utilized.

669.183.214.25

Continuous Steelmaking in Rotary Reactor Systems.-IV. (Ind. Heat., June 1974, (V), 41, (6), 24-26) GOSS, N.P. and BLOUGH, A.K. The decarburization of molten steel in a rotary reactor is described. Finely divided ore (FeO) or mill scale is injected into the molten metal in the reactor by a multijet lance system. Mixing of the FeO and the bath is controlled so that about 2400-2850°F (1316-1566°C) is achieved to decarburize the bath. Other details of the reactor operation are given.

669.183.214.25

Continuous steelmaking at the National Research Institute for Metals. (I.S.I. of Japan, Proc. Int. Conf. on the Science and Technology of Iron and Steel, Tokyo, 7-11 Sept., 1970, Part 1, 290-293) Nagagawa, R., Ueda, T., Yoshimatsu, S., Sato, A., Mitsui, T., Uehara, I., Fukuzawa, A. Research on the continuous steelmaking process has been carried on in NRIM since 1964. The multi-stage furnace was installed in 1967. This installation consists of a 15 ton holding furnace, a three stage trough type furnace and a pneumatic flux feeder. The total molten pig iron of 12 ton is fed to the furnace at the r of 125 kg/min. The powdered flux is injected with oxygen gas through all lances or specified lances into each furnace. The specified reaction can be carried on at specified furnace in the multi-stage steelmaking process. Several troubles which have occurred during our campaign were adjusted one by one. Special attention was paid to the propertic of slag in these experiments. The NRIM continuous steelmaking process is described as technical feasible.

669.183.214.25

An Experimental Continuous Hearth Steelmaking Unit. (Stal', May 1974, (5), 422-424 (in Rus.); Steel in the USSR, May 1974) GLINKOV, M.A., MOROZOV, V.A., CHERNENKO, M.A., KOZLOV, L.I. and UEOGOV, I.P. Two versions of a continuous steelmaking unit, each with four baths connected in series by a fritted hearth, are described. The furnaces are equipped with gas-O roof burners and O lances. The small-scale furnace with 6 ton capacity baths, was designed to produce 15 ton steel/h. The full-scale furnace has a first bath of 80 ton capacity, and the remaining baths each of 60 ton capacity. It is planned to provide up to 240 ton steel/h.

669.183.214.25

Continuous Steelmaking Processes. (International Iron and Steel Congress, Dusseldorf, May 1974, paper 3.3.1) (from Fr.) BERTHET, A. et al. A review of developments over the last ten years in continuous production of steel; problems in processes involving pre-reduced ores and scrap will soon be resolved industrially. Most problems in continuous pig-iron refining have been solved and delays are due to the scale needed for the process to compete with oxygen steelmaking. (Price: £6)

BISI 13118

669.184.15

Technical and economical considerations of the IRSID/CAFL oxygen converter gas recovery system. (Iron Steel Eng., Sept. 1973, 50, (9), 87-97) MAUBON, A. Innovations and improvements in gas-recovery systems developed during the past ten years by the French Research Institute of the Iron and Steel Industry (IRSID) in conjuction with a number of French installations are described. The unburnt-off gas-collection system has a number of advantages, such as a lower volume of gases to be handled and cleaned, a lower total enthalpy of the gas to be cooled, and recovery for fuel because the gas has a high CO content and a calorific value of 2000 kcal/m^3. Various installations are illustrated, and operating statistics and savings are shown.

669.184.214.25

Continuous Steelmaking in Rotary Reactor System.- III. (Ind.Heat., Apr.1974, 41, (4), 24-28, 30) GOSS, N.P. and BLOUGH, A.K. A rotary kiln-flash heater-rotary reactor system for producing hot metal from ore and coal fines is described. It is important that the ore and reducing agent be mixed in proper proportions. The rotary reactor makes it possible to control retention time so that reactions between metal and flux can be precisely controlled and carried to the desired end point. Using such a system also makes it possible to cope with the vast quantities of CO gas generated when Fe ore is reduced.

669.183.214.25

The Continuous Production of Steel. A. Berthet, B. Trentini, and P. Vayssière. Centre Document. Sidérurgique Circul. Inform. Techn., 1975, 32, (5), 1249-1260 [in French]. Problems encountered in the continuous manufacture of steel are dealt with. Two types of continuous process are considered: the refining of liq. cast iron and the melting of reduced ore and scrap. For the continuous refining of iron a wide variety of processes carried out on a pilot or semi-industrial scale are reviewed. For continuous melting, a Russian process is briefly described, as well as two processes based on the electric arc. 14 ref.-J. M. S.

669.183.214.25

Studies of the NRIM (Japan) Continuous Steelmaking Process. R. Nakagawa et al. (Tetsu to Hagane (J. Iron Steel Inst. Jpn), 1973, 59, (3), 414-429) (HB Translations No. 9026) Fundamentals of the NRIM multistage trough-type continuous steelmaking process developed by the Japan National Research Institute for Metals are covered. The most recent operating results obtained are reported and a layout of the NRIM experimental plant is provdied. The best way of separating steelmaking reactions at each process stage is suggested. Operating know-how and its application on the industrial scale are detailed.

(20)

669.183.214.25

45 0530 Continuous Steelmaking. M. A. Glinkov. Izvest. V.U.Z. Chernaya Met., 1975, (3), 41-48 [in Russian]. An account of the theory, present state and future prospects for the development of various modifications of the continuous steelmaking process, based on published data is presented.-M. L. T.

A discussion on development trends in continuous steelmaking. (Stal', 1973, (5), 414-415) (from Russ.) MEDVEDEV, V.A   A report of a discussion of the scientific and technical council of the USSR Ministry of Iron and Steel. Converter developmer of emulsion processes, flow-type units of hearth type and stream of jet methods of refining were reviewed. Contributions of various research institutes are briefly indicated. (Price: £4) 669.183.214.25

BISI 11690

669.183.214.25

The Continuous Production of Steel. A.Berthet, B. Trentini, and P.Vayssiere. (Centre Document. Siderurgique Circul. Inform. Techn., 1975, 32, (5), 1249-1260) (in Fr.) Problems encountered in the continuous manufacture of steel are dealt with. Two types of continuous process are considered: the refining of liq.cast iron and the melting of reduced ore and scrap. For the continuous refining of iron a wide variety of processes carried out on a pilot or semi-industrial scale are reviewed. For continuous melting, a Russian process is briefly described, as well as two processes based on the electric arc.

669.183.214.25

Continuous Steelmaking in Rotary Reactor System.-II. (Ind. Heat., Mar. 1974, 41, (3), 16-18, 20) GOSS, N.P. and BLOUGH, A.K. The action and reactions that occur in rotary reactor steelmaking, and types of linings are discussed. The hot metal, ore, coal and flux are fed into one end of the reactor and reacted product, hot metal, semiprocessed hot metal or steel, ejected from the other end. Since metal and ore, which is constantly fed into the reactor, follow a long helical path through the reactor, it is possible for the flux to remove the impurities under the most favourable conditions and the metal flow in the reactor may be likened to a long runner wound into a helix. For steelmaking it is preferable to use two reactors in series: the first to remove, Si, S and P and a second for decarburization using FeO. The advantages of the rotary reactor are outlined.

669.183.214.25

Continuous Steel Refining Processes. (V.D.Eh. Internat.Iron Steel Cong., Dusseldorf,1974, 1974, (Vol.II), 3.3. 1 1-23) (in Fr) BERTHET,A. TRENTINI,B. and VAYSSIERE P. Theories of continuous steelmaking are considered and related to experimental work carried out in several counties. Procedures for refining molten iron include:(i) successive partial refining in cascade sequence,(ii) channel refining with concurrent or countercurrent slag flow,(iii) spray steelmaking by air atomization, and (iv) emulsion refining. Procedures for remelting scrap and ore by combustion, or arc heating, are considered. Most initial difficulties appear to have been overcome, and a commercial continuous refining plant is considered technically feasible.

669.183.214.25

Continuous Steelmaking. M. A. Glinkov. Izvest. V.U.Z. Chernaja Met., 1975, (3), 41-48 [in Russian]. An account of the theory, present state and future prospects for development of various modifications of the continuous steelmaking process, based on published data is presented.—M. L. T.

669.184.244.24

Side-blown steel converter practice. (Steel Furnace Monthly, Sept. 1973, 8, (9), 515-520) ROBINSON, J.R. The history, principles, and chemistry of the Tropenas converter and its operation are reviewed. Vessel design, the blowing cycle, bath composition, products quality, thermal efficiency, and process control are discussed

669.184.244.6

Australian iron and steel brings bof steelmaking to port kembla facility. (33 Mag. Met. Prod., Sept. 1973, II, (9), 34-37) SCHOLES, W.A., A major expansion that increased steelmaking capacity about 45% involved a new blast furnace and BOF plant. Both are described, and data are given on furnace designs, sizes, structural details, temp., volumes and production rates.

669.184.244.6

Stelco's first BOF. (J. Met. 1972, 24, Oct., 15-19) NEWTON, G. The three-vessel BOS plant at the Steel Co. of Canada's Hilton Works is described. Details are given of the general layout of the plant, materials handling facilities, the three 120-ton vessels, two teeming aisles, holding canyon and mould stripper building. The plant is process controlled by a GEPAC 4020 computer. Initial performance results are stated to be encouraging and it is expected that planned aims and objectives will be exceeded.

669.184.244.6

The new oxygen steelmaking process. (Iron and Steel Internat. Oct., 1973, 46, (5), 440-448) CHATTERJEE, A. A review is made of the OBM and LWS processes of steelmaking which are based on introducing O through the bottom of a basic converter within a peripheral shield of another medium hydrocarbon gas in the case of the OBM process and steam or fuel oil in the LWS. A similar use of this injection principle, applied to the open-hearth process, and known as SIP, is also considered. Details are given of the principles of operation of each process, as are typical data from an operating plant; an assessment is also made of the relative advantages and limitations.

669.184.244.6

Technical and economical considerations of the IRSID/CAFL oxygen converter gas recovery system. (Iron Steel Eng., Sept, 1973, 50, (9), 87-97) MAUBON, A. Innovations and improvements in gas-recovery systems developed during the past ten years by the French Research Institute of the Iron and Steel Industry (IRSID) in conjuction with a number of French installations are described. The unburnt-off gas-collection system has a number of advantages, such as a lower volume of gases to be handled and cleaned, a lower total enthalpy of the gas to be cooled, and recovery for fuel because the gas has a high CO content and a calorific value of 2000 kcal/m^3. Various installations are illustrated, and operating statistics and savings are shown.

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669.184.244.6

BOP operations at South Works, U.S. Steel Corp. (Iron Steel Eng., July, 1973, 50, (7), 71-75). ALBERTS, R. J., A basic oxygen process shop with three 200 ton vessels produces a product mix including special killed drawing quality sheet steel, rimmed and capped sheet steel, alloy steel and killed and semikilled C steel. The vessels have water-cooled trunnion rings, a planetary furnace tilt mechanism, a torsion bar restraining device which acts as a buffer between the furnace and drive mechanism, and a ladle car which is offset from the centre of the furnace to induce swirl in the ladle. Hot metal mixers provide storage forhot metal and improve thecomposition and temp. All solid effluent and exhaust gases are collected by a hood-cooling and gas-cleaning system.

669.184.244.6

Present and Future Steel Production Using Oxygen (Jernkonterets Ann., 1973, 157, (3), 81-86) (in Sw.) LINDSKOG, L. The methods considered for steel production using O were the LD-processes, the method by B. Kalling in Domnarvet (Kaldo-process) using a rotating furnace, the OBM (or Q-BOP) process, Ar/O decarburization, and the Uddeholm process. O is blown through the bottom in the third and fifth processes and in side-wall nozzles in the fourth process. The possibilities of the processes are outlined. Charge composition, blowing method, O, N, C content, and converter life are discussed for the first process.

669.184.244.6

Oxygen steelmaking in bottom blown converters. (C/R.M. Met., Reports 1973, (35), June, 3-10) NILLES, P., BOUDIN, M., A report is given on the trial made since 1968 on the conversion of covering high and low phosphorus hot metal by blowing pure oxygen through the converter bottom, use of propane or natural gas as a protective fluid, results obtained and modification of the Basic Bessemer shop at Monceau. Production increased to 3 000 t.p.d., i.e. and increase of 30% with the same converters.

669.184.244.6

Improvement of the Productivity of Basic Oxygen Steel Plants. (V.D.Eh.Internat.Iron Steel Cong.,Dusseldorf, 1974, 1974, (Vol.11), 3.2.1 1-24) DECKER A. and NILLES P. Recent improvements in the productivity of basic O steel plants are analysed and attributed to (i) equipment, improved layout, charging, use of mixers, converter design, exchangeable bodies and improved lances, (ii) operation, lining repairs, optimization of the CaO and scrap qualities, and dynamic control, (iii) chemistry single slag process for high P metal, and bottom blowing with pure O, and (iv) ladle metallurgy, control of temp. and composition, reduction of P and S vacuum treatment, and improvements in casting pit practice.

669.184 244.6

Improvement of the Productivity of Basic Oxygen Steel Plants. (C.R.M., Sept.1974, (40), 3-10) DECKER A. and NILLES P. A review of the factors that have led to increased productivity in O steel plants is presented including improved equipment, rapid charging, and the adaptation of lance design to take account of converter size. Improved operational factors include regular analysis of the molten metal and temp., optimization of lime and scrap qualities, improved refractory linings, and math. models for charge calculation. The new OBM/Q-BOP process is described.

669.184.244.6

Basic Oxygen Steelmaking—the Process Problems Experienced and Future Developments. G. W. Thompson. SEAISI Q., Oct. 1974, 3-4, 20-26 [in English].

The L-D, B.O.F. or B.O.S. steelmaking processes produce > 60% of the total world steel output. The Broken Hill Pty. Ltd. Co. has kept pace with the latest developments in B.O.S. steelmaking and recently installed a new modern O.G. type B.O.S. plant at its Australian Iron and Steel Hoskins Port Kembla Works. The basic design features of the Port Kembla Plant are described and a stepwise description of the actual B.O.S. steelmaking cycle is included. Some of the steelmaking problems encountered in the B.O.S. process are discussed as well as present and future techniques for achieving improved control of the process.--AA

669.184 244.6

Effective Utilization of Oxygen in Iron and Steel Making. W. J. Scott and D. Bryant. SEAISI Q., Apr. 1974, 3, (2), 13-30 [in English].

Proper use of O improves the efficiency and cost of all stages of Fe and steelmaking including blast furnace, openhearth, basic O process and electric arc furnace. Many operating details are given.—F.G.N.

669.184.244.6

45 0355 New Advances in Oxygen Steelmaking. J. Astier, L. Coche and P. Vayssiere. SEAISI Q., Apr. 1974, 3, (2), 31-36 [in English].

A review is given on the development of the different O steelmaking processes, starting with O lancing from the top (L.D.), the new bottom blowing processes (OBM; LWS) and the latest developments in continuous O steelmaking: the Worner process (Worcra), experiments in the Soviet Union, the Bisra Spray Refining process and the IRSID process. The description of the IRSID process of continuous steelmaking includes general scheme, description of laboratory installation and Hagondange semi commercial plant of 500 tons/day and metallurgical results. Application of IRSID continuous steelmaking process

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669.184.244.6

BOF Gunning. J.S. Pearce, C. L. Profitt and W. M. Gladys. Iron Steelmaker, July 1975, 2, (7), 20-26 [in English].
Basic oxygen furnace gunning programmes are described for Dominion Foundries and Steel, Jones and Laughlin Steel and Wheeling-Pittsburgh Steel. Effects of gunning on furnace availability and production rates are cited.—A. P. K.

669.184.244.5

Investigating the Basic Oxygen Steelmaking Process with a Controlled Rate of Oxygen Injection. R.V. Starov, V.I. Ganoshenko, V.K. Didkovskii, Yu. E. Poludnev, and N.N.Nikolaev. (Stal', Oct. 1975, (10), 888-887 (In Rus.); Steel in the USSR, Oct. 1975)
A practice is described in which the O feed rate during the initial five min of the blow of a 145 tonne basic O converter is increased to 500 m^3/min, This increased rate of O injection accelerates C oxidation from the melt, and reduces the duration of the blow.

669.184.244.

The Basic Oxygen Steelmaking Process. P.L. Aggarwal. Tisco, Oct. 1975, 22, (4), 101-104)
The main reason for the failure of the development of the LD process in India is the inconsistency in the supply of hot metal which rather high in Si. Experience gained in the last 15 years in O steelmaking is reviewed to suggest possible solutions to the many problems. Charging a higher proportion of scrap, weighing of inputs, lance design, double deslagging, faster blowing and a slight change in the converter design have yielded improved steel. Control of operation even at the stage of blast-furnce burden preparation will have to be considered to regulate converter inputs. The nature and quality of refractories used in the LD converter seem to play a very important role.

669.184.244

The History of the Early Development of Oxygen-Blown Steelmaking. B. Marincek. (Chimia, 15 Dec. 1975, 29, (12), 510-512) (In Ger.)
Work done in 1940-43 leading to the trial on the commercial scale of the LD process pilot plant is described. This work was done on melts of 6-10 kg ofpig iron melted in an induciton furnace and oxidized in two ways. The first was by a water-cooled Cu lance dripping to a variable immersion in the melt, which could reduce the C content to 0.1% in under 15 min. The second was the use of a separate crucible probided with an O inlet in the middle of the bottom, and with a tilting frame to cast the melt. During the oxidation time (which could be as short as 5 min) the decrease of the Mn, S, and Si content of the melt was observed. Other tests checked the rate of removal of S, Cr, P, and V and the rate of increase of

Recent Developments in Oxygen Steelmaking Processes. M.N. Dastur and T.V.S. Ratnam. (SEAISI Q., Jan. 1976, 5, (1), 44-56) 669.184.244.6

The economics of the L-D have been so attractive that it is today the leading steelmaking process, with a share of over 40% in the world steel production. During the period of this rapid growth, a number of LD improvements have taken place. In recent years, bottom-blowing processes, such as the OBM, LWS, Q-BOP, and SIP, have been developed. Compared to top blowing L-D, the bottom-blowing process has the inherent advantage of a quieter blow and better mixing. The development and growth of the bottom-blowing processes are discussed. An attempt is made to indicate the pattern of development of the steelmaking processes in the foreseeable future.

669.184.244.5

Increasing the Operational Efficiency of Existing Oxygen-Converter Shops (for Steelmaking). Ya.A. Shneerov, V.V. Smoktii, and A.M.Poyarkov. (Stal,' May 1975, (5), 414-418) (in Rus.) Means of improving the production efficiency of O-blown converters of 100-130 tons nominal capacity at six different steelworks are considered. The proposals include increasing the charge weight to 160 tons and the O consumption from 350-450 m^3/min. Advantages can also be obtained by the use of rapid analysers installed on the shop-floor, stabilizing the molten pig iron and lime qualities, improving the handling of the scrap by baling, and generally standardizing the melt charges, and equipping the converter shops with automated melt-control systems.

669.184.244.6

World Roundup of Basic Oxygen Steelmaking. J.K. Stone. Iron Steelmaker, Apr. 1976, 3, (4). 31-36 [in English].
The number and size of furnaces and the existing and future annual capacity (grand total 474 257 000 and 197 030 000 tons respectively) are given by country and shop. Seventy nine shops have waste heat boilers. Of the 77 shops with closed hood systems, 36 recover the combustible gas (instead of burning it in the hood) as a means of energy conservation.—F.G.N.

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Development of Steelmaking Practice in 350 Tonne Basic-Oxygen Furnaces Without Complete Combustion of the Waste Gases. I.A. Smirnov et al. (Stal', Feb. 1976, (2), 114-121 (In Rus.); Steel in the USSR, Feb. 1976)
A new basic-O steelmaking converter plant has been developed using a melting technique for producing rimming, semi-killed, and low-alloy steels in 350 tonne converters operating under conditions of partial combination, and with incomplete combustion of the CO. Melting practices to ensure safe operation of the waste gas ducts, a high productivity, and high degree of refining using an iron with a P content between 0.2 and 0.3% are described. By varying the O blowing rate during the conversion the blow duration was reduced to 14-15 min, and the tap-tap period to 42-45 min. Optimum conditions necessary for dephosphorization require a fluid slag of high basicity, and a max. depth of slag/metal emulsion.

Recession-Scarred, the Boom in BOF Steelmaking Dwindles to a Beep. ——. 33 Mag. Met. Prod., May 1976, 14, (5), 47-51 [in English].
Results of the latest annual basic-O-steelmaking capacity survey by Kaiser Engineers Div are discussed, showing only a 4% increase worldwide in 1975, but with an expectation of reaching 670 million tons by 1980. A table of furnace output and start-up date for each country accompanies the article. Japan, the world's largest O steelmaker, plans to expand by 14% to reach ~146 million tons by 1979.--J.W.S.

The structure of prime costs in the BOF plant in the Lenin steelworks. (Wiadon. Hutn., 1973, 29, (1)) GRZYB, J. During less than 3 years of operation prime costs in BOF plant of Lenin Steelworks have been reduced to a value of below that in open hearth plant. Especially low are plant overhead costs which are half as large as in the open hearth plant. The good economic results of BOF plant in the period 1966–1970 are due to good utilization of the labour force, constant improvement of labour productivity, effective use of raw-materials, equipment and output reserves and technical and organizational progress.

Statistical Approach to Oxygen Steelmaking. A.A. Greenfield. (Metals SOciety Math. Process Models in Iron- and Steelmaking, Amsterdam, Feb. 1975, 1975, 125-133; 143-148, The Metals SOciety)
A Statistical approach to process control by means of a digital computer is considered, the description being illustrated by ref. to a basic-O steelmaking process. Also described are the process itself, the research environment, and the control objectives.

The Addition of Metallized (Iron) Pellets in the Charge of Basic Oxygen Furnaces. V.I. Baptizmanskii et al. (Stal', July 1975, (7), 592-594. (In Rus.) Steel in the USSR, July 1975) Pellets with metal contents of 31.4, 73, 7, and 91.8% were added to three trial charges in 55 tonne capacity basic O furnace. Molten pig iron savings from 125-150 kg/-tonne of steel were achieved with no adverse effects. Notwithstanding the high SiO_2 content (9.9-10.8%) no additional CaO was necessary, owing to its improved rate of assimilation. Further benefits included a 0.1-0.5% improved yeild, less MgO loss in the furnace lining, and in some cases, the elmination of the use of flurspar.

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Oxygen Blowing by the LWS (Loire-Wendel-Spruckel) Process. General Application to Establish a New Metallurgy of Protected Immersed Tuyeres. P. Leroy, A. Maubon ,and J. Bastien. (Rev. Metall., June 1975 72, (6), 473-491) (in Fr.) Bottom blowing with pure O provides most of the advantages of steel-refining processes with the vertical lance while avoiding the disadvantages of lances, by reducing the lack of equilibrium between slag and metal and permitting a faster working rate. Blowing is steady and rapid, with an excellent thermal balance. Data are given on converter resources, sizes and linings, the tuyere supply system (O and fuel oil), and conversion from a basic Bessemer plant.

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Oxygen Blowing By The Lws Process General Remarks On A New Metallurgy: With Immersed Protected Tuyeres. P.Leroy, el al. (from Fr.) (Rev. Met., 1975, 72, (6), 473-491) The LWS process (from Creusot-Loire/Wendel Sprunck) consisting of a bottom-blown oxygen converter unit with fuel oil supply and nitrogen purging unit is described and its advantages over the basic Bessemer and the various top blown converters are set out. Conversion of an open hearth furnace site to LWS without interrupting production is also described. (Price:- £ 12.00)

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BISI 13867

Technical and Economic Data for the Conversion of an Open-Hearth Steel Plant to a Blown Converter (LWS Process). A. Maubon and E. Bonnaure. (ILAFA. Mem. Tec. XV Congr. Latinoam., Bogota, Colomb., Oct. 1974, 1974, 265-289) (In Sp.) The productivity, economics, and technical details of the LWS process are described.

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The Operation of 130 Ton Basic Oxygen Furnaces with Preheating of the Scrap by Gas-Oxygen Burners. (Stal', May 1974, (5), 402-403, (in Rus.); Steel in the USSR May 1974) TULIN, N.A., MOROZOV, A.N. KRAVTSOV, N.F., MARKOV, B.L. and KIRSANOV, A.A. The proportion of scrap which can be remelted in a basic oxygen furnace is greatly increased by pre-heating using a gas-O burner lowered directly into the vessel. The duration of the blow, in 130 ton furnaces, was reduced by 2-2.5 min. The quantity of scrap per heat was increased by 3-7% of the metal charged with a corresponding reduction in pig iron consumption.

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Some aspects of automatic control of the BOF steelmaking process. (Tehnika, 1972, 27, (7), 1299-1303) [in Serbo-Croat] POCEK, S. Possibilities for the practical implementation of the computer control to the BOF steelmaking process are considered. The main interest is concentrated on the dynamic control with a short review of some methods of static control. The importance of the process kinetics in subordination of the vital variables is underlined. The role of the process computer and control system strategy in automatic control of this fast metallurgical process is given.

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Bottom-blown steel processes now number three ..... Q-BOP. LWS and SIP. (33 Mag., 1972, 10, Sept., 34-38) A brief description is given of three bottom-blowing developments in North America: United States Steel Corp's Q-BOP furnaces, drawing on earlier work by Air Liquide of Canada and Maximilianshütte of Germany the LWS process developed by Creusot-Loire in France and the SIP (submerged injection process) introduced at Sydney Steel of Canada (SYSCO). The most detailed description is of the Q-BOP drawn from Maxhutte's British patent specification.

669.184.244.62

Development of the bottom-blown oxygen converter. (Neue Hutte, 1973, 18, Mar., 170-174) [in Ger.] SCHEIDIG, K., KLEINSCHMIDT, R. A review of trends in steel production, based on the published technical literature. Comment covers oxygen-enriched blast in basic Bessemer steel production, design of tuyeres for bottom-blown oxygen converters, operating methods including LWSm OBM and OEK processes, and probable future developments in O_2 blown converters. (24 refs.)

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Oxygen steelmaking in bottom-blown converters. (UN-IDO Third Interreg. Symposium Iron Steel Ind. Brazil, Preprint, Oct. 1973, (ID/WG.146/38) 31 pp) NILLES, P. Encouraging pilot scale trials were followed by the installation of a 21 ton experimental, bottom-blown O converter, for the conversion of both high and low P hot metal. The converter was fitted with double tuyeres located in the bottom. The conversion of a basic Bessemer shop to OBM steelmaking, has increased productivity by over 30%. Slag and metal are in equilibrium at turndown, and a rapid measurement of the O activity in the metal bath allows the rapid determination of corrective additions in the converter and of the deoxidizing additions in the ladle.

669.184.244.62

The Theory and Practice of Bottom-Blowing Oxygen Metallurgy. ([UN-IDO] Third Interreg. Symposium Iron Steel Ind. Brazil, Preprint, Oct.1973, (ID/WG 146/103), 20pp) BROTZMANN K. The advantages of the OBM (0 bottom-blowing) process are that 0 reacts with the metal ideally and lime can be simultaneously injected. The special tuyeres are protected from attack by the simultaneous injection of gaseous or liquid hydrocarbons, and the process can also be applied to electric-arc and open-hearth furnaces. The advantages of bottom as opposed to top blowing are discussed. By comparison with the top-blown process, the iron oxide loss is only 25%. Trials using a wide range of C steels are also reported.

669.184.244.62

Development of the OBK process for the refining of pig-iron in the bottom blown oxygen converter in the VEB Maxhutte Unterwellenborn. (Neue Hutte, 1973, May, 18, (5), 277-281) (from Ger.) SCHEIDIG, K. The OBK process is established as a real alternative to customary methods of building or reconstructing steelworks working on molten pig iron. It is a pure oxygen bottom blowing process. The process of development is described. The process requires extended life of the converter bottom and this is achieved by cooling the jet particularly at the tip. (Pr[illegible] 5)

BIS' 11954

669.184.244.62

Oxygen steelmaking in bottom blown converters. (C.R.M., June, 1973, (35), 3-10). NILLES, P., and BOUDIN, M., The technological and metallurgical problems encountered during pilot-scale studies of the conversion of low- and high-P hot metal by blowing pure 0 through the converter bottom in the presence of a protective fluid (propane or natural gas) are described. This technique gives a rapid conversion into quality steels. Implementation of these procedures into a basic Bessemer shop increased the productivity by > 30%. The metallurgical results agreed with the experimental data; in particular, slag and metal are shown to be in equilibrium.

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New Steel Production Method by Oxygen Blowing from the Converter Bottom. (Jernkontorets Ann., 1973, 157, (3), 86-91) (in Sw.) BROTZMANN, K. and KNUPPEL, H. This process for steel production (also named the OBM process) was developed in Maxhutte in Germany after some experimentation. O with limestone powder is blown through 5-15 nozzles in the converter bottom and 3% hydrocarbons are added as protecting medium. The bottom is exchangeable. Its mean life is approx. 300 charges. Plots are shown for the relations of FeO content in the slag to relative blowing time, and of S content in steel to S content in pig iron. P and H contents in 22 and 100

669.184.244.62

The bottom-blown oxygen converter: A new process for steelmaking. *(Stahl u. Eisen, 25 Oct. 1973, 93, (22), 1018-1024) [in Ger.]* KNUPPEL, H., BROTZMANN, K., FASSBINDER, G. The technical and economic reasons for the conversion of existing basic Bessemer steelplant at the Maxhutte works to bottom-blown oxygen methods are discussed. Higher tapping weight, shorter blow time, increased yield and longer refractory life were achieved. The metallurgical results obtained in processing both high and low phosphorus irons are reported and differences from the top-blown oxygen process are emphasized. A particular advantage is the possibility of pre-heating scrap above the bottom tuyeres so that the scrap charge can be increased by about 100 kg/ton crude steel.

669.184.244.62

Two New Processes for Producing Steel with a Bottom Blow: Q-BOP or OBM and SIP. (XXVIII Congresso Annual da A.B.M., Salvadore, Brasil, 24-30 June 1973, Pp 23) BROTZMANN, K., HAHMANN, B. and WEBER, R. Reviews the development, technology and metallurgy of the steelmaking process known in Germany as the OBM process and in the U.S. as Q-BOP. Characteristics of the materials used in the charge are discussed. Advantages of the process over the LD process are cited and present and planned installations throughout the world are noted. The SIP process is treated in similar fashion. Operating data and results of a simulation of the SIP process in Brazil are given and the process as applicable to any steelworks in the country is characterized. Advantages are projected for Brazil in the adoption of both processes.

669.184.244.62

Bottom-Blowing Oxygen Converter - A new Steelmaking method. (International Iron and Steel Congress, Dusseldorf, 1974, Paper 3.2.2.5.) (from Ger.) BROTZMANN, K. A note on the increased use and advantages of the OBM process, together with case studies of its introduction at steelworks at Gary, Indiana and at Surahammars. (Price: £3)

BISI 13117

669.184.244.62

The Neuves-Maisons OBM Steelworks. (Rev. Met., June,1974, 71, (6), 511-517), [In Fr.] FAYOLLE J. The characteristics of the OBM process, and its application in a works, comprising two 600-tonne mixers and 5 20 cu.m converters are described. The possibilities offered by O bottom blowing make it possible for steelworks of older designs fully utilize their means of production and handling. At neuves-Maisons where the overhead cranes permit a charge of 50 tonnes, increasing the charge to the converters to 34 tonnes has provided optimal use of the existing plant, so that the production of ingots per 8 - h shift has increased from 560 tons in the last year of operation with enriched air blast (1969) to the current rate with OBM og 810 tonnes, i.e. an increase of 45%. Minor modifications to the scrap supply, and of casting pit transport, should permit full utilization of the potential of the converters, i.e. production of the order of 1000 tonnes per shift. F.M.W.

669.184.244.62

Two New Processes for Producing Steel by Bottom Blowing: Q-BOP or OBM and SIP. (Metal. ABM, July, 1974, 30, (200), 451-459) (in Port) BROTZMANN, K. HAHMANN B. and WEBER. R. The origins, mechanics and metallurgy of the Q-BOP or OBM process and its principal advantages over the LD process are reviewed. The SIP process is treated in similar but briefer fashion with no reference to the LD process. The applicability of the SIP process in Brazil is discussed. Both processes are seen as permitting expansion of the Brazilian steel industry with a min. of investment.

669.184.244.62

The Conversion of the Usinor-Valenciennes Basic Bessemer Steelworks into an OBM (Oxygen Bottom-Blown) Steelworks. A. Moyaux. (Rev. Metall., June 1975, 22, (6), 511-518) (in Fr.). The conversion of the three 50-tonne converters and the shutting down of the two 30-tonne units are described. The gases used (O, propane, N, and air), safety considerations, flow-rate control, output, productivity, and the consumption of refractories are discussed.

669.184.244.62

Recent Progress in the OBM Process. K. Brotzmann, A.H. Brisse, and W.T. Lankford, (Rev. Metall., July-Aug. 1975, 72, (7/8), 527-539) (In Fr.). The OBM bottom-blowing in which O sheathed by hydrocarbon gases, is introduced into the liquid iron represents a different approach from that of the conventional BOP process. The accepted relationship between metal and slag have to be altered, and dephosphorizing and desulphurizing mechanims are different. Very complete decarburizing is facilitated and refining times are shortened. The converter is flexible and can produce a wide range of steels, from low-C grades to specilized stainless steels.

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The Bottom Blow Oxygen Converter, A New Method of Steelmaking. (V.D.Eh. Internat. Iron Steel Cong., Dusseldorf, 1974, 1974, (Vol II), 3.2.2.5 1-9) BROTZMANN K. The use of bottom blow O converters for refining high and low P pig irons is considered. Details are given of the first year of operating experience with 200 ton bottom blown O converters, and of the commissioning of a new plant. Technical and economic comparisons with basic open hearth and basic converter practice are made. Chemical analyses of the refined steel, and the productivity of the units are satisfactory.

669.184.244.62

The Metallurgy of the OBM Process. J.Claes, J.Defays, and P.Dauby. (C.R.M., Dec. 1974, (41), 3-9). An analysis of the behaviour of residual elements during blowing, stirring by agitation with air, O or N and at tapping is presented. Factors favouring desulphurization are high slag basicity, high O flow rate during the entire blow and advanced slag melting. Approximately 20% of the total added weight of S is transferred to the gaseous state during the blow. N content is affected by the charged cooling agents and the endothermic fluid protecting the tuyeres. H content depends upon the type and duration of stirring. At turndown, the Mn and P contents, O activity and slag Fe are strongly inter-related.

669.184.244.62

Oxygen steelmaking in bottom-blown converters. (Ironmaking and steelmaking, 1974, 1, (1), 22-27) NILLES, P. and BOUDIN, M. In O steelmaking in bottom-blown converters the technique promises excellent technical and metallurgical possibilities with both high- and low-P hot metal, allowing quick and quiet production of quality steels. Specific advantages are that metal and slag are in equilibrium at turndown, bottom wear is drastically reduced in comparison with the basic Bessemer process, and the use of double tuyers for final temp. and analysis adjustments in the converter before tapping is possible. The metallurgical results obtained have confirmed findings made on an experimental converter.

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Development of an Oxygen Bottom Blowing Practice in a Converter. Ya. A. Shneerov et al. (Stal', March 1976, (3), 214-217 (In Rus.); Steel in the USSR, March 1976)
The development of a satisfactory steelmaking practice in a 24-tonne capacity bottom-blown converter using O and natural gas is described. Experiments were carried out in which powdered lime was injected with the O to produce high C (upto 0.8%) steel stopping the blow at the specified C content. The advantages of this system, compared with that of top-blowing, include the possibility of operating with a high O injection rate, and a corresponding reduction in the blow-time, an improvement of about 2% in the yield of molten metal, and ensuring more favourable conditions for steelmaking, with a C content 0.05%, a lower consumption of deoxidants, and reduced costs.

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On The Metallurgy Of A Bottom Blown Oxygen Converter. K. Scheidig & E. Richter (from Ger.) (Neue Hutte, 1973, 18, (7), 385-388)
Advantages such as greater output and lower phosphorous content are obtained by the change over from the basic Bessemer converter process to the bottom blown oxygen converter process. Details are given of the changes in the refining mechanisms involved. (Price:- £ 5.50)

669.184.244.62

Q-BOP steelmaking developments

J. Pearce

A new steelmaking process—Q-BOP—can replace an open hearth shop, a conventional BOF shop or be utilized as a greenfield installation. Development, equipment and operational aspects are covered.

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669.184.244.62

The (OBM/Q-BOP) Bottom Injection Processes for Oxygen Refining of Steel. Guy Savard and Robert Lee. SEAisI Q., Apr. 1974, 3, (2), 8-12 [in English].
In the bottom blown process the jet of O carrying suspended powdered lime is surrounded by an annulus of protective fluid (as oil, propane or natural gas) which prevents erosion of the adjacent refractory. The chief advantages are lower operating cost, higher yield and improved plant layout because of the decreased head room required.
—F G K

669.184.244.62

The development and operation of the Q-BOP process in the United States Steel Corporation. (UNIDO 3rd Interreg. Symposium Iron and Steel Ind., Brazil, Oct., 1973, Preprint ID/WG/145/4, pp. 25) BRISSE, A.H. A broad research programme to develop the technology necessary to produce high quality steel in 200-ton furnaces was undertaken. By the end of 1973, there was some 8 million tons steelmaking capacity in the Q-BOP process, at Gary and Fairfield. Natural gas is used to show the bottom blowing O_2 jet: catch-carbon practice is employed, with lime injection. Low N and P levels are achieved and the steel has proved valuable for most purposes.

669.184.244.62

Recent Advances in Q–BOP Steelmaking. K. Brotzmann, W. T. Lankford, Jr, and A. H. Brisse. Ironmaking Steelmaking, 1976, 3, (5), 259-267 [in English].
The bottom-blown Q–BOP is a different approach to O steelmaking than the conventional BOP. With bottom flux-injection, the past concepts of slag–metal relationships do not appear to apply to the Q–BOP. The dephosphorization and desulphurization processes are different, and decarburization to very low levels is easier. The rapid reactions are attributed to a mechanism involving gas-diffusion-limited enhanced vaporization. This is thought to bring about dephosphorization of the bath to P levels significantly below those associated with conventional slag–metal equilibria. The rate of oxidation of C at C levels >0.2% is controlled by diffusion of CO_2 in the gas stream to the gas bubble/metal interface. At C levels <~0.2%, the rate of decarburization is believed to be controlled by diffusion of C from the bulk metal to the bubble surface. C levels as low as 0.01% can easily be attained. The ladle H and N contents of Q–BOP steel are comparable with those of BOP steel. The present life of the stationary lining on the 200 tonne Q–BOP at works in the United States is ~1000 heats, and the goal of 300 heats as the min. life of a bottom plug appears to be within reach. Essentially, all grades are being made in the Q–BOP, including low-C sheet and tinplate steels, capped and semi-killed medium-C steels, rail steels, and Ni–Cr and Cr–Mo steels. 16 ref.—BA

669.184.244.62

Q-B.O.P. Steelmaking Developments. (Iron Steel Eng., Feb.1975, 52, (2), 29-33) PEARCE.J The Q-B.O.P. steelmaking system offers higher productivity rates and higher metallic yields over B.O.P. plus the advantage of lower installation costs. West Germany's Maxheutte successfully applied a bottom-blown tuyere to modified Thomas converters in 1970. The injection of powdered lime with bottom-blown O eliminated the need for the over-head bins and O lances of B.O.P. Quiet blowing characteristics, absence of slopping and less fume generation offered a low-profile basic O steelmaking system that could fit in the low headroom available in conventional openhearth buildings. U.S. Steel converted the Fairfield openhearth shop (12 200-ton furnaces) to Q-B.O.P. (two 200-ton converters) with design capacity of 3.5 million annual tons. Q-B.O.P. installed capacity has grown from 3 million tons in 1970 to 16 million annual tons. The impact of Q-B.O P. technology in the next two decades will have a similar economic impact on the steel industry to conventional B.O.P. over the last two decades. Details of equipment, operational and metallurgical aspects are covered.

669.184.244.62

Control of the OBM/Q-BOP Process. Paul E. Nilles and Pierre H. Dauby. Iron Steel Eng., Mar. 1976, 53, (3), 42-47 [in English].
A two-stage charge calculation model has been developed for the control of OBM/Q-BOP refining and applied to designing the static and dynamic open-loop control system at a French plant which is installing three 150 ton OBM converters. The charge calculation is made in two stages, one to determine the composition of the slag, the second to resolve Fe, O and heat simultaneously. A digital computer system provides production monitoring, determines charging weights (with the above model) and provides process control data based on

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Development and operation of the Q-BOP process in the U.S. Steep Corp. (Iron Steel Eng., Oct. 1973, 50, (10), 37-43) HUBBARD, H.N., LANKFORD, W.T. The bottom blown O process (Q-BOP) offers all the advantages of the BOP with less capital investment, particularly when the equipment can be installed in an existing openhearth shop The process also has shorter heat times and higher yield and can be adjusted to melt more scrap without lowering productivity when economic conditions warrant. The Q-BOP is now in operation at Gary Works, producing rimmed, capped and Al-killed ho and cold rolled sheet, tin-mill products, structural and plate products, rails, billet products and grain-oriented electrical sheets. A second shop is being installed.

669.184.244.62

Q-BOP Facility Planning and Economics. J. Pearce. (Iron Steel Eng., Mar. 1976, 53, (3), 27-37) Q-BOP facilities are increasing becuause of the lower capital investment and operating costs, the higher productivity and metallurgical improvements such as improved yield, higher residual Mn, lower Al, lower flux requirements, more efficient use of bottom O andimproved steel ladle lining life. Facilities requirements, capital costs and rates of return on investment are given for converting openhearth shops to Q-BOP steelmaking.

669.184.244.62

The Developement and Operation of the Q-BOP Process in the United States Steel Corp. H.N. Hubbard, and W.T. Lankford, (Efficient Use of Fuels in the Metallurgical Industries 1975, 433-455 Symposium, Chicago Dec. 1974)
The Q-BOP offers many advantages over other steelmaking processes. The investment costs for a Q-BOP shop are lower than for a BOP on a greenfield site, and installation of the Q-BOP in an existing openhearth shop can result in even greater savings of capital. High-quality steel can be produced and operating cost benefits realized because of the high speed and higher metallic yeild possible with the Q-BOP. U.S. Steel has made a major commitment in the Q-BOP at two steelmaking locations with the ability to produce some eight million tons of raw steel annually.

669.184.244.62

The Q-BOP at Fairfield Works. J. Hill and J. M. Egge. Iron Steelmaker, June 1976, 3, (6), 37-40 [in English].
Fairfield is a fully integrated steel plant with iron and steel production facilities consisting of seven coke batteries, three blast furnaces and prior to the advent of the Q-BOP, a 50 year old openhearth shop containing 12 230 tons furnaces. The Q-BOP furnaces are located approx. on the centreline of the openhearth furnaces in the centre of the shop so that the existing hot metal and ladle cranes can be used without alteration. The peripheral equipment includes supply and control of O, N and natural gas, fluxing materials, waste gas cleaning, hood water supply and cooling, scrap handling, slag disposal and a process computer.—R.C.D.

Worldwide BOF round-up. (33 Mag. Met. Prod., Feb. 1974, 12, (2), 37-44) STONE, J.K. The worldwide LD furnace situation summarized includes company names, plant locations, number of furnaces and output per heat, start-up dates and existing and future annual capacities of raw steel of individual countries. The major growth in future capacity is anticipated in the U.S.S.R. and South Africa. Small increases in 1973 were reported in many countries, but those in the U.K., France and Italy accounted for about half of the total. The U.S. and Japan, the two leading tonnage producers, lagged behind the world in percentage increases.

669.184.244.66

Some developments in top-blown BOF equipment (UNIDO 3rd Interreg. Symposium Iron and Steel Ind., Brazil, Oct., 1973, Preprint, ID/WG/146/12, pp. 29) HAMABE, I. YAMAZAKI, S., TSUNODA, J., YAMADA, S., YANAGIDA, K. The LD basic O furnace produces the major proportion of steel currently made. Details of the latest design factors and operation are provided principally based upon Japanese practice. These include; vessel volume/metal output relationships, vessel tilt drives, waste gas cooling and cleaning systems, and an automatic relining machine capable of laying 1000 bricks/h.

669.184.244.66 1975

Worldwide Oxygen Steelmaking Capacity-1975. (Iron Steel Eng., Apr. 1976, 53, (4), 89-92) Although worldwide basic O steelmaking capacity increased only 4% to 471 million tons in 1975, future planned increases by the major producing countries indicate a 1980 capacity of 670 million tons. Japan, the world's largest O steelmaker, increased capacity by 3% during 1975, but almost doubled planned additions. In the U.S. the existing capacity increased only fractionally to 89 million tons, but the estimated 70 million ton production for 1975, will fall far short of capacity.

669.184.244.66

Improvement of steel production in oxygen converters and the open hearth furnace. (Metallurg, 1972, (11), 22-24) [in Rus.] SMOKTII, V.V., BOTVINSKII, V.Ya. This is a survey of the following: technology of melting in the converter and OH furnace; choice and quality of converter steel, method used to control steel melting processes.

669.184.244.66

The argon oxygen refining (AOR) process. (81st Gen. Meeting, AISI, 1973, May 24th preprint pp. 15) HODGESS, E.E. jun. SACCOMANO, J.M. The paper [illegible] aspects of A.O.R. development and trends. Quality aspects of A.O. refined stainless steel are also discussed.

669.184.244.66

Rotovert: a new steelmaking process. *(I.S.I. of Japan, Proc. Int. Conf. on the Science and Technology of Iron and Steel, Tokyo, 7-11 Sept., 1970, Part 1, 297-300)* RAMACCIOTTI, A., PRAITONI, A., SPAGGIARI, T., IMBERTI, B., DE ROSA, G. Rotovert is a new steelmaking process in which a vertical rotating converter is used. This paper reports the experimental heats run on the pilot 6ton converter at Lulea in a cooperative research established between the Centro Sperimentale Metallurgico and the Metallurgiska Forskningsstationen. The results so far achieved indicate two main advantages of the vertical rotation: it is possible to increase by about 18% the scrap charged by means of the CO--combustion and the heat can be worked in the furnace after turndown by alloy additions which are dissolved very rapidly in the rotating steel, allowing extremely low S contents to be achieved.

669.184.244.66

A new application of pneumatic steelmaking. (Ind. Heat., 1972, 39, May, 884-885) A brief discussion of the development and scale-up of the Q-BOP steelmaking process is presented. In the Q-BOP method, a removable bottom section enables O_2, natural gas and lime to be bottom blown up through the molten charge by means of a number of small-bore tuyeres. The Q-BOP process capital costs compared favourably with the BOS vessel and shows great savings compared with the OH. U.S. Steel, which has been operating a 30-ton experimental unit, is to replace an outdated facility in Fairfield, Alabama, U.S.A. with a 200-ton Q-BOP unit.

669.184.244.66

Production methods for making higher grade steel. (Technica, 1972, 21, Aug. 4., 1403-1408) [in Ger.] ACKERMANN, W. The Henrichs-Hutte steelworks at Hattingen changed to the LD method of making steel in the Autumn of 1970. Continuous casting plant is also installed. Pig iron is desulphurized continuously with Ca-carbide by the Rheinstahl whirling equipment as the molten metal is tapped. Some of the steel produced is rinsed with inert gas in the ladle, the ladle having a special porous refractory base for the passage of the gas. Ladles with slide value closures are used for special after-treatments. Steels are produced for forgings and special plate. These have very low P contents. Alloys for steels are usually added to the pouring stream from the LD converter. The low S content in the steels produced have much reduced the appearance of sulphidic inclusions in the steel. Metal for ingots and slabs in melted under a layer of casting powder to maintain a fluid slag. (3 refs.)

669.184.244.66

Tuyere-Oxygen Steelmaking Processes.--I. D. H. Houseman. Steel Times, Sept. 1975, 203, (9), 810-812 [in English]. Historical approaches towards reducing bottom and tuyere wear in Bessemer and Thomas converters are reviewed with ref. to possible parallels with the basic-O process. Introduction of metal liners to insulate the refractory from the O-air or other gas mixture, and of steam-O blowing to absorb the localized heating, is particularly discussed.--J. R.

669.184.244.66

Scrap-oxygen steelmaking in top-blown converter. *(NML Techn. J., 1972, 14, Feb., (1), 1-8)* BISWAS, S.K., GHOSH, S.B., CHATTERJEA, A.B. Investigations were conducted at NML on conversions of solid scrap of assorted sizes and variable chemistry to molten steel by top blowing with oxygen in a basic-lined converter. The oxygen requirements and its efficiency, oxidation and yield for the converison of molten pig iron or the conversion of solid scrap to steel were compared. The influence of scrap on the process, the use of calcium carbide, instead of solid fuel, are determined. The effects of different fluxes, basicity degrees of the slag and the bath temperature on dephosphorization are examined. The influence of manganese on desulphurization and the influence of the different process parameters on the efficiency of conversion of scrap to steel are outlined. The suitability of the process for industrial application is discussed.

669.124.244.66-LD

The technology of the LD process. *(Met. Ital. (Atti Notizie), Nov. 1973, 28, (11), 659-669) [in It.]* BETTI, S., CANE, V. The work cycle, charge materials and O supply of the LD converter are considered. The physical chemistry of the steelmaking process is described, including the oxidation and decarburization equilibria, Si and Mn reactions, the thermodynamics and equilibria of slag formation, and the metal/slag reactions involved in P and S removal. Conditions favouring a high transfer of P and S from metal to slag are discussed, as is the removal of S via the gas phase, through the direct oxidation of S to SO_2 in the metal phase, which can account for up to 8% of the total S present.

669.124.244.66-LD

The Production Capacity of LD Steel Works and Some Ecomonic Considerations. (Met. Ital. Atti Notizie, 1973, (10), 585-587) (from Ital.) BETTI, S. et al. Measures adopted during the last 10 years to increase productivity are briefly reviewed and the blow cycle for a 100 tonne converter is discussed in detail. Reference is made to Japanese practice, and the main economic advantages of LD plants are summarised. (Price: £5)

669.124.244.66-LD

Investigations of improving the steelmaking process in LD converters. *(Metalurgia, Oct., 1972, 24, (10), 659-664) [in Rom.]* TRIPSA, I. Laboratory studies were made on a model of a 130 tonne LD converter (on reduced scale 1:26) using water as liquid steel bath and paraffin oil as slag to relate the intensity of the air blast and the position and geometry of the blast nozzles with the output of the converter. The dia. of the model of the converter was 194 mm. Static and dynamic characteristics of the model are discussed. Three, four, or seven nozzles with a total cross section of 33.16 mm^2 were used in experiment and the most satisfactory results were obtained with four nozzles. The results obtained on the model were applied on an industrial scale, in the first stage, to 12 burdens, with an increased O flow of 350, 400 and 450 m^3N/min resp., but the most significant results were obtained on the next 340 burdens where the output was increased by 10-12%. Possibilities of further increasing the output are discussed.

669.184.244.66-LD

The LD/AC steel plant of the Hainaut-Sambre company Belgium. *(Acier Stahl Steel, 1972, 37, Nov., 460-465)* SCHOLZ, P. The report is a summary of the considerations and factors, both practical and technical, which governed the design of the steelwork by VOEST. Of which about 55% was in steel of type ST37 (normal construction steel) and the remaining 45% in European Type St44 steel of higher yield strength.

669.124.244.66-LD

Comparison of LD operation with three and four hole lances. *(Tisco, Apr. 1973, 20, (2), 35-44)* CHATTERJEE, A. Using 3-hole and 4-hole lances, in a 120 ton LD converter 7% more O could be introduced without affecting metal yield. An increased O content in the metal, and a more rapid rate of decarburization resulted. A more fluid slag formed early in the blowing period, was responsible for a better P partition, but had no influence on the S distribution.

(39D)

669.184.244.66 -LD

Process Metallurgy of LD Steelmaking. A. Chatterjee, N.-O. Lindfors, and J. A. Wester. Ironmaking Steelmaking, 1976, 3, (1), 21-32 [in English].

A picture is presented of the events occurring within a LD vessel from the start of the blow until vessel turndown. Much of the data used in formulating this 'physical model' of the LD process has been obtained from heats blown in the 6 tonne experimental converter at the Metallurgical Research Plant in Lulea, Sweden. So far, about 120 experimental LD heats have been blown to study various aspects of the LD process. On the basis of this investigation various aspects of LD steelmaking, including bath circulation, bath homogeneity, rate of scrap melting, and oxidiation of the metalloids, are discussed; a new mechanism of the decarburization reaction is proposed. 23 ref.—AA

669.184.244.66 - LD

The Impact of the L–D Process Upon Steel [illegible] Usage. Joseph K. Stone. Efficient Use of Fuels in the Metallurgical Industries, 1975, 405-423 (Met.A., 7605-72 0067) [in English].

A study of the [illegible] from openhearth steelmaking to basic O, electric furnace and direct reduction shows how this shift affects the amount and sources of energy used in the steel industry. For years the steel industry has used byproduct and waste heat for preheating air for the blast furnace, openhearth and soaking pits, as well as to generate steam and electric energy for general plant usage. In spite of the steel industry's good record in energy conservation, top gases from B O F's have to date been wasted or used only to a very small extent. The theoretical basis, progress and suggestions for using waste heat from L-D furnace gases are discussed. Preheating scrap, precalcining and preheating lime and prereducing iron ore for the charge are considered the best outlets for the use of waste energy.

669.184.244.66—LD

L-D Replaces the Open Hearth Process-Case Study in Productivity. J. K. Stone. (Iron Steel Eng., Mar. 1976, 53, (3), 38-41)

Advantages of the L-D process as compared to open-hearth processing include reduced processing time and manpower requirements, high productivity, fuel efficiency, efficient use of oxidizing media, improved yields, lower capital and operating costs, more efficient material handling and simplified gas cleaning. Measurement and control devices for use with the L-D process have been improved as quick immersion thermocouples, well-designed orifice meters and computerized charge calculations have been developed.

669.184.244.66 -LD

The Flexibility of LD Operation. K. Wakabayashi. Ironmaking Steelmaking, 1976, 3, (5), 252-258 [in English].

An account is given of some of the experience Nippon Steel Corporation has had with LD converter operation at various hot-metal ratios. The effects of using cold pig iron, charges with high reaction-heat values (coke, Fe-Si, CaC_2, SiC), and preheated scrap and cold pig iron at low hot-metal ratios are described in some detail. The requirements for operation at high hot-metal ratios are also discussed.—AA

669.124.244.66-LD

Further World Development of LD Steel Production. H. Sperl. (Stahl Eisen, 3 June 1976, 96, (10/11) 498-502) (In Ger.)
There was a 4% increase in LD steel production in 1975; however, an increase of 41% is projected up to 1980. With the present high cost of energy, a significant number of steel plants now utilize the converter waste gas. Information is given on existing and planned O converters throughout the world, although information for the U.S.S.R. and China is limited.

669.184.244.66-LD

Process Metallurgy of LD Steelmaking. A. Chatterjee, N.O. Lindfors, and J. A. Wester. (Ironmaking Steelmaking, 1976, 3, (1), 21-32)
A picture is presented of the events occurring within a LD vessel from the start of the blow until vessel turndown. Much of the data used in formulating this 'physical model' of the LD process has been obtained from heats blown in the 6 tonne experimental converter at the Metallurgical Research Plant in Lulea, Sweden. So far, about 120 experimental LD heats have been blown to study various aspects of the LD process. On the basis of this investigation various aspects of LD steelmaking, including bath circulation bath homogeneity, rate of scrap melting, and oxidation of the metalloids, are discussed; a new mechanism of the decarburization reaction is proposed.

669.124.244.66

Use of Colemanite as a Flux in LD Steel-Works. Comparison with working without Flux or with Flourspar. M. Jeanneau. (Cent. Doc. Sider. Cir. Inf. Tech., 1975, 32, (4) 829-838-839) (in Fr.)
Test have been carried out at an LD steel-works to compare the efficiency of two fluxes: colemanite and flouspar. Melts without a flux served as ref. After 15 heats the following conclusions were reaches: (i) dephosphorization is the same with fluorspar or colemanite: (ii) desulphurization is better when using fluospar, and (iii) the use of coleminite was more expensive than that of fluorspar.

669.184.244.66-LD

The New LD-Steel Shop at Fried. Krupp Huttenwerke AG Rheinhausen Works. J. A. Kotsch. (Iron Steel Eng., June 1976, 53, (6), 33-36)

The new LD steel shop of Fried. Krupp consists of desulphurization facilities, converters, degassers, continuous slab casting machines and conventional ingots casting facilities. Initial capacity of 3 tons year is to be doubled. Descriptions cover hot metal transfer, converters, gas cleaning systems, continuous casting and provisions for expansion. Data acquisition and process control are computerized.

669.184.244.66 LD

20 years of the LD process. (Stahl Eisen, 1972, 92, 20 July, 709-718) [in Ger.]
TRENKLER, H. A review is given of the applications of the process culminating in a considerable further development as regards the shape of converter suspension, mounting and drive of the converter, size of crucible, shape of tuyeres, progress of operation, lining development of special processes, automation of the process, steel grades produced and protection of the surroundings.

669.184.244.66 (54)-LD

Fifteen Years of L-D Steelmaking in India. Experiences at Rourkela Steel Plant. P. L. Agrawal. National Metallurgists' Day and N.M.L. Silver Jubilee Celebrations, Jamshedpur, India. 14 Nov. 1975, Pp 19 [Preprint–English]
At present the LD shop has five converters with an ingot capacity of 1.5 million tons. To increase lining life for the required conversion, 400 mm thick single brick lining has been replaced with 700 mm thick lining consisting of two 350 mm bricks of green tar dolomite. Part of the lime has been supplemented by calcined dolomite to maintain a level of 6-7% of MgO in the slag. This has resulted in a beneficial coating of MgO on the lining, thereby retarding wear and giving longer life. Other factors affecting productivity are reduced tap-to-tap time, quality of inputs (hot metal, lime, scrap), and pit side practices.–R.C.D.

669.184.244.66;
669-988

The LD Process and Its Possible Combination With the Vacuum Technique. Ernst Sebastnik. Present and Future Technology of Steel Fabrication in Latin America. 1974, 177, 179-193 + 10 plates (Met. A., 7505-72 0031) [in Spanish].
Equipment and practice in LD steelmaking in combination with vacuum degassing, deoxidation, alloying and decarburization by the D. H. method at VOEST (Vereinigte Osterreichische Eisen-und Stahlwerke, A.B.), Austria, are discussed. Special attention is given to the decarburization of melts of different initial analyses by means of standard, oxidizing or reducing vacuum treatments for the production of very low-C steels. Refractories in the LD furnace and the vacuum vessel are discussed. Most of VOEST's production of vacuum-treated LD steel is special deep-drawing steels, enamelled steel and unalloyed and Si steel for plate; some high-temp. steels, special weldable steels, case hardening steels and hot forging steels are also vacuum treated. The development of the LD process and the contributions of VOEST are reviewed, as are vacuum methods of processing steel, with the exception of vacuum melting. It is predicted that the LD-vacuum combination will assume an increasing role in steelmaking and may in the future be used in conjunction with continuous casting. 7 ref.–S. M.

669.184.244.66-LD
669.012.57

Energy Use in the Steel Industry. II.-Intensified Utilization of Waste Heat from the L-D Process. J.K.Stone. (Iron Steelmaker, Apr. 1975, 2, (4), 22-26). In addition to present-day energy recovery by waste heat boilers and combustible gases, it is recommended that use be made for scrap preheating, lime calcining and preheating and iron ore prereduction. The L-D process in the U.S. loses about 2% of the energy consumed by the steel industry, or 83 trillion Btu/year, or for each ton of steel, 1/4 million Btu of sensible heat and 3/4 million Btu of combustible heat.

669.184.244.66-LD;
669.187.2

A Wider range of Steel Grades can be obtained by the combined use of the LD-Converter and the Electric Arc Furnace. O.Darmann and G.Helf. (Brit.Steel Corpn. 7th Internat. BOT Working Meeting May, 1975, 1975, Preprints 23 pp) Production of moderately alloyed and high-alloy steel grades by means of a combined LD/LBO (ultra-high power arc furnace) process is discussed. Three examples are considered: corrosion-resistant Ni-Cr steels; alloyed steel grades for large shaped castings; and heavy alloy steel forging ingots. Future possibilities for operating combined LD/LBO blows are indicated.

669.184.244.66;
621.14

Dynamic Control of LD Converter Steelmaking. K. Koga, Y. Ohkita, M. Mizutani, and A. Kawai. (Ironmaking Steelmaking, 1976, 3, 146-152) A description is given of the various stages and control models which have been used in arriving at the dynamic control method in use on LD converters in a Japanese steelworks. The methods investigated were (i) static control using a computer and data from waste-gas analyses and (ii) dynamic control using a computer and the results of measurments of the temp. and C content of the steel bath made using a sublance. The development of the latter method, which is that adopted for control of the LD converters, and of the sub-lance sensors, is described in detail.

669.184.244.66-25K

The SACILOR Kaldo and OLP steelworks. (CDS Circ., 1972, 29, (4), 991-1004; discn. 1004-1005) [in Fr.] CESSELIN, P., TOUZÉ, R., PAPIER, P. The works of the Societe des Acieries de Lorrain (situated about halfway between Metz and Thionville) include the following installations: – a Kaldo process steelworks with two furnaces producing on average 230 metric tons of steel per heat; an OLP steelworks with the same output from two converters. roughing and merchant mills. The Kaldo and OLP plants are adjacent and therefore share the same changing cranes etc. There are not blast furnaces and the pig iron is brought to the furnaces in 150 and 200 t ladles from the Wendel-Sidelor concern's blast furnaces. This paper gives a detailed description of the layout of the works, methods of supply and distribution of raw materials, and removal of ingots and slag. Production methods and operating data on furnaces and converters are also included, as well as descriptions of dust control methods. The annual output of mild steel alone is 3.7 m tonnes, and other types of steel are made.

(43)

669.124.244.62
658.152

At Great Lakes, U.S.A. capital cost of 1.71 million tons steel, produced by Basic oxygen process is $45 million and $134.14 is cost per ton.

Source: EPA-600/1-76-034C, December 1976, P.64.

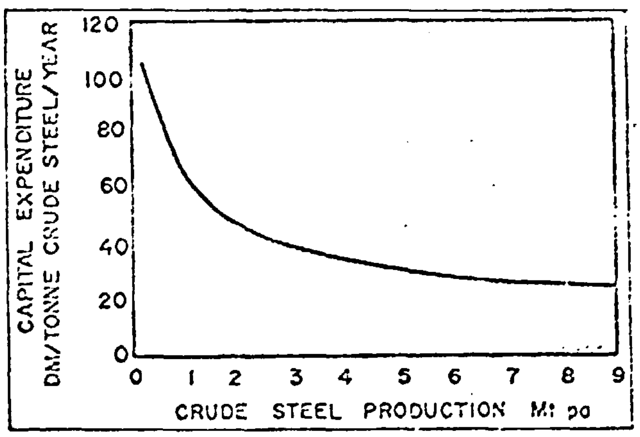
669.124.244.66;
658.152

Capital cost for production of ½ million to 7 million tons of steel produced in Basic oxygen furnace ranges from DM 65 - DM 30 per ton.

Source: (Stahl u. Eisen 90, 1970, No. 4)
UNIDO/ICIS/25, 15 December 1976, P. 201.

669.124.244.66;
658.152

GROVES The changing world steel industry



Typical economics of scale curve. (in this case based on LD Shop capacity, 1970 West German Data). Source: H. Schenck & K. Consemuller, Stahl Eisen, 1970, 90, (8), 386.

SEAISI Quarterly Jan 77
P 12

(44)

(438)

669.187.2

Electric arc-furnace steelmaking. *(Trans. J. Brit. Ceram. Soc., 1973, 72, (3), 113-116)* PINDER, E. The paper traces the development of the electric arc process since 1903 in both the size and number of the furnaces and the steel output to 1971.

669.187.2

Bethlehem station. *(J. Met., Nov. 1973, 25, (11), 47-52)* Three 22-ft. dia., 150-ton, 60 000 kVA electric furnaces produce up to 110 000 tons of steel per month in a steelmaking shop installed in a former open-hearth installation. A computer system for the melt shop has three functions: scrap weighing, power demand control and steel analysis.

669.187.2

Electric Furnace Steelmaking. James W. Brown. Metal. ABM, Nov. 1974, 30, (204), 761-770 [in Portuguese].
A comparative cost analysis of four steelmaking alternatives, based on conditions in Brazil, covers the blast furnace-converter process, the direct reduction-electric furnace process, the electric furnace process with 100% scrap in the charge and the electric furnace process with 70% scrap and 30% prereduced pellets in the charge. Capital equipment and operating costs for plants capable of producing one million tons of steel/year by each process are considered. Factors which have led to widespread adoption of the electric furnace process and will enhance its future growth are discussed.– S.M.

669.187.2

Armco's Innovative Electric Furnace Practice. (J.Met., Nov.1974, 26, (11), 43-44) ANON
Four 175-ton electromelt electric arc furnaces were installed. These were to be serviced with a 40-50% hot metal charge. As these were operated, there was a continuous dribbling of slag from the door of the 22 ft.dia.furnace when tipped back about 5° from the horizontal. This operation further includes two submerged tuyeres blowing O under the bath at rates of up to 2000 ft^3/min during the refining period. Armco's advocacy of the direct reduction method is not entirely for the cost savings. Better metallurgical control is possible, especially when more sophisticated grades of steel are to be made. By using Fe pellets, the problem of residuals being brought in with scrap is minimized. From an environmental standpoint, the plant is pollution free as far as water and air requirements.

669.187.2

Auxiliary Operations of a 180 Tonne Electric-Arc Furnace. W. Robert Siddall. [ILAFA] Hornos Elect. y Tecnol. Proceso, Caracas, Venezuela, Oct. 1974, 1974, R1-R6 (Met. A., 7603-72 0042) [in Spanish].
An electric steel plant is described. The methods of charging, increasing the C level, and the effects of electrodes on refractory life are considered.–H. S.

669.187.2

Electrical balancing of UHP arc furnaces. *(CDS Circ., 1973, 30, (2), 501-509) [in Fr.]* LIGOT, G. After brief discussion of the arc furnace as an economic means of steel production the most important changes in arc furnace technology are reviewed. Increase in power ratings, development of ultr-high power furnaces and introduction of the concept known as refractory wear index, have made the problem of electrical balancing more urgent. Descriptions are given of some possible techniques, e.g. use of different voltages in three phases, triangulation, and the von Roll and butterfly systems. The author's preference is for triangulation. (2 refs.)

669.187.2

Construction and operation of UHP electric furnace. *(I.S.I. of Japan, Proc. Int. Conf. on the Science and Technology of Iron and Steel, Tokyo, 7-11 Sept., 1970, Part 1, 309-311)* YOSHIHARA, H., NAKAZAWA, K., HARAGUCHI, T. The newly constructed UHP electric furnace of 70 ton capacity in Kobe Works, Kobe Steel, Ltd. is described giving an outline of its facilities and operation. Special mention is made of the method of power distribution.

669.187.2

Developments at Toshin in electric furnace steelmaking. *(SEAISI Quart., July, 1973, 2-3, 23-32)* UDO, I. A large Japanese steelworks uses two 50-ton electric furnaces, two continuous casters, two rolling mills and two section mills to produce 40,000 tons of steel month. Methods used for material blending, melting, C content control, oxidation and reduction refining, fuel utilization and refractory conservation are described. Detailed operational data are also given.

669.187.2

Developments in electric steelmaking. (Ironmaking and Steelmaking, 1974, 1, (1), 28-34) ASTIER, J.E. and ANTOINE, J. This paper is divided into four parts, devoted resp. to: (i) the increasing application of electric-arc steelmaking to the production of many different types of steel, (ii) the use of a wide range of raw materials in electic-arc steelmaking, (iii) the energy aspect of electrical steelmaking, either with scrap or with pre-reduced iron ores, and (iv) the evolution of the construction and operation of electric-arc furnaces.

669.187.2

Developments in Electric Steelmaking. J. E. Astier and J. Antoine. Steel Furnace Monthly, Oct. 1974, 9, (10), 691-699 [in English].
Construction and operation of arc furnaces and their use with various types of steel and wide ranges of raw materials are reviewed. Aspects discussed include energy and economic factors, automation and continuous working, the Korf and Tamsa continuous-charging systems, the SKF double furnace, and use of scrap and pre-reduced ores. 20 ref. --J. R

669.187.2

The Development of Electric-Arc Steelmaking. ——, Iron Steel Int., Dec. 1975, 48, (6), 451, 453-454 [in English].
The development, principles, and advantages of electric-arc steelmaking are examined, and technical advances which have contributed to the success of the arc furnace are explained.--BA

46

669.187.2

The Different Steelmaking Processes, Importance of the Electric Furnace, [and] Future Prospects. J. Antoine, J. Astier, and Ch. Roederer. Automation and Process Control in Electric Steelworks and Foundries, 1975, 43 pp (Met. A., 7512-72 0[illegible]) [in English].
The present and future significance of the steelmaking arc furnace are reviewed and the main steel-production processes described. The growing importance of the arc furnace is stressed and automation of this process is considered in detail. 22 ref.—R. E.

669.187.2

(Direct) Production of Electric-Furnace Steel Without (Preliminary) Reduction by Coke. S. A. Pchelkin, V. S. Kudryavtsev, V. V. Ponomarenko, and V. I. Mardosevich. (Stal', Feb. 1976, (2), 131-133, (In Rus.); Steel in the USSR, Feb. 1976)
The direct production of a range of steels, is described. Iron-ore pellets are partly reduced by lignite or brown coal by heating in a kiln and the hot product melted directly in an electric-arc furnace. Reduced fuel and electric-power consumptions are claimed as a result of semi-industrial scale tests. The steel produced exhibit improved impact properties at low temp., and increased ductility at high temp. when compared with similar types of steel produced by conventional means from scrap.

669.187.2

The Electric-Arc Furnace for Steelmaking: Capacities and Characteristics. George D. Lawrence. [ILAFA [Hornos Elect. y Tecnol. Proceso, Caracas, Venezuela, Oct. 1974, 1974, D1-D15 (Met. A., 7603-72 0912) [in Spanish].
The characteristics of the main types of electric-arc furnace are described. Furnace capacities and structural features are considered. 10 ref.—H. S.

669.187.2

Electric Steelmaking Assumes New Role. (Iron Age, 1 Apr. 1974, 213, (13), 45-48, 53-56) MCMANUS, G.J.
Advantages of electric furnaces are flexibility, early pay off and steelmaking capacity provided by about 1/5 the capital requirement of a blast furnace-BOF complex. The greatest disadvantages in electric steelmaking are high prices for ferrous scrap and possible shortage of it. A way around the problem is direct reduction of ore. The electric furnace has gradually been scaled up into a production tool for C steel, the current limit being the availability of 28-in. electrodes. Scrap inventory availability and price are discussed. Performance of existing direct reduction plants is reviewed, and the problems with the need for natural gas by the process, as well as economics of the process, are considered.

669.187.2

The Increasing Significance of the Electric Arc Furnace [illegible], Oct. 1973, 31, (85), B212-B217) (in Ger.) LAUFER, H. and REIMANN, G. The advance of electric arc steelmaking from its earliest stages of use of alloy- and corrosion -resisting steels is discussed. Productivity, using the various processes, during the period 1960-1972, is outline. Constructional features and changes to meet the mechanical. electrical and thermal requirements for modern high-performance electric arc furnaces are discussed. Aspects considered include shape of size of vessel, electrical loading and triangulation of feed. Feeding of sponge Fe into the arc furnace is discussed. World capacity for production of sponge iron by direct reduction in 1970 is given as 2 X 10^6 t/year, and that for 1975 is expected to reach 11 X 10^6 t/year, while a figure for 1980 is estimated as 62 X 10^6 t. Investment costs are considered and mini steelworks are discussed.

669.187.2

A Modern Electric Steelworks. (Ing.Ind.,1973, August,(452), 47-50). LACOSTE,B. (From Sp). A description is given of electric furnace steelmaking and continuous casting at the USIBA mini-works in Brazil, which has an Hyl direct-reduction plant, a 90-120 tonne UHP furnace, continuous (IRSID-designed) iron charging system and a 6-strand billet casting machine. (Price: £6).

BISI 13315

669.187.2

The New Electric Steelworks of Ugine Aciers at Fos. D. K. Hermont, D. A. Gueussier, and D. P. Quinton. [ILAFA] Hornos Elect. y Tecnol. Proceso, Caracas, Venezuela, Oct. 1974, 1974, F1-F15 (Met. A., 7603-72 0042) [in Spanish]. The equipment and processes used at Ugine Aciers, designed to produce 250 000 tonnes of steel/year are described.—H. S.

669.187.2

The new electric steelworks of the Benteler Group. (Klepzig Fachber., 1973, 81, Apr., 180-181) [in Ger.] HARMSEN, L. The Benteler works requires 380000 tpa of steel and can supply only part of this from their own production facilities. This comes from the electric steel plant in Schloss Neuhaus (200000 tonnes) and is continuously cast (90% in octagonal billet for seamless tube production). A further 200000 tpa are required for the manufacture of welded tube and for sheet steel construction and all the necessary flat product has to be bought. The new electric steel plant in Lingen (EmS) casts slabs for hire rolling into strip. Factors determining the choice of location of the new works (including capital costs, purchase of land, infrastructure, services, transport and power) are discussed. Details of anti-pollution measures (dust and noise) and of plant, power supply and layout are given.

669.187.2

The ASEA-SKF Process. J. Fecht. Centre Document. Sid. [illegible] Circ. Inform. Techn., 1975, 32, (3), 611-629; [illegible] [in French].

A refining process in a furnace-ladle is described which comprises stirring by induction, electric arc heating, degassing, and auxiliary control equipment. These operations are completed in the same vessel. When used in conjunction with arc furnaces, production can be increased. A wider range of steels can be manufactured when used in conjunction with a converter or o.h. furnace.—J.M.S.

669.187.2

New method of manufacturing steel: the SKF–MR process. *(Rev. Mét., 1972, 69, Apr., 323-324) [in Fr.]* The first piblic demonstration of the patented MR process for making steel was given at the SKF steelworks at Hällefors, Sweden, in Nov, 1971. The fundamental principle of the process is to utilize maximum electric power for a long as possible in the melting unit. The latter in this case is the twin shell furnace invented by SKF. The twin shells are fitted with interchangeable roofs, only one having electrodes. When melting is complete in one shell and the molten metal has reached a suitable temp. the roofs are exchanged and melting begins in the other shell of preheated charge materials. A mixture of O_2 and lime is blown into the melt to dephosphorize it. Charge materials can be preheated by gas electricity. Another special furnace is used for refining. A description is given of the furnace gas cleaning system.

669.187.2

Recent Developments in the Field of Electric (-Arc) Furnace Steelmaking. J. Antoine (Steel Furnace Monthly, Apr. 1975, 10, (4), 151-167).

Aspects extensively reviewed include general principles of heating within the furnace and their application in melting scrap iron; thermal problems in melting pre-reduced materials; controlling the C-content of the bath P-removal, and desulphurization in high-power furnaces; and ladle metallurgy designed to accelerate refining. The use of high-power arc furnace is discussed.

669.187.2

Recent Progress in the Field of Electric Furnace Steelmaking. Jacques Antoine. Rev. Latinoam. Sider. Dec. 1974, (176), 2-13 [in Spanish].

The arc furnace as a melting and heating apparatus and the metallurgical consequences of the use of ultrahigh power are the central themes of a survey of recent experimental and industrial experience in the field of electric furnace steelmaking. A review of the general laws of operation of the arc furnace prefaces an examination of the application of these laws to the melting of ferrous scrap and prereduced charge materials. Thermal problems arising from the melting of prereduced materials, accelerated refining methods and simplification of the refining process are discussed within the stated context. 59 ref.—S.M.

Secondary refining for electric steelmaking

J. C. C. Leach

Ironmaking and Steelmaking, 1977 No.2
pp 58-59

The author discusses early applications in electric steelmaking for hydrogen and oxygen control and the gradual extension of secondary processes to perform more basic aspects of conventional melting practice, notably decarburization, deoxidation, desulphurization, and compositional control. The various methods of ladle and secondary vessel treatment are discussed, as are their present standing, degree of utilization, and accomplishments. The paper includes an examination of future possibilities in the production of electric-furnace steel. IS/166S

669.187.2

Some aspects of the process dynamics of electric-arc steelmaking. (I.S.I. of Japan, Proc. Int. Conf. on the Science and Technology of Iron and Steel, Tokyo, 7-11 Sept., 1970, Part 1, 434-439) ELLIOTT, J.F. The use of the electric-arc furnace for the production of carbon steels has been growing rapidly in the United States. Continued growth will depend to a considerable degree on such factors as availability of an adequate supply of scrap and metallized ore, the performance of the electrodes, and the ability to operate with a semi-continuous, or continuous [illegible] factors are presented [illegible] metallurgist.

669.187.2

The Status of the Ultra-High-Power Electric Arc Furnace. W.E. Schwabe. (Iron Steelmaker, July 1975, 2 (7), 14-19). A review of the development, past and present status and future of the ultra-high-power electric arc furnace is presented. Topics discussed include trends in furnace development, principles and criteria of UHP operation, utilization of UHP, planning stage of an arc furnace installation, deficiencies of furnace equipment, melt-shop management methods and future outlook.

(50)

Start-Up of 150-Ton Electric Arc Furnace at Lukens. V.J. Pongia. (Iron Steel Eng. Dec. 1975, 52, (12), 36-44)

Emission control considerations indicated that electric arc furnace capacity should be increased, with the ultimate displacement of all open hearth production. This move was a continuation of a programme which had begun in 1958 with the installation of the first 100 tons electric furnace, followed in 1962 with another 100 tons furnace and in 1965 with a 150 tons unit. When the new 150 tons "D" furnace tapped its first heat in 1974, the company had virtually culminated this programme dedicated to converting Lukens to all-electric steelmaking. The resulting four-furnace shop, with other support facilities, provided the company with a modern, economical, efficient and flexible electric melt shop capable of producing 1 million tons annually comprising a product mix of roughly 75% C and 25% alloy steel.

669.157.2

The Story of Electric-Arc Steel Making.-I. ——. Cast. ... (Sydney), Mar.-Apr. 1975, 21, (3/4), 32-35 [in English]. Electric-arc steel making is reviewed with respect to the principles of the method and the procedures used. A brief description of the vacuum-degassing process is given. A special C deoxidation technique during ladle-to-mould degassing may be used to reduce the H content of the steel to < 1.5 ppm. W.J.

Two Routes to Steel. G.R. Heffernan. (IEEE 12th Biennial Conference on Electric Process Heating Industry. 1975, 1-4). The direct reduction-elect[ric] arc furnace route for steelmaking presents a viab[le] economic alternative to the blast furnace-O steel making route where the Btu cost of hydrocarbons and electrical energy is below the Btu cost of co[k]ing coal or where markets are too small to accommo[]date a large-scale BF/BOF plant. It is expected that major strides will be made in closing the economic gap between the BF/BOF and the relatively new DR/EF steelmaking techniques. These advances are now underway in the development of solid reduct[]ant DR processes and the up-scaling of DR plants. In the long-term future it is possible that HTGR nuclear plants will be integrated with continuous direct reduction-electric furnace plants operating with H as a reductant and using electrical power for melting and refining. 669.157.2

51

669.187.2

Economic Effectiveness in Using Powdered Materials in Electric Furnace Steelmaking. I. G. Reznik, M. F. Sidorenko, E. V. Nikitina, N. A. Smirnov, and A. S. Morozov. Stal', July 1974, (7), 651-652 [in Russian].

The technical advantages of injecting powdered slag-forming materials into steelmaking furnaces are outlined. They include (i) greater chemical activity, (ii) reduced time of melting-down period (the slag forming materials are added only after the metal charge is melted), (iii) more rapid melting of the powdered materials, as opposed to the customary lump material, (iv) faster oxidizing period and (v) accelerated refining time. The mean heat time is reduced by 16%, and the consequent economic advantages are detailed.–J. W.

669.187.2

- Improving the Rate of Steel Production in Electric Arc Furnaces. Miroslav Kepka. Hutnik (Prague), 1974, 24, (5), 178-183 [in Czech].

Improving the output of electric arc furnaces by accelerating the rate of the steelmaking process is discussed. Improvements can be made by preheating the charge, the injection of powdered slag forming and deoxidizing materials, and increasing the degree of desulphurizing, dephosphorizing, and the deoxidation of the steel. The injection of powdered materials is an important requirement in the automation and mechanization of arc furnace operations. 8 ref.–R. M.

669.187.2

The IRSID Continuous Electric Furnace: Description and Initial Results. ——. French Techniques: The Metal Industries, 1974, [IM-1-74-203], 6 pp [in English].

A continuous steel-making plant is described and illustrated, in which the charge is continually fed into an arc furnace with a basic lining. The molten steel is tapped through a syphon spout into a tilting-channel-type induction furnace, which is lined with magnesia concrete. This furnace raises the melt to the required temp. and the charge can be adjusted to the desired grade. Oxidizing operations take place in the arc furnace and the C content adjusted to ~0.3%, either by additions of C or by O lancing. Deoxidation and alloying additions are made in the second-stage channel-type induction furnace.–J. W.

669.187.2

[Direct] Production of Electric-Furnace Steel Without [Preliminary] Reduction by Coke. S. A. Pchelkin, V. S. Kudryavtsev, V. V. Ponomarenko, and V. I. Marcosevich. Stal', Feb. 1976, (2), 131-133 [in Russian].

The direct production of a range of steels, including 18Kh2N4VA and U8A grades, is described. Iron-ore pellets are partly reduced by lignite or brown coal by heating in a kiln and the hot product melted directly in an electric-arc furnace. Reduced fuel and electric-power consumptions are claimed as a result of semi-industrial scale tests. The steels produced exhibit improved impact properties at low temp. and increased ductility at high temp. when compared with similar types of steel produced by conventional means from scrap.–J. W.

The Usine Aciers Electric Arc Steelworks at Fos-Sur-Mer. (J. Four Electrique, 1974, Oct., (8), 173-179) (from Fr.) SEVIN, R. A description of the installations and their capacity (the electric furnace, rolling mills and finishing shops), the system of water supply and anti-pollution measures. (Price: £5)

BISI 13123

669.187.2

70 Years of Steelmaking in the Arc Furnace. O. Etterich. (Stahl Eisen, 23 Oct. 1975, 95, (22), 1028-1031) (In Ger.)
The development of the arc furnace is reviewed, and the incresed capacity of furnaces is discussed with ref. to power consumption and the supply of raw materials. Characteristics of the layout of the furnaces are described, and methods of increasing productivity considered.

669.187.2

Worldwide Look at Electric Arc Furnace Performance. L. J. Voisinet. Iron Steelmaker, Mar. 1975, 2, (3), 44-49 [In English].
Factors involved in the growth of electric arc melting are discussed: increased furnace size, increased use of O, quality improvements in refractories and electrodes, power input programmes, automatic charging and scrap segregation. Maximum production rates at low-cost levels require properly trained people, good maintenance, judicious use of power and time and a proper flow of materials. Past and proposed future world steel production figures are given for various furnace processes. It is estimated that ~27% of all steel produced in 1980 will be processed in electric arc furnaces. 13 ref.

669.187.2 (410)

What future is There in the UK for the Electric-Arc Furnace? R.D. Langman and T.H. Harris. (Ironmaking Steelmaking, 1975, 2, (4), 253-261)
Electric-arc steelmaking is reviewed with an emphasis on the energy requirements and the costs of the process in the UK. Views are expressed on the influence of energy cost trends which suggest that the expansion of electric-arc steelmaking will not be limited by energy availability. Ref. is made to the impact of the minimill concept. Related areas such as raw-material availability and the possible links of the process in an integrated works are discussed.

669.187.2 (41)

What Future in the UK for the Arc Furnace? R.d. Langman and J. H. Harris. (Br. Steelmaker, July-Aug. 1975, 41, (7/8), 10-12, 14-16, 18-19,22)
The present and future roles of the electric arc furnace in the United Kingdom are reviewed with ref. to energy requirements and availablities. Aspects discussed include capital, electrical-power, and operating costs, conflicting scrap needs of the arc-furnace and basic-O processes, effects of mini-mill, continuous-casting, direct-reduction, and environmental considerations, and design and power-system disturbance. The electricity generation and supply facilities are expected to cope with Potential electric-Steel productions of 7.5-10 Mt/year, but the long-term scrap position will be a dominant factor influencing arc- furnace expansion.

669.187.2 (437.1)

The New Electric Steel Plant of the Lenin Metallurgical Works of Hungary. (Bany, Koh, Lapok, Kohaszat) March 1974,107,3, 114-118 (in Hung) KISS.
A detailed description of the new electric steel plant (scrap handling plant, furnace room, 50 ton capacity arc-furnace, magnetic stirring equipment, furnance handling equipment, fume - extraction and purifying equipment, etc) is presented together with operational experiences so far. Improvements in the life of furnace lining by using a particular electrode type and refractory-brick type, and in the quality of steel by vacuum or argon treatment, are discussed.

669.187.2 (47)

Aspects of Development in USSR of Electric Steelmaking Production. O.M. Chekhomov, N.V. Sidorov, S.K. Filatov, and Yu.V. Gerasimov. Stal', Aug. 1974, (8), 702-703 [in Russian].
Developments in electric steelmaking production are reviewed. They include ultra-high power electric arc steelmaking, vacuum treatment of the metal outside the furnace, and homogenizing the temp. and composition of the metal by blowing an inert gas through the melt. Aspects to be considered in steelmaking processes include the more efficient utilization of alloy waste materials, and the reduced quantity of scrap available following the wider adoption of continuous casting procedures. 7 ref.—J.W.

669.187.2 (47)

Trend in Electric Furnace Steelmaking in the USSR. (Stal', Apr., 1974, (4), 319-323, (in Rus.); Steel in the USSR, April, 1974) MOROZOV, A.N. Trends in world and USSR steelmaking are reviewed in the context of electric steelmaking. The desirability of developing in the USSR the production of C and low-alloy steels in arc furnaces inconjunction with the basic-O steelmaking process is emphasized.

669.127.2(47)

The Progress of Electric(Furnace) Steel Manufacture in the U.S.S.R. A.F.Kablukovsky and R.G.Kamalov. (Metallurg.Feb.1975, (2), 17-21) (in Rus). The present state of electric (furnace) steel manufacture in the U.S.S.R. is described and ways for increasing the production and improving the quality of the steel are reviewed. Attention is directed to the improvement of the construction of arc furnaces refining the steel outside the furnace, its processing with synthetic slags, vacuum treatment and gas refining of the steel. Steel smelting using metallized nodules is also considered.

669.187.2(497.1)

Present position and importance in the future of the electric arc furnace in the Yugoslavia iron and steel industry. (Electrowärme Int., 1973, B. Apr., 78-84) BULAJIC, R., RAIC, T. The authors deal with the problems involved in the evolution of electric steelmaking in Yugoslavia and with the conditions that led to this development: raw materials and sources of electrical energy. Specific advantages of the arc furnace process and the chances of using new processes and improvements are discussed which are apt to promote further development and help to produce production costs. Technical details and the development of these installations are discussed with special emphasis on the advantages of UHP furnaces and on power supply and economic aspects.

669.187.2(540)

Parameters for growth-electrical steelmaking in India. (Steel Furn. Mon., 1972, 7, Oct, 401-403A) ANON. Economic factors affecting the possible development of electric steelmaking in India are discussed with emphasis on scrap, power electrodes and technological improvements.

669.187.2(71)

Electric Arc Furnaces Provide Production Units for New Quebec Steel Plant. (Metalwork. Econ., Mar. 1974, 37, (2), 30-33) The Sidbec-Dosco Ltd. plant at Contrecoeur employs the latest steelmaking technology. Its combination of the direct-reduction-plus-electric furnace process may permit the plant to be expanded to perhaps one million tons by 1980. Construction at the melt shop started in the fall of 1970 and the first heat was tapped in Dec. 1971. Handling of scrap and ingots, Fe supplies for the plant and the reduction process are discussed.

669.187.2(8)

A look at electric arc furnace steelmaking in S. America. (33 Mag., 1972, 10, Mar., 52-55) BROWN, J.W. A brief survey is given of electric arc steelmaking in South America, which it is estimated will reach 8.6 m.t. out of 31 m.t. total steel production by 1980 (1970: 3.65 m.t. out of 13 m.t.). Short accounts are given of individual companies in Brazil, Argentina, and Venezuela with a summary of reasons behind the continuing trend to the electric arc process.

669.187.2
658.152

Capital investment for an electric furnace shop with annual design capacity of 1.71 million ton is $65 millions, whereas 1 ton cost is $139.89.

Source: EPA-600/1-76-034C, December 1976, P. 86.

669.187.2
658.152

Capital cost of Electric furnace with steelmaking capacity of 500,000 tons figures $44.00 per ton.

Source: UNIDO/ICIS/15, December 15, 1976, P. 208.

669.187.2
658.152

In electric furnace with capacity of one million tons unit per year and 2 million tons/year, the cost of continuous casting is $28.8 and $55.3 respectively.

Source: ID/WG/ 146/29, P.18, Table 3.

Electric Steelmaking for the Expansion of Siderurgica del Orinoco C.A. (Venezuela). Pedro G. Martinez, Enrique Briceno, and Julian S. Jatem. [ILAFA] Hornos Elect. y Tecnol. Proceso, Caracas, Venezuela, Oct. 1974, 1974, V1-V13 (Met. A., 7603-72 0042) [in Spanish].
A description is given of the increased production which a steelmaking plant has achieved by employing sponge iron in the electric-arc process. -H.S.

669.187.2.002.1

Electric melt shop economics. (J. Met., 1972, 24, Nov., 60-64) JONES, D.R., MONTEITH, W.F. The economics of electrid arc furnace melting are discussed with reference to the experience at the Butler and Houston works of Armco Steel Corp., USA. The aspects considered are load factor, demand, furnace-curtailment etc. It is shown that the primary objective of minimum cost per ton and the seondary objective of minimum energy cost per ton are not compatible. The secondary objective must be sacrificed to achieve the main goal of minimum cost per ton.

669.187.2.004.86

CHITU.G.

Factors Controlling the Reduction of Specific Consumables in Electric Steelmaking. (Metalurgia, Dec.1973, 25, (12), 786-789) (in Rus) Factors affecting specific consumptions in the electric steelmaking process including metal charges graphite electrodes, electrical energy, refractories and casting equipment are considered. Graphs showing the reduction of each factor over a period of six years in two steel plants are presented, and discussed. Special emphasis is directed towards the adoption of new technologies, optimizing the production processes, the use of computers and of highly qualified personnel.

The Industrial Development of the Channel Induction Furnace in Steelmaking: The Manufacture of Steels at the [French] Sacilor Steelworks. J. Antoine, A. Berthel, and R. Perie. Cent. Doc. Sider. Cir. Inf. Tech., 1975, 32, (6), 1447-1465 [in French]. 669.187.2 621.365.5

The technology and the thermal and metallurgical performances of channel furnaces used for steel production are described. Induction heating is carried out by simple electrical equipment away from the hearth, and operations as long and as varied as desired (vacuum treatments, alloy additions, degassing, deoxidation, decarburization, etc.) can be performed to produce high-quality metal under the best conditions. Examples are given of the manufacture of low-alloy steels contg. C ~0.1 or 0.5%.—J.M.S.

669.187.2; 621.365.5

Application in the steel industry of large line-forequency induction furnaces. (Canada Department of Energy, Mines & Resources IC 278, 1971, Oct., pp. 31) REHDER, J.E. Induction furnaces of moderate size are being used today for minor steelmaking and in vacuum degassing equipment. However, the large, high-powered induction furnace has some characteristic features that have not been adequately explored for tonnage steelmaking. Important among these are the ability to emulsify slag into the molten steel to obtain very high interface area and rate of reaction, the feasibility of handling considerable slag volume with maintenance of slag temperature, and the ease of obtaining nearly continuous production. Effective application of such factors will constitute new methods of steelmaking. Processing of solid-state reduced pellets seems particularly well suited to the induction furnace.

55A

669.187.2: 621.341.1-122

The Use of Metallized Pellets for the Melting of Electric Steel. (Stal,' Oct.1974, (10), 907-907, (in Rus); Steel in the USSR Oct.1974) KOLYASNIKOV, M.P. LEVIN, V.Ye, and DUBUKIN, A.A. The advantages of metallized pellets in electric steel melting are reviewed. They include the production of high quality, low inclusion count, steels, such as bearing and tool steels, improved productivity from the continuous charging of metallic pellets into electric furnaces, reductions in electric power and electrode consumption, and the production of steel with improved mechanical properties. The problems in increasing the output of metallized pellets are considered.

669.187.2: 621.746-412

The Most Economical Steelmaking Process With Electric Furnace and Billet Caster. K. Fujinami. (SEAISI Q., Oct. 1975, 4-4, (665), 22-26)
The need for savings in energy, resources and manpower is being emphasized in every industry around the world. Funabashi Steel Works developed an economic steelmaking process consisting of multi-sequence casting with single arc furnace and billet caster for its exclusive use and ultimate possibility of endless casting in the field of billet casting; hot billet charging into reheating furnace; severe process, raw material and quality control; experimental melting of 1 000 ton of Midrex prereduced pellet; and development of new rolling mill techniques with higher productivity, yield and less energy consumption.

See 55B

669.187.2: 669-982

Vacuum Metallurgy as an Adjunct and Complement to Electric-Arc Furnaces. Jose Maria Palacios. [ILAFA] Hornos Elect. y Tecnol. Proceso, Caracas, Venezuela, Oct. 1974, 1974, P1-P16 (Met. A., 7603-72 0042) [in Spanish].
The low-vacuum processes currently used in the steel industry and their principal advantages are discussed. The choice of suitable degassing methods is considered. 12 ref.—H. S.

669.187.2: 669.012.37

Primary Energy and the Electric Steel Process. O. D. Schoenmaker. Radex Rundsch., July 1975, (2), 345-377 [in German].
World steel production is reviewed and future trends in the amounts produced by the different processes are discussed. Primary-energy consumption is considered with particular ref. to electric furnaces. The use of fossil fuels and atomic energy as sources of primary energy is also considered. 23 ref.—H. Su.

669.187.2:
669.012.57

Energy Considerations for the Preparation and Processing of Iron Ores Including Direct Reduction and Agglomeration Processes. E.J. Bagnall and C.W.Brock. (SEAISI Q., Apr. 1975, 4-2, (665), 14-22) The energy requirements for the two alternative steelmaking routes of blast furnace-BOF and direct reduction-electric furnace-are presented. Steelmaking by the more conventional route is essentially dependent on the availability and reliability of supply of good coking coals. or suitable substitutes such as formcokes, although other energy forms are also needed. The direct reduction-electric furnace operation requires large quantities of cheap electric power. Preparation of the ore feed is essential for efficient operations using either of the alternative steelmaking routes.

669.187.2:
669.012.57

On the Energy utilization in Electric Steelmaking. Noda. (SEAISI Q., July 1975, 4-3, (665), 8-15) Electric arc furnace steelmaking energy requirements are considered as practices in construction and operation with total energy involving that put into the labour, time, raw materials, furnace linings and electrodes, as well as actual energy to run the furnace. Comparison with a BOF maximill requiring 4.97 Gcal/metric ton of wire rod, the arc furnace minimill operating from sponge requires 4.85, and from 100% scrap 1.06 Gcal. Thermal efficiency data are given along with a comparison of long arc with short arc operation. Methods of recent operation time saving procedures are tabulated. A model plant for arc furnace matching with diesel generator is described. A thyristor controlled wattless power compensator in use for flicker suppression is described. Properties of refractories for arc furnace are given.

669.187.2
669.012.85

Steel Production Using Preheated Scrap. V.Ya. Konyukh, V.P.Asanin, Yu.V.Chaplygin, and V.K. Didkovsky. (Metallurg.i Gornorud.Prom., Jan.-Feb. 1975, (1), 13-14) (in Rus.) One of the disadvantages of producing steel in converters and electric furnaces is that large volumes of scrap cannot conveniently be processed in these units and relatively large amounts of electrical power can be consumed in such melting. Preheating the scrap before charging into the furnaces can provide considerable savings. Methods of achieving this preheating are discussed. In a typical case, by using gas-air burners to preheat the scrap, over a period of 25 min, to a temp. of 500°C, the rate of production of the furnace was almost doubled.

Argon–oxygen steelmaking at Electralloy. (ASM: 3rd Internat. Symp on Electroslag and other special melting technology, Part 2, Pittsburgh, 1971, June 8-10, 13-27) 669.187.2 : 669.046.564.5

SMITH, E.S., PANIGRAHY, P.C. An account if given of a recent process for steelmaking, the argon-oxygen decarburization process, commonly referred to as AOD, patented by Union Carbide Corp. Electrally is a custom melting operation comprised of a 25 ton electric furnace, a 5000 lb. vacuum induction furnace, two air induction furnaces and the 17 ton AOD unit. The AOD unit was chosen to expand and enhance melting capability. It is prime tool in the conversion of marginal charge material into prime ingot product. The Electrally installation was the second commercial stainless producing installation in the U.S. and was the first to make stainless steel ingots for commercial flat rolled products. The first heat was tapped Sept. 9, 1970.

667.187.2 669.046.564.5

Pneumatic addition of lime and coal in the electric arc furnace. (Stahl und Eisen, 1973 93, (16), 2nd August.) (from German) FENNE, M. Continuous addition of lime and carbon is briefly considered with a short summary of the devices used. (Price: £3)

BISI 11774

669.187.2 669.054.85

Firth Bown's Atlas Melting Shop. Electric Melting and Refining as Two Separate Processes. (Metallurgia and Metal Forming. Oct., 1974 41, (10) 296-299)
A method is in use for producing high quality steels whereby the melting and refining processes are separated. Steel scrap is melted in a high-power arc furnace and then tapped into a ladle where it can be vacuum - degassed, stirred, reheated and given alloy additions before casting. Increased production, improved steel cleanliness and greater uniformity of the molten steel caused by the stirring result.

669.187.2: 669.054.85

Preheating of Scrap in the Electric Steel Shop of Establcimientos Metalurgicos Santa Rosa, S.A. A. Benoit, C.M. Roccatagliata and C.de Vedia. (Siderurgia, Aug-Sept. -Oct. 1974, 1, (1), 111-124; (In Sp.)
The development of a scrap preheating system which, in addition to increasing furnace productivity, has provided monthly savings of $122 000 in electric power and electrode costs for a furnace producing 4000 tons of steel/month is described. These savings are offset by $32 000/month for increased consumption of natural gas and costs of bucket maintenance. The scrap is preheated four charging buckets by burners at the top of the buckets; gases are exhausted through the bottom.

669.187.2:
669.181.2

Use of Directly Reduced Iron Ore in Electric-Furnace Steelmaking. A. N. Biswas and Mainak Mukherjee. Trans. Indian Inst. Metals, Apr. 1974, 27, (2), 105-108 [in English].
A note. Directly reduced iron ores can be substituted for scrap in the furnace charge without any significant operational difficulties.—B.A.M.

669.187.2
669.181.2

Utilization of direct reduction iron in electric steelmaking. (UN-IDO) Third Interreg. Symposium Iron Steel Ind. Brazil, Preprint, Oct. 1973, (ID/WG. 146/87, 26 pp). SMAILER, R.M., JENSEN, H.B. and SCOTT, W.W. The overall results obtained, demonstrated that a variety of direct reduction iron products can be used in electric-furnace steelmaking. With high-power furnaces, the maintenance of a C/O boil is essential to minimize refractory wear. The process becomes dynamic when the continuous charging of direct reduction iron, O-blowing, and lime introduction while the power is on is adopted, and this increases productivity. For developing countries, direct reduction iron is a suitable alternative to steel scrap for small steel plants.

669.187.2:
669.181.4

Electric Steelmaking Using a Pre-Reduced Charge. A.T.Barnaba. (Met.Ital., May 1975, 67, (5), 255-257) (in It.) The manufacture of steel in countries not fully industrialized, where there are rich ores and fuel but little scrap is considered. To meet this need an auxiliary melting furnace is recommended, for each group of steelmaking furnaces, in which a scrap substitute is produced by melting recycled plant scrap with pre-reduced sponge iron.

669.187.2
669.181.4

Improved Technology for Processing Sponge Iron in the Electric-Arc Furnace. K. Schermer. Ironmaking and Steelmaking, 2, (3), 188-192 [in English].
The rationale for developing a particular melting technology for the processing of sponge iron in the electric-arc furnace is set out and the underlying theory is explained briefly. Melting tests carried out in 1969, which achieved the expected results, are reported. A comparison is made between the operating results of various processors of sponge iron and the operating results achieved at Dunswart Iron and Steel Works since March 1973, where 40 000 tons of sponge iron have been used. The comparison shows that the special melting technology used leads to favourable results in respect of hourly output, power, and electrode, as well as refractory consumption. 13 ref.- AA

669.187.2
669.181.4

Industrial Operation of an Electric Steel Shop With a Sponge Iron Charge. Medardo de la O Jiménez. Present and Future Technology of Steel Fabrication in Latin America, 1974, 123, 125-133 + 3 plates (Met. A., 7505-72 0081) [in Spanish].
[illegible] and practice in a shop with an annual production capacity [illegible] tons of high-purity killed steels processed from charges [illegible] ~45% sponge Fe and 55% scrap are described. Three 51- [illegible] electric furnaces (modified from an original 35 tons) [illegible] 50 grades of steel to API, DGN, SAE and other speci-

(59)

669.187.2
669.181.4

New Results Obtained in High Duty Arc Furnaces with Scrap and Sponge Iron Charges. (V.D.Eh.Internat. Iron Steel Cong., Dusseldorf,1974, 1974,(Vol.II)3.1.2. 2 1-19) ELSNER E.A. and VOSS H. A change from scrap to sponge Fe increased the refractory wear index by 17-21%. This was rectified by enlarging the furnace shell and adjusting the power factor. The proportion of free Fe in the sponge was a critical parameter., a low proportion requiring an increased energy consumption, and leading to low yield, and high slag volume. Details of a number of heats carried out in a 60 ton, and an 85 ton fur furnace, and the variations in power consumption and efficiency with different conditions of charge and operation are presented.

669.187.2
669.181.4

Selected Test Results on Charging of Sponge Iron in a High Performance Arc Furnace. (Elektrowarme Internat., June 1974, 32 m(B3),B127-B137)(In Ger) OTTMAR,H.OERTER,A. SCHMEIDUCH,G. and AMELING.D. Technical data on a 60 tonne arc furnace are presented with production figures for 1969-72 inclusive. Illustrations show the charging system and the arc furnace. Diagrams show the power consumption, charging of Fe sponge,temp., and levels of C,P,S, and O. A diagram shows the variation of N and H contents during the course of a melt. The energy consumption of the arc furnace is discussed. Results of recordings of noise emissions during the progress of different melts are presented in a diagram.

669.187.2
669.181.4

Some Special Problems in the Processing of Sponge Iron in the High Duty Arc Furnace. (V.D.Eh. Internat. Iron Steel Cong., Dusseldorf,1974, 1974, (Vol.II).3.1.2.1 1-14) (in Ger) OTTMAN.H.OERTER,A.SCHMEIDUCH,G.AMELING,D. and SIEGERS,U. The processing oc charges contg.up to 50% sponge Fe in the arc furnace, and problems arising are considered. Electrode wear through point tapering, side loss and breakage is discussed, together with heat balance and power consumption which are related to the thermo-chemistry of the heat. Control of the reactions can be achieved by regulating the C and O content of the Sponge. Results obtained with sponge and scrap Fe heats are compared.

Process for electric arc furnace production of steel from sponge iron. (*Stahl Eisen, 1973, 93, Mar. 1, (5), 194-201*) [*in Ger.*] MEYER, K., POST, C. Although the electric arc furnace has been used to melt down a wide variety of types of sponge iron, reports on working results have contained conflicting conclusions. The authors aim at reconciling these contradictory data by investigating properties of iron sponge, the various melting down techniques and other relevant factors. The most significant difference between sponge iron and blast furnace pig iron is in iron and gangue content. Existing melting techniques for sponge iron are described. The authors have used models to determine the most efficient method, power consumption and productivity (in comparison with melts of scrap) being criteria of a successful process. Continuous melting down of a liquid bath with overlapping melting and refining periods is considered with most efficient method. The liquid bath involves some problems about refractories; methods of protecting the latter are discussed. There is an increase in productivity of as much as 20% in large and 45% in small furnaces employing the recommended method. Some future possibilities are considered, such as improvements in furnace design, continuous tapping and charging with hot iron sponge. The last-named would reduce power costs and save in electrode consumption. (18 refs.) 669.187.2: 669.181.4

669.187.2:
669.181.4

/Improved Technology for Processing Sponge Iron in the Electric-Arc Furnace. K.Schermer.(Ironmaking and Steel-making, 2 , (3),188-192). The rationale for developing a particular melting technology for the processing of sponge iron in the electric-arc furnace is set out and the underlying throry is explained briefly. Melting tests carried out in 1969, which achieved the expected results, are reported. A comparison is made between the operating results of various processors of sponge iron and the operating results achieved at Dunswart Iron and Steel Works since March 1973, where 40000 tons of sponge iron have been used. The comparison shows that the special melting technology used leads to favourable results in respect of hourly output, power, and electrode, as well as refractory consumption.

669.187.2:
669.181.4

/ **The Use of Sponge Iron in the Steelmaking Process in Electric-Arc Furnaces.** Eugeniusz Mazanek, Jozef Swietalski, and Bronislaw Lyko. Hutnik (Katowice), May 1975, 42, (5), 200-205 [in Polish].
Methods for the production and remelting of sponge iron are described, and the results of investigations on the quality of steel produced from sponge iron are reported. 17 ref.–BA

669.187.2:
669.181.4

The Development of a New Steelmaking Process Utilising Highly Metallized Sponge Iron. H. M. Willars and R. C. Madden. (Iron Steel Inst., Aug. 1975, 48, (4), 313-317, 319-321)
The processing of sponge iron by an American steel company is described with ref. to steelmaking practice The use of highly metallized sponge iron improved the metallic yield of the final product, permitted the use of ultra-high power inputs continuous feeding, permitted flexibility in the mix of up to 100% sponge iron and made pratical the economic production of high quality rod products.

669.127 :
669.181 4

Demands on the Quality of Sponge Iron for Steelmaking. Heinz-Dieter Pantke and Christian Queens. Stahl Eisen, 15 July 1976, 96, (13), 652-657 [in German].
The properties of sponge iron and the way in which they differ from existing materials used in steelmaking are discussed, with special consideration to gangue, reduction ratio, and C and P contents. Operating experiences of sponge iron use in arc, induction, open-hearth, and BOP furnaces are given, together with the different qualities needed by sponge iron for each process. 9 ref.-BA

669.127.2
669.181.4

The Use of Sponge-Iron in Electric Steelmaking. (Metalurgia, Aug. 1973, 25, (8), 456-462) (in Rom.) HATARASCU, O., VLADESCU, M., LOTHAR, D. and ALEXANDRESCU, A. Partial replacement of steel scrap by up to 50% sponge-iron, in electric steelmaking was investigated. Steel scrap can be replaced successfully by up to 30% sponge-iron. In quantities in excess of this both the specific energy consumption, and duration of the heat are drastically increased. An increase in energy consumption of 54% was obtained when 51% of sponge iron was charged, and the direction of the melt was prolonged from 394 to 478 min, using 43% sponge-iron.

669.127.2:
669.181.4 HYL

The Use of HyL Sponge Iron in Electric Steelmaking and Its Advantages in Continuous Casting. D. Yanezg. (ILAFA Hornos Elect. y Technol. Proceso, Caracas. Venezuela, Oct. 1974, 1974, 01-011) (In Sp.) The physical and chemical characteristics of steel made with HyL sponge iron are discussed. The factors affecting processing and rolling are considered.

669.127.2:
669.181.4 PUROFER

Use of Purofer Sponge-Iron in a 35-Ton Electric Arc Furnace. (Stahl u. Eisen, 1 Aug. 1974, 94, (16), 711-729) (in Ger./Sp.) SCHOENMAKER, O. and GULDENMUNDT, J.P A series of trial melts to produce steel from sponge-iron has been conducted. An average of 57% sponge-iron was charged, mainly by continuous addition, with the scrap, which comprised the balance of the charge. Three grades of sponge-iron contg. C 0.4-0.8, 0.55-0.91 and 0.91-1.81% resp. were used, and the effects of C and O contents examined. A control device allowed a specific melt down rate to be achieved during the sponge-iron addition. Uniform CO refining, andexact composition are factors favouring the use of sponge-iron.

669.187.2 (54)
669.1814

The future of electric steel production in India depends upon the development of scrap recovery and use of direct reduction ore. (Steel Furnace M., 1973, 8, March, (3), 131-135) SRINIVASAN, D. Problems faced in India at the present time with respect to electric steel production are described. India is shown to have a lack of scrap, and the author stresses the need for the establishment of sponge ion plants inorder to achieve future production targets.

669.187.2;
669.181.4
621.365.5

Melt-Down of Sponge Iron in the Induction Furnace. W.Wenzel, F.R.Block, and V.Grumbrecht. (Stahl u. Eisen, 22 May 1975, 95, (11), 496-502) (in Ger.) Experiments in a 1.5 tonne and a 130 kg furnace have been completed and may constitute a guide to the design and process control required for commercial installations for the reduction melting of sponge iron. The gangue content of the sponge iron must be as low as possible to minimize slag promotion as this is deleterious. Bath temp. not exceeding 1500°C are suggested but this has the disadvantage of premature slag solidification. Intensive agitation and possibly additional top-healing are suggested means of maintaining a molten slag. The sponge should be passed through the slag layer, possibly by a charging pipe connected to a screw conveyor, to limit contact with slag. The development of a duplex process, with the crucible furnace serving as a melt-down unit, and the liq.metal is collected for casting in a regenerative furnace to be brought to the desired temp. and composition is to be considered.

669.187.2
669.181.4
621.365.2

Prospects for the use of Arc Melting Furnace in Electric Steel Plants. (Elektrowarme Int., 1974, Dec., Ed.B, (6), B.240-344). MARKWORTH E.F.E. (from Ger). The feasibility of building larger high--power furnaces is considered; practical realization and the limits are outlined. The choice of circuits for the furnace transformers is surveyed, and the problem of variations in the electric power supply when charging scrap or melting sponge-iron pellets is discussed. (Price: £5).

BISI 13124.

669.187.2;
669.181.4;
658.562

The Benefits and Drawbacks of Using Sponge Iron in Electric-Arc Steelmaking. A. Barbi. Iron Steel Int., Aug. 1976, 49, (4), 257-262 [in English].
The presence of tramp elements in scrap poses a serious problem to quality control in electric-arc steelmaking. A solution is to be found in the use of sponge iron which acts as a 'purifier' in the scrap burden. However, there are drawbacks to this solution: higher power consumption and increased electrode and refractory wear. The pros and cons of using sponge iron in electric-furnace burdens are discussed, with particular emphasis on the economic aspects of its us 17 ref.--BA

669.187.2.036

The SKF double furnace. (I.S.I. of Japan, Proc. Int. Conf. on the Science and Technology of Iron and Steel, Tokyo, 7-11 Sept., 1970, Part 1, 293-296) TIBERG, M., SUNDBERG, Y. One way of obtaining a better utilization time is to tap the arc furnace immediately after melting down and to carry out the refining in a special vessel. This procedure is used in the ASEA-SKF Process. A further step is to use the SKF double furnace, which is the subject of this paper. The paper first gives a brief description of the mechanical and electrical design, and after this operational and metallurigical view-points are discussed. Finally, the economy is commented upon.

669.187.2.036

The (Swedish) SKF Double-Hearth Furnace. M.Tiberg. (Centre Document.Siderurgique Circul.Inform.Techn., 1975, 32, (5), 1139-1153; 1153-1156) (in Fr.) A description is given of the state of development of the double-hearth furnace, heated successively by gas and by electricity by means of exchangeable roofs. The steel is subsequently refined in a furnace-ladle. The first experimental furnace produced 130 000 tonnes in a year. The eventual aim is to preheat as effectively as in a Martin furnace, melt as in an arc furnace, and decarburize as in a converter.

669.187.2.036

Contemporary Design Solutions for Electric Steelmaking Shops. V. S. Rozentsveig and A. V. Khvoshchinskii. (Stal', Jan. 1976, (1), 35-39 (in Rus.); BISI 14306) Previous installations were studied analytically before designing new electric steelmaking shops with furnaces of 100- and 200-tonnes capacity. The recommendations made include the supply and charging of scrap metal, and of bath and alloying additions. The possibility of adopting pneumatic feed and conveyer systems is evaluated as is the supply of steel to continuous casting lines fed with metal melted in adjacent bays. A plan and sectional arrangement drawing of a shop contg. four furnaces of 100 or 200 tonnes capacity for an output, depending upon furnace sizes, of 1-2.2 x 10^6 tonnes/year is illustrated.

669.187.2.036

Electric furnace round-up. Part I, 2, 3. (33 Mag., 1972, 10, July, 25-7; Aug., ?; Sept., 47-9) Data are presented in tabular form for electric arc furnace [illegible] making in the U.S.A. showing locations, types of furnace capacities and other information.

64

669.187.25

IRSID Continuous Arc Melting Process. J. Antoine, J. Asue and C. Roederer. Institut de Recherches de la Sidérurgie Francaise, 1974, Pp 25 [Pamphlet—French].
Six series of tests have been carried out on IRSID's continuous electric arc furnace and during ~140 h of operation >500 tons of steel have been produce. The maximum power to melt continuously sponge iron or shredded scrap could be utilized permanently, thus allowing the optimal use of the installations. Obtaining a good thermal yield leads to a low lining wear and decreased electrode consumption. Dividing the metallurgical operations into two stages leads to a specialization of the apparatus, the second stage ensuring deoxidation and grading. The channel induction furnace allows a good regularity in the deoxidation, due to a knowledge of the oxidation level in the metal and to the control of the reoxidations arising from air intake. The reached P-, S- and O-contents and the accuracy in analysis adjustment of alloying elements induce the possibility of producing various grades of C steels or low-alloy steels in the continuous electric arc furnace.—AA.

669.187.25

The IRSID Continuous Electric Furnace: Description and Initial Results. French Techniques: The Metal Industries, 1974, (IM-1-74-203), 6 pp) ANON. A continuous steel-making plant is described and illustrated, in which the charge is continually fed into an arc furnace with a basic lining. The molten steel is tapped through a syphon spout into a tilting-channel-type induction furnace, which is lined with magnesia concrete. The furnace raises the melt to the required temp. and the charge can be adjusted to the desired grade. Oxidizing operations take place in the arc furnace and the C content adjusted to about 0.3%, either by additions of C or by O lancing. Deoxidation, and alloying additions are made in the second-stage channel-type induction furnace.

669.187.25

First Results from the IRSID Continous Electric Furnace. (Centre Document. Siderurgique, Circul. Inform. Techn., 1974, 31, (2), 387-398) ANTOINE, J., MATHIEU, J.J. and SAUVAGE, F. Starting from crushed scrap-iron and other products 250 tonne of metal were manufactured in a continuous electric furnace in 25 h of continuous operation. Initial melting takes place in a 2700 kW arc furnace, but deoxidation and final composition and temp. adjustments are made in a second 500 kW induction furnace prior to casting. Advantages include reduced energy and electrode consumption and improvements in productivity and steel quality.

669.187.25

Rapid Addition of Charge Materials in Continuous Electric Furnace Steelmaking.
R.H.Nafziger. J.E.Tress and W.L.Hunter.
(Iron SteelmakerMay 1975, 2, (5), 33-37)
Both shredded auto scrap and commercial prereduced iron ore material were continuously charged in each heat into the 0.9 metric ton electric furnace at feed rates ranging from 13.8 to 47.1 kg/min. At the lower feed rates, an open bath was maintained, whereas the higher feed rates resulted in an accumulation of unmelted material in the furnace. Despite the rapid feed rates, neither power surges nor interference of the unmelted material with electrode motion was observed. The effect of choke feeding on total energy consumption is summarized in chart form. In the work described, all energy consumption values were corrected to a temp. of 1600°C. This was accomplished by correcting the tap. temp. to 1600°C, using a correction factor of 0.51 kW-h/degC. it was noted that higher melting rates were attained when both scrap and prereduced iron ore were choke-fed into the furnace. This indicated that the furnace was not utilized at optimum efficiency at the power levels employed when lower feed rates were used to maintain an open bath. Under open bath conditions, more power input is required to keep the bath molten. Coke-feeding is therefore more efficient with respect to the objective of producing quality steel ingots.

Experimental Continuous Electric Melting Furnace. 669.187.25
J.Antoine, J.Astier, and C.Foederer. (Centre Document. Sidérugique Circul. 1975, 32, (2), 669-685)
(in Fr.) Experiment plant for the continuous electric melting of scrap iron or pre-reduced products in a two-stage process is described. In the first stage, melting is completed in a 2700-kW arc furnace, while the second stage involves deoxidation and final adjustments to composition and temp. in a smaller 500 kW furnace. The advantages obtained include the permanent use of max.power, optimum use of the installations, a long lining life, and reduced electrode consumption. Effective control of the amounts of alloying elements and of P, S and O in the steels indicates that the process can be used for various types of C and low-alloy steels.

669.187.25

The BBC-Brusa Method. A New Process for Producing Steel in the Arc Furnace. H.W.Leu, U.Brusa, F.Neumann and R.H.Ptach. (29th Annual Cong. of ABM, Porto Alegre, 1974, pp 29) (in Port). In the BBC (Brown Boverei and Co.)-Brusa Method, the material to be charged into the furnace is preheated by independent nonelectric means and by exhaust gases from the furnace and is then charged and melted. The preheating vessel is a long drum, tilted and revolving on its longitudinal axis, that discharges continuously directly into the furnace. Electrical energy requirements are less than with UHP arc furnaces; melting costs are consequently less. A prototype plant has been operated on a production basis with charges of 100% light scrap or 100% sponge iron. Noise levels in the vicinity of this plant have been measured at 80 decibels, and operation is almost emission-free. A second shop comprising two furnaces to be served by a single charging drum and with a design capacity of 600 000 tons/year of liquid steel is scheduled for initial operation late in 1975. It is designed to permit conventional charging so that heavy scrap can be used when light scrap or sponge iron are not available. Design and construction details of the prototype installation and a layout drawing of the installation under construction are presented. The principles of the method, its advantages and operating results obtained are discussed.

669.187.25

The BBC-Brusa Steelmaking Process. F.Neumann, H.Leu, R.Ptach, and U.Brusa. (Stahl u. Eisen, 8 Jan.1975, 9, (1), 16-23) (in Ger.) Scrap or sponge iron is preheated to 1000°C in a 13 m long rotary kiln furnace using heat transfer from waste gases and the combustion of natural gas. The preheated metal is discharged into a 36 ton capacity electric arc furnace. The meltdown rate is doubled, and the electric power consumption reduced by approximately 200 kWh/ton, compared with conventional arc furnace practice.

669.187.25

The BBC-Brusa Process: A Contribution to the Economical Production of Arc-Furnace Steel. R.H. Ptach, H.W. Leu, and F. Neumann. (Brown-Boveri Rev., Jan-Feb.1975, 62,(1/2), 5-11) Factors leading to the development of the BBC-Brusa steelmaking process are outlined. The basic principle of this process is that continuous preheating of the charge material is combined with arc furnace melting. The preheating system utilizes the heat in the flue gases together with the additional combustion of fuels such as oil and gas. This direct combination of the two process phases allows a continuous flow of material through the heater and hence continuous charging into the arc furnace. The metallurgy of the process and its performance in practice are described and compared with conventional arc furnace techniques, with special ref. to the economics.

669.187.25

New Electric Steelplant and Continuous Casting at the S.A. Cockerill-Seraing. (C.R.M., Mar. 1974, (38), 11-21) MAAS, R., LEGRAND, T. and HAUZEUR, F. A new electric steelplant with a furnace capacity of 80 tonnes, together with installations for high-yield degassing and continuous casting are described. The H_2O requirements of this plant are met by a semi-closed circuit ion-exchange treatment plant.

669.187.25
622.341.1-182

Continuous Charging and Preheating of Prereduced Iron Ore. (Rep.Invest.No.8004,U.S. Dept.of the Interior, Bureau of Mines, Washington,1975,Pp 10) TRESS,J.E. HUNTER W.L. and STICKNEY W.A. The Bureau of Mines has developed a process to utilize waste heat from electric arc steelmaking furnace gases to preheat the ferrous material charged to the furnace. Four heat exchangers were designed, tested and operated successfully on one-ton electric arc furnaces. Briquettes and pellets were charged continuously, both countercurrent to the hot furnace off-gasses and at ambient temp. A comparison of the electrical energy consumed in each situation showed that preheating can lower energy requirements as much as 15.6%.

669.187.25
622.341.1-182

Continuous melting of hot metallized pellets in the electric furnace. (Stal', 1972, (12), 1091-1093; Steel in the USSR, 1972, (12), 974-976) [in Rus./Engl.] KUDRYAVTSEV, V.S., PCHELKIN, S.A. The use of hot metallized pellets as the charge for electric furnaces greatly reduced the consumption of electricity for melt-down and increased furnace productivity. The hydrogen content of the finished metal is less than 0.0004%, that of nitrogen being 0.006-0.009%.

669.187.25:
669.012.57

Continuous EF Steelmaking Process Reduces Energy Requirements. AMM (33/Mag. Met. Prod., Apr. 1976, 14, (4), 38-39)
Pilot-plant tests show that a 40% saving in energy requirements/ton of steel is achieved by continuous melting in a shaft furnace followed by electric furnace refining. Further improvements include continuous electric furnace operation and continuous casting. This KYS Process can be operated with light or heavy fuel oils and possibly pulverized or slurried coal. It can be compatible with the BOF process while permitting use of more scrap and less pig.

669.187.25
669.046.512

Optimization and Programming of the Electric Steelmaking Process by Computer. A. Maitre and P. Moreau. Centre Document. Sidérurgique Circul. Inform. Techn., 1975, 32, (3), 599-609 [in French].
After reviewing the electrical characteristics of the furnace and the optimum use of the energy of the arcs, a working cycle is established for melting the metal. Optimization consists of melting in a min. time using optimum power in the charge, consistent with a reasonable lining wear and an allowance made for the heat losses in the system. Optimization is also applicable to charging, refining, the calculation of additions, and casting. BA

669.187.25:
669.181.4

Continuous Melting of Iron Sponge in a Ten-Ton Electric Arc Furnace. (Stahl u. Eisen, 20 Dec. 1973, 93, (26), 1251-1255) (in Ger.) EISERMANN, E. et al. The effects of various proportions (20-70%) of sponge iron charged using the Contimet process in a 10-t electric arc furnace, on power consumption, productivity, feed rate and operating costs were investigated. Up to 45% sponge iron reduced power consumption, relative to 100% scrap operation. Max. productivity was found using 25% sponge iron additions. The output rate was improved by 34% over scrap operation, and this led to an 11% reduction in operating costs. The specific feed rate was 30kg sponge iron per MW. min (1.8kg/kWh).

669.187.25:
669.181.4

Electric furnace melting of pre-reduced charges (Steel Furnace Monthly, Oct.1973, 8, (10), 565-567) MANNARSWAMY, T.V., PARANJPE, V.G., Trials, to gain experience in sponge-Fe melting, are reported. The central-hole continuous-charging technique, suitable for the 10-ton arc furnace employed, was chosen for simplicity, with 25-60% of sponge Fe in the charge. This was successfully melted without damage to the roof, and feed rates of 30 kg/MW.min were achieved. Periodic rabbling of the bath was necessary under the test conditions, and power consumption was comparable with that in all-scrap melting.

App. 8
(ref. para 13)

INFORMATION PROFILE ON CONTINUOUS CASTING

Continuous casting may be called more a technology of the future than of the present. There is no doubt that this technological breakthrough of the recent decades will gain further momentum in development, as more and more plants with even larger capacities come into existence after the teething troubles that still plague the technique are over.

This concise profile on continuous casting covering some 115 items divided into six sections offers a glimpse into the world of continuous casting from the available in-house material and external material to which access could be had.

The profile items cover the period 1971-1976, when a lot of work has been done in the area of extending the process to different type of plants and products - increasing their capacity, output range and sophistication - and these are fully reflected in the items that are presented here. As far as possible, the items selected have been made representative in geographic distribution, state of technology and developmental prospects.

The first section deals with the continuous casting process and practice in general - the emphasis being on various experimentations and trials in this area. Items 2 (p.1), items 1,2 and 3 (p.2), item 2 (p.3) and others give a very able summary of the historical developments of the process and its future trends. The remaining items in this section deal with the experience of the process in different plants and countries and the problems and promises of the adaptation of the process under varying circumstances.

The second section containing 26 items spread over 8 pages, deals with the technical aspects of the process details in precise areas. For instance, item No. 3 (p.8) deals with continuous casting of beam blanks, item 2 (p.9) that of long products; item 1 (p.10) of 09G2 steel; item 1 (p.13) continuous casting of steel in the German Democratic Republic and item 2 (p.14) the manufacture of fine profiles of pipe semis from continuous ingots.

Sections 3 and 4 deal with specific products: section 3 with billets and section 4 with slabs. They give an insight into the problems in specific product areas and how these problems are being tackled.

Continuous casting plants - individual or integrated into steel plants - claim the 5th and the largest section of the profile spread over 12 pages. (38 items). The plants cover a wide range of types, locales, products, etc., and the details give a good bird's eye view of the status of the operating technology as it prevails now.

The profile concludes with an investment and cost section, which gives investment and operating cost data from seven countries and also by process and product. The estimates, although indicative, give an idea of the magnitudes involved, and provide a basis for comparison, which, it is hoped, would be found useful.

Contents

621.746.047

Wood, J.F.B. Regan, P.C.

The Hazelett continuous casting process – innovations and new applications of the endless moving cold mould (Iron Steel Eng., 1971, 48, Dec., 47-42).

The basic features are given of the two endless moving metallic belt configuration the results of research and development in this continuous casting technique are briefly reviewed and details of new design concepts and features are outlined. Th development of a nine wheel-belt caster is also described.

621.746.047

Thornton D.R.

Continuous casting process (Steel Times, 1972, Jan., 99 - 105)

The history and development of continuous casting is briefly reviewed and the design of various types of continuous casting machines is discussed with examples. The technical aspects examined are the control of liquid steel temp and teeming rate, and factors affecting casting rate and the rate of billet withdrawal (9 refs.)

621.746.047

Thomson, R. and Ellwood, E.G.

Closed-head continuous casting Part 1- process and applications. British Foundryman, Vol.65, Part 4, April, 1972, p.133

In the first of three papers on closed-head continuous casting from graphite moulds, a perspective view is taken of various commercial casting process from the stand points of range of application, operation, productivity and design. The use of intermittent withdrawal is discussed with reference to mould reciprocation, and data is presented on the casting rates obtained in the T.R.I., = Flocast and wortli casting process. Subsequent contribution will deal with the experimental investigation of mould/billet interactions, the effect of intermittent withdrawal on castability, and the solidification and heat transfer rates obtained in water-jacketed graphite moulds.

621.746.047

Bruderle, W., Schiefer, P., Weber, W.

Dynamic problems with melt emissivity control of a continuous casting plant. Mannesmann Forschungsber., 1972, (602), 1-10). (in Ger.)

Automation of a continuous casting plant poses certain difficulties, especially as regar control of the level of molten metal in the mould. The authors explain the development (on an analogue computer) of a circuit for controlling melt level governed by emissivity from the melt, including use of a scintillation counter for measuring radiation from the molten steel in the mould. Other topics discussed include influence of ferrostatic pres in the ladle, electrohydraulic drive and specific difficultiesxpress in development of a completely automatic system. (10 refs.)

621.746.047

Cox, R.J.
Continuous casting – a broad look. (Ind. Process Heating, 1972, Nov., 18–20)

Process developments are briefly outlined. Over the last few years there has been a great growth in the use of the process, although Bethlehem Steel Still will not use it. Companies producing equipment are mentioned BSC produces only 1.85% of steel by this method but by 1974 it is expected that the figure will be nearer 17%.

621.746.047

Tarmann, B.
Continuous casting development. (Iron Steel Eng., 1972, 49, Dec., 61–67).

The present state of continuous casting is discussed and the curved and straight mould designs are compared. Future trends in terms of higher capacities, i.e. higher casting speeds in the case of slab casting, are considered. The problem of non-metallic inclusions in continuously cast materials is mentioned and the manufacture and maintenance of moulds are also briefly referred to. (13 refs.)

621.746.047

Galo, W.K.V.
The Continuous Story of Continuous Casting. (Brit. Steel, Summer 1974, (25) 10–15)

The development of continuous casting is traced from Bessemer's patent in 1857 through the Junghans process and British applications culminating in the construction, in 1964, of the Shelton steelworks relying solely on continuous casting techniques. The cut-off apparatus, the curved-mould method, and other advances are illustrated and discussed, and possible effects of continuous casting on future steelmaking process and vise versa are considered. Locations of, and technical data on, continuous-casting plants in the U.K. are presented.

621.746.047

High Speed Continuous Steel Casting. Gerd Vogt and Klaus Wünnenberg. Stahl u. Eisen, 23 May 1974, 94, (11), 462–473 [in German and English].

The results of experimental investigations, and theoretical considerations of high speed continuous casting relating particularly to the processes occurring in the mould, mould support, billet drive and cooling system are discussed. Measures to further increase the output of such plants are considered, and the suitability of various plant designs are related to constructional requirements and quality considerations. 13 ref.—P. V.

621.746.047

Something entirely new in continuous casting

J. A. Botta, Jr.,[1] Koppers Co., Inc., Pittsburgh, Pa.

J. L. Zalacain Beloqui,[2] Metaldom, Santo Domingo, Dominican Republic

An entirely new type of continuous casting machine was developed for Metaldom to meet its specific requirements, both for product and available space. This new machine concept turned out to be a revolutionary approach.

Iron and Steel Engineer July 1974

621.746.047

Continuous Casting—Present Situation and Future Prospects. Jobst-Thomas Wasmuht. Present and Future Technology of Steel Fabrication in Latin America, 1974, 195, 197-205 + 10 plates (Met. A., 7505-72 0081) [in Spanish].

Developments that permit the application of the continuous casting process to steels having special requirements with respect to mechanical properties and purity, process automation, increased casting speeds, shorter set-up time, methods of facilitating sequential casting and direct reduction of the continuously cast bar are discussed and their impact on ease of operation, metal quality, productivity and/or operating costs is noted. 14 ref.—S.M.

621.746.047

The Tundish in Continuous Casting: Its Incidence on the Cost of Processing Steel. Juan A. Vallomy and Eduardo N. Ivusich. Siderurgia, July-Sept. 1975, 2, (5), 73-90 [in Spanish].

Changes in the design of tundishes and particularly of their refractory linings have had a favourable impact on refractory consumption and hence on the cost of processing steel in the continuous casting unit at the plant of Dalmine Siderca in Argentina. The tundishes described and illustrated are used on a four-strand machine producing billets ~75 mm square.—S. M.

621.746.047

Incorporation of Continuous Casting into BOP Steelmaking Plants. Fritz Willim. Stahl u. Eisen, 27 Feb. 1975, 95, (5), 169-175 [in German].

The introduction of continuous casting strands into BOP steel-making plants is discussed with particular emphasis to the material flow rate and the general plant and auxiliary transportation layout. Suggestions are made in respect of plant design to provide the most satisfactory operation.—P. V.

621.746.047

Basovi, S.

The Present Position and Future Prospects of Steelmaking by Continuous Casting (Met. Ital., Jan. 1975, 67, (1), 18-20) (in It).

The advantages of continuous-casting procedures in rationalising steelworks plant layout and increasing capacity are described and the differences between the four principal casting systems compared. Examples are given of detail improvements in casting-machine design being introduced, and of improvements likely to be made.

621.746.047

Continuous Casting Update. Charles R. Taylor. Metall. Trans. B, Sept. 1975, 6B, (3), 359-375 [in English].
A critical survey is presented of the available information on primary and secondary cooling of continuous cast steels. The effects of the cooling on solidification constants and their validity in mathematical modelling is discussed. The function and mode of mould lubrication are reviewed. The important effects of the various parameters and of liquid metal handling procedures on the internal and external quality of strand cast billets and slabs are described. 46 ref.—H. B. C.

621.746.047

Continuous Casting Developments. ——. [BSC] Steel-research, 1975, 17-19 (Met. A., 7600-72 0162) [in English].
Recent advances in continuous casting practice are discussed. The control of the temp. of the liq. steel by gas flushing is described. Methods of deoxidation control and refractory developments are discussed. Studies of heat transfer have led to a better understanding of the development of thermal stresses and attempts to reduce these stresses below the YP of the mould material are discussed. Factors influencing the effect of secondary cooling are considered and a spray control system is described. Finally, research into the cause and remedy for longitudinal facial cracking and internal centreline cracking is described.—R. E.

621.746.047

Continuous casting: a local viewpoint

Iron and Steel International, June 1977

W.K.V. Gale

p169

Continuous casting has been the subject of discussion at numerous conferences and meetings throughout the steel world. The keen interest in this rapidly growing process was seen at a UK conference, 'Continuous casting for the Midlands', held earlier this year at Bilston, West Midlands. Organised jointly by the Metals Society and the Staffordshire Iron and Steel Institute, this one-day event attracted over 200 delegates from Britain and abroad.

Matsumoto, T. et al 621.746.047(52.9)

Continuous casting at Fukuyama Works, (Nippon Kokan Techn. Rep. Overseas, 1972 Dec. (5), (15) 23-41).

The first part of this report presents reviews and examinations made in selecting the type of caster in the design stage and the problems involved. The next part of the report describes the details of sequence casting, in which charges are joined together without interruption by changing the tundish. Finally, the product quality is dealth with.

The specifications of the three large-sized continuous-casting machines are described, and cross-sections through two casters are depicted. The machines cast steel slabs of different grades for sheet strip and plate production. Details are given of operation practices with regard to C-and high-strength steel for plate and also for deep-drawing Al-killed steel production. Both internal and surface slab quality are considered, and the effects of changes in composition on material quality are mentioned. The mechanical properties and microstructures of low-C steel and high-strength steel plate and cold-rolled steel sheet are discussed.

621.746.047(52.9)

Matsumoto, T. et al

Continuous casting nf at Fukuyama Works. (Nippon Kokan, 1972, (57), 429-453). (in Jap.)

The continuous casting facilities of the Fukuyama Works consist of three large continuous slab casters of a heat size of 250 tons capable of producing three million tons annually. These casters are separated from the BOF and ingot casting buildings so as to permit casting operations independent of the other operations. There is a slab conditioning line behind the casting facilities; molten steel from BOF is treated on a fully continuous line from casting, slab-making up to conditioning. In operation, the practices include twin casting of slabs for sheet and strip, high speed casting at 2m/min max. and many other distinguished features. Products cover almost all the grades for plate and sheet, and high quality products for various uses are being cast from different grades from high strength steels up to deep-drawing quality aluminium killed steels.

621.746.047(59.0)

Bhongbhibhat. G.,

Continuous Casting Practice at SISCO. (SEAISI Quart., July 1973, 2-3, 6-11)

Continuous casting has replaced conventional ingot casting at a Thailand steel mill because of the lower investment cost, reduced space requirement, automated operation, more homogeneous product and higher yield of semi-finished products. Descriptions of the casting machine, steel structure cooling chamber, steam exhaust second cooling, chamber, tundish and tundish car, heating and tilting station, tubular mould, mould guide and drive, strand guide, pinch roll straightener, dummy bar and shear are given. The installation produces 300 kg billets for a new rolling mill.

621.746.047(4

do la Vega Tejenina, Fernandez Avila, J.

The continuous casting unit of Ensidesa (Aviles works). (Rev. Met., 1973, 70, Feb., 175-192). (In Fr. and Engl.)

The paper describes the commissioning of the oxygen melting shop and continuous casting plant at the Ensidesa (Aviles) works.

Sigler I., Schmidt G.E., and Turek J.R. 621.74.047(73)

Continuous Casting at McLouth (Steel Corp.) (AIME Open Hearth Proc., 1973, 56, 52-71, discuss 72-73)

The pilot-plant operations to cover the transition from ingot steel casting to continuous casting are described, including details on major problem areas where solutions were achieved and those that have not yet been fully resolved. Techniques were developed for casting Al-killed, rimmed the stainless steels. Set-up, equipment and operation of the commercial plant are described in detail. In discussion, the operations were compared with those at Inland Steel Co., and a number of questions were raised.

621.746.047(81)

Continuous Casting Practice at Siderur... a M. Dedini. José Waldemire Macari. Present and Future Technology of Stee Fabrication in Latin America, 1974, 215, 217-224 + 8 plates (Met. A., 7505-72 0081) [In Portuguese].

The three-strand Concast machine at the Dedini steelworks, Brazil, the operating practice developed between 1968 and 1972 and results obtained are described. The machine casts square bars from 75 to 125 mm on a side from C steels with C contents from 0.10 to 0.90 that have been processed in electric arc furnaces. Tundish and ladle nozzles and the tundish lid used to replace the original components, life of tapered and straight-side moulds, metallurgical quality and mechanical properties of products, causes and prevention of metallurgical defects and operating costs as compared with those of conventional casting are among the topics covered.—S.M.

621.746.047(914)

RAMON NAVARO

The Operation of Continuous Casting Machine at Philippines Blooming Mills Co. Inc.

Presented at the SEAISI Manila Seminar Philippines 1976

P 63

621.74.047
62-982

A Process of Continuous Casting Under Vacuum, by C. Gui-chard and J. C. Soret, *Mem. Sci. Revue De Metallurgie* (French), 1973, Vol. 70, No. 9, pp 577–593. Process of com-bining vacuum degassing and refining with continuous casting as a continuous vacuum treatment-casting system. Present use of process for production of uranium bars, but readily ap-plicable to steels and nonferrous metals and alloys. General advantages of continuous casting and aims of vacuum treat-ments; drawbacks of discontinuous vacuum processes. De-scription of the CCV (continuous casting under vacuum) pro-cess where a continuous vacuum process is developed with the use of a dynamic vacuum lock system of successive chambers with stepped pressures. Casting machine and gen-eral CCV process layout. Continuous casting train—secon-dary cooling and cutting in air. Casting a composite strand (uranium with a graphite core). Description and operating characteristics of various sections of the system. Control mechanisms. Operating cycle for uranium, with and without a graphite core. Results obtained. Economic considerations. Discussion. (Brutcher HB 9200—$19.50)

621.746.047
621.365.2

Cockerill instals an 80 tonne electric furnace at Seraing and plant for degassing and continuous casting. *(Cockerill-Cugree-Providence, 1973, 24, (172), 4-8)* [in Fr.]
LEGRAND, T. After a preliminary explanation of the reasons for considering a new steelworks necessary, the author gives detailed descriptions of the ASEA ultra-high power furnace, dust control and degassing plant, and the continuous casting machine. The last-named has been built by Schloemann under licence from Concast. Its maximum calculated capacity is 18000 tonnes of blooms per month. The output of steel is intended for the forging, foundry and special steels division of Cockerill and also for its subsidiary, Usines a Tubes de la Meuse. The new steel works draws its water supplies from the river Meuse and has erected a large installation for filtering, softening and decontaminating the water.

621.746.047
621.744.074

United States Steel Corporation

Water cooled mould for continuous casting metals. Government of India Patent specification No. 92875.

According to the present invention, we provide a water-cooled mould in which opposite side walls and end walls define an open ended cavity extending in vertical direction for continuously casting metal wherein each side wall comprises an inner plate supported by a backing structure spaced outwardly there from by flexible staybolts distributed over the outer face of each structure and permitting thermal movement of said plate in respect of the backing structure, the spacing between said inner plate and backing structure providing a cooling passage between laterally spaced vertical edges of the backing structure in sliding engagement with the inner plate, each end wall being disposed between the inner plates of the side walls and determining the spacing of the opposite side walls, and means being provided yieldingly forcing the side walls toward each other.

621.746.047
621.771.

Continuous Casting as a Process Between Steelmaking : Finish Rolling, by W. D. Liestmann, *Stahl und Eisen*, man), 1975, Vol. 95, No. 1, pp 23-27. Merits of direct ca. of molten steel in dimensions suitable for feeding into ishing mills as a high-yield continuous process; devel ments in recent years. Demands of wide-strip hot mills, pla mills, heavy, medium and small-section mills on layout of th continuous casting plant and the melt shop. Extent of conditioning of slabs and billets. Possibility of coordination between melting unit and continuous casting plant; slab casters. Theoretical increase in output with increasing casting speed and sequential casting. Working cycle between furnace, conti-casting plant, and ingot-casting shop; limitations of tapping weight for billet casting plants with two, four and six strands depending on edge length and a given casting time of ladle. Future developments of plant and process engineering. (Brutcher HB9488-$18.00)

621.746.047:
621.771.252

Continuous Casting and Rolling of Metal Wire Rod. Herbe Berendes. Wire World Int., Mar.-Apr. 1976, 18, (2), 62-64 [in English].

Alternative methods for the continuous casting of wire rod are con ed and details given of the Krupp-Hazelett continuous-casting belt. The advantages are high output of ≤ 55 tonnes/h, which matches the throughput capacity of conventional wire-rod mills, without loss of quality. The rate of fracture when drawing unshaved material to s dia. is reduced.—P.C.K.

621.746.27:
621.771.26

Continuously Cast Beam Blanks, by W. Puppe and H. Schenck, *Stahl und Eisen*, (German), 1975, Vol. 95, No. 25, pp 1238-1243. Development of continuous casting installations for heavy sections other than round, oval, octagonal, and rectangular in shape. Outcome of preliminary trials: a smaller number of passes required in the rolling mill; higher yields; fewer strand cross-sections for a comprehensive beam production program; and good technological properties of the beams. Data on dimensions, areas and weights of continuous casting blanks and beams; reductions/pass for roughing and finishing mills at a Canadian plant. Sectional shapes for static and continuous cast semis. Curved mold casting plant for shaped strands. Arrangement of backing rolls and cooling water nozzles. Roll stand arrangement downstream of the reheating furnace. Capital investment and processing costs calculated on basis of four different models. Comparative processing costs for static and continuous casting; advantages of the latter. (Brutcher HB9707-$22.00)

621.746.047
669.1-422

Continuous Casting of Iron Ups Quality, Lowers Costs. T.C. DuMond. Iron Age, 6 Sept. 1976, 218, (10), 41-42 [in English].

Continuous casting is used to produce Fe bar stock in dia. from 3/4 to 20 in. The process also can be used to produce a range of shapes within these same dimensional limits. By specifying shapes which closely approx. the final part contour, considerable machining time and expense can be saved. The as-cast structure is extremely fine-grained, even when large cross-sections are involved, and the castings are completely free of internal shrinkage and open grain structure. The mechanical properties developed in continuously-cast grey Fe are generally superior to those normally obtained in static *sand castings*. Hardnesses compare with those of sand castings, ranging from 180 to 220 HB. Other irons show hardnesses up to 360 HB, depending upon composition. Presently continuous casting of Fe is limited to grey and ductile types as well as the Ni-Resists.

621.746.047
669.14

Continuous Casting of Steel. Long Products. High-Outp. Plant, by J. Barbe. *C.D.S. Circ.* (French), 1972, Vol. 29, No. 4, pp 1025–1034. After a general review of present and future design features, plant capacity is discussed with special reference to production range, casting speed, number of strands and availability. (BISI 11998 - *$12.50*)

621.746.047;
669.14 -

Continuous Casting of Steels: Characteristics of the Proc[illegible] and Design of Molds. Ulysses Sousa Patto; Odmar Sim[illegible] Pires and Mauricio Prates de Campos Filho. Metal. A[illegible] Apr. 1975, 31, (209), 249-255 [in Portuguese].

An analytic method for determining the optimum length of a mould [illegible] the continuous casting of steel is proposed. It is based on the hy[illegible] thesis of the cumulative effect of the thermal resistances of the [illegible] mould system on solidification times. The use of the method is *exemplified by considering the case of a cooled mould for mild st[illegible]* Descriptions and diagrams of the three main types of continuous ca[illegible] ing machines and a discussion of the basic features and functions [illegible] their principal components precede the proposal of the method. 26 ref.—S. M.

621.746.047;
669.14

The Present State and Trends in the Continuous Casting of Steel. A.P. Savchenko. Stal', Jan. 1976, (1), 27-31 [in Russian].

Experiences in the continuous casting of steel with particular ref. to its development and present practices are considered. Future developments involve increasing the efficiency of the process, and accelerating the casting speed up to 1.5-2 m/min. Vertical-type installations are of limited value, and a high-output curved-mould installation for processing 350 tonne heats is described. To enable high casting speeds to be attained, strict quality control over the molten steel is essential. When planning a continuous casting layout, the juxtaposition of the casting section and the rolling mills to ensure the most rational transportation of the cast billets to the mills must be taken into account.—J. W.

621.746.047:
669.14

51 0768 Continuous-Casting Practice for the Production of 09G2 Steel. V. G. Osipov, A. M. Kondratyuk, D. A. Dyudkin, S. P. Efimenko, and A. A. Kurdyuko. Stal', Apr. 1975, (4), 310-313 [in Russian].

Improved pouring conditions, casting quality, and mechanical properties were achieved in a continuous-casting plant producing 09G2 steel plate. These advantages resulted from a progressively improved deoxidation practice and the provision of a protective coating of amorphous graphite, of known ash content over the surface of the molten metal. The initial deoxidation involved the addition of Mn 12.9, silico-manganese 10.7, calcium-silicide 3.0, Al 0.3, and ferro-titanium 1.0 kg/ton. This was superceded by additions of Mn 5.2, silico-manganese 20, Al 0.3 and ferro-titanium 1.5 kg/ton. Finally the Al was increased to 0.7 kg/ton. This last practice ensured an impact strength ≮ 3.0 kg. m/cm² at −40 °C in 10-20 mm thick plate in the hot-rolled condition, and ≮ 5.0 kg. m/cm² in the normalized condition, at −70 °C.—J. W.

621.746.047:
669.14

The Outlook for the Development of the Continuous Casting of Steel. D. P. Evteev. Stal', May 1975, (5), 418-421 [in Russian].

A marked expansion in the amount of steel made by continuous casting basic O steelmaking plants is envisaged, and means whereby this aim can be achieved are considered. Increasing casting speeds and improved production and handling techniques between the continuous casting machines and the rolling mills are amongst the factors discussed. Extending the process to the casting of hollow billets, for subsequent processing into seamless pipes and tubes, and increasing the range of sizes, shapes, and qualities that can be made will ensure that the process will occupy an increasingly prominent position in the steel industry.—J. W.

621.746.047:
669.14

Improvements in the Continuous Casting of Steel. R. Alberny, J.-P. Birat, and A. Leclercq. Cent. Doc. Sidér. Cir. Inf. Tech., 1975, 32, (11), 2409-2421 [in French].

The improvements made possible by analysing different functions of continuous casting installations are discussed. Techniques were developed for controlling the melt temp. and the deoxidation. Ingot moulds can be improved, giving them better resistance to deformation and assuring solidification of a more uniform skin. Electromagnetic stirring is an efficient means of improving solidification conditions and the axial properties of billets. 13 ref.—J. M. S.

621.746.047:
669.14

Continuous Casting of Steel. Simeon A. E. Buxton. Steel Furn. Mon. (Calcutta), Mar. 1976, 11, (3), 125-126 [in English].

The continuous casting process is compared with the traditional method and the advantages of the former are pointed out. These are more consistent quality, greater production yield, and reduced cost.
—W. J.

621.746.047;
669.14

Croce, M.

Continuous or ingot casting of steel. (Danieli and Co: Mini-steel plants. Symposium held in Buttrio, 14-16 Oct., 1971, Preprints, pp.8) (in Ital)

The basic principles and operation of the two alternative methods are described and a comparison of their characteristics is presented. The quality of continuously cast billets is better than that of ingots but their casting requires greater care. Whereas the yield of ingot casting is 83 to 92% the corresponding figure for continguous casting is 95 - 98%. The substitution in the rolling mill of small ingots by continuously cast billets has been found to result in an increase of mill productivity by 14 - 26% and in a simultaneous substantial improvement of the rolling yield. Where labour cost for the two processes is approximately the same the cost of materials and energy to transform 1 ton of liquid steel into ingots is approximately £0.90 as against £0.55 for transformation into continuously cast billets. (Both examples for a 35/40 ton furnace operation based on present Italian Prices). Particular aspects of continuous casting are discussed such as, sequence casting, reduction of section during casting and continuously cast billets with the mechanical characteristics of rimming steel.

621.746.047;
669.14

Petersen, U.

Continuous casting of steel - actual and future aspects (Steel Furnace Monthly, 1971, 6, Oct., 448-457).

An outline is given of the state and future development of continuous casting of steel based on development work and experience in the continuous casting machines of Mannesmann. The different types of continuous casting machines in operation are discussed as well as breakouts, mould construction, strand cooling, powder casting and scarfing questions. Further discussions touch upon the advantages of continuous casting with regard to steel quality, yield, material flow, possibilities of rationalization and the integration of continuous casting machines in steel works. Other developments deal with the questions of automation, future designs of continuous casting machines and the casting of hollow strands for the fabrication of seamless tubes.

621.746.047;
669.14

Tarmann, B. and Assinger, G.

Continuous casting of steel, trends in development and application. (Bänder Bleche Rohre, 1972, 13, Dec., 605-613). (In Ger.)

Continuous casting is the process of becoming one of the dominating production methods in the steel industry mainly for slabs rolled to plate and strip. Continuous steel casting is also extensively used by mini steel works concentrating on smallsection-steel rods and wire. Lately this process is also employed for supplying blooms and billets as basic material for channels and other rolled section. Developments are chiefly concentrated on increasing the productivity per casting strand.

621.746.047:
669.14

Petersen, U.

Continuous casting of steel - actual and future aspects. (I.S.I. of Japan. Proc. Int. Conf. on the Science and Technology of Iron and Steel. Tokyo, 7-11 Sept. 1972, Part 1, 244-247).

An outline is given of the development of the continuous casting of steel, based on long standing development work, and experience with casting almost 5 m tons of steel produced in the continuous casting machines of Mannesmann. The different types of continuous casting machines in operation today are discussed as well as breakouts, mould construction, strand cooling, powder casting and scarfing questions. Further discussions touch upon the advantages of continuous casting with regard to steel quality, yield, material flow, possibilities of rationalizatio and the harmonic integration of continuous casting machines in steel works. Final views on future development deal with questions of automation, future design of continuous casting machines and the casting of hollow strands for the fabrication of seamless tubes.

621.746.0
669.14

Baumann, H.G.

Contribution to the continuous casting and processing of steel. (Draht-Welt, 1972, 13, June, 319-327). (In Ger.)

Processes for the continuous casting of steel, continuous casting with in-line rolling and high-reduction rolling are described. High-reduction trial rolling operations with swinging rolls are discussed. Trial operations were made with the object of examining the behaviour of corners and surfaces, material flow and internal soundness of steel during high-reduction rolling. The results of such trial rolling operations are reported.

621.746.047:
669.14

Taylor, C.R.

Continuous Casting Update. (Metall. Trans. B, Sept. 1975, 6B, (3), 359-375)

A critical survey is presented of the available information on primary and secondary cooling of continuous cast steels. The effects of the cooling on solidification constants and their validity in mathematical modelling is discussed. The function and mode of mould lubrication are reviewed. The important effects of the various parameters and of liquid metal handling procedures on the internal and external quality of strand cast billets and slabs are described.

621.746.047:
669.14

Doring, K.

Development of the Continuous Casting of Steel in the German Democratic Republic. (Neue Hutte, May-June 1975, 20, (5/6), 334-338) (in Ger.)

Continuous casting in the G.D.R. from 1951 to the current large scale production of steels for various purposes is recorded with notes on the various difficulties encountered and overcome. Projected extensions of the process are considered.

621.746.047;
669.14

Savchenko, A.P.

The present state and trends in the continuous casting of Steel. (Stal, Jan. 1976, (1), 27-31, (in Rus.); Steel in the USSR, Jan. 1976)

Experiences in the continuous casting of steel with particular ref. to its development and present practices are considered. Future developments involve increasing the efficiency of the process, and accelerating the casting speed up to 1.5-2 m/min. Vertical-type installations are of limited value, and a high-output curved-mould installation for processing 350 tonne heats is described. To enable high casting speeds to be attained, strict quality control over the molten steel is essential. When planning a continuous casting layout, the juxtaposition of the casting section and the rolling mills to ensure the most rational transportation of the cast billets to the mills must be taken into account.

621.746.047
669.14

Buxton, S.A.E.

Continuous Casting of Steel. (Steel Furn. Mon. (Calcutta), Mar. 1976, 11, (3), 123-126)

The continuous casting process is compared with the traditional method and the advantages of the former are pointed out. These are more consistent quality, greater production yield, and reduced cost.

621.746.047:
669.14-14

The Present State of Continuously Cast Steels. Hubert Löwenkamp. Technology of Special Steels, 1975, K/1, K/3-K/18; discussion, 1 p (Met. A., 7610-72 0161) [in Spanish].
A comparative study of surface condition, internal porosity, segregations, purity and mechanical properties in continuously cast special steels and special steels cast in conventional ingots shows that the former are equal to the latter in quality and are even better in some cases. Most of the evaluations concern steel Ck 45, and a few pertain to steels Cf 53 and 34 Cr 4; carburizing steels and bearing steels are also mentioned. A comparison of the structure and mechanical properties of specimens taken from crankshafts forged from continuously cast Ck 45 steel and Ck 45 ingot steel showed no differences save for reduction in area, which was slightly higher in the continuously cast material. A list of automotive parts forged from continuously cast steels shows the type of steel in each case. The continuous casting installation for special steels at the Röchling-Burbach plant in Völklingen, GFR, is briefly described. This plant produces spring steels, C and alloy structural steels, and C and alloy tool steels in the form of square billets 240 mm on a side.—S.M.

621.746.047:
669.14-412

Manufacturing Fine Profiles of Pipe Semis from a Continuous Ingot. I. S. Zhordaniya, V. P. Bulgakov, and G. A. Dzigvashvili. Metallurg, May 1976, (5), 30-31 [in Russian].
The effect of initial structure and defects in continuous ingots from St 10, St 20, St 35, St 45, and D steels of 220 × 280 mm in cross-section on the quality and properties of pipe semis, was investigated. Taking into account the occurrence of fine cracks in the intermediate zone and the central porosity in a continuous ingot, a rolling scheme was determined enabling pipe semis of 110-120 mm in dia. of a reasonable quality to be obtained.—L. G.

621.746.047
669.14-412

Allyn, J.B. MacDougall, A.

The Hazelett continuous casting process - Operating practice, continuous pressure pouring and Hazelett casting at Oregon Steel Mills (Iron Steel Eng., 1971, 48, Dec., 52-55)

Some of the initial operating problems and successful improvements made to the casting facility are described and the advantages of the pressure pour furnace are described. The performance is stated to be excellent. Max. casting speed was 6 fpm for 5½ x 10in billets and 9 fpm for 4 x 8 in. billets. The production rate was 66 - 88 tons per 8 h shift and the product quality stated to be good with little internal centre line porosity and few te

621.746.047:
669.14.018.2/8

Production of Special Steels in the Continuous Casting Process. J. Thomas Wasmuth. Technology of Special Steels, 1975, 1, 3-18; discussion, 1 p (Met. A., 7610-0181) [in Spanish].

A partial survey of the production of special steels by continuous casting cites producing firms throughout the world, types of steel produced by each, production problems, successes with products deemed unlikely candidates for the continuous casting process, failures with others, and advantages provided by the use of techniques such as submerged casting, vacuum degassing, electromagnetic stirring and refining by the AOD and VOD processes. Categories covered by tables and text are: C and alloy steels contg. <0.25% C, C and alloy steels contg. >0.25% C, free-cutting steels, leaded steels, fine-grain steels, 1% Cr steels, steels contg. additions of Ca, Si steels and stainless. —S.M.

621.74.047
669.14.018.252.3

Continuous Casting of High-Speed Steels. Jerzy Sulkowski, Henryk Szwej, and Jan Labus. Wiad. Hutn., June 1975, 31, (6), 201-204 [in Polish].

Results of investigations concerning causes of defects in continuous high-speed steel ingots are discussed. Lower tapping temp. and somewhat higher casting rate reduced the frequency of surface porosity which was the principal defect. Optimum amount of oil for mould lubrication was also determined. 8 ref.—AA

621.746.047:
669.14.018.8-412

Experience With the Continuous Casting of Stainless Steel Slabs. I.—Continuous Casting Performance at Shunan Works, II.—Details on BOF-VAC-CC Practices. III.—Results Obtained With Austenitic, Ferritic and Martensitic Stainless Steels. Y. Nakano *et al.* Tetsu-to-Hagané (J. Iron Steel Inst. Jpn.), 1973, 59, (11), S335-S337 [BISI Translation No. 9232]

The plant facility at Shunan Works for manufacturing wide-slab continuous casting, austenitic, ferritic and martensitic stainless steel is described. The adapting of the continuous casting machine for production of stainless and the efficiency of the process are discussed. This continuous casting and steelmaking method, called BOF-VAC-CC, is compared in detail with the conventional ingot production and is proven advantageous in quality and efficiency.—D.R.

Billet Casting at Malayawata Steel

POH KIM SENG
MASAAKI TAHARA

The economics of continuous casting at Malayawata Steel has always been a major factor. It was therefore necessary to develop continuous casting within the framework of the existing roll design and mill practice. Thus size and weight of cast billet had to be comparable with the established practice on small ingot pouring. It was found that 100 x 100 mm billets were ideal sizes from which all the required small diameter bar sizes could be produced on the existing mill rolls and pass designs. Because it is possible for the mill to roll a given bar size from billets or ingots, this in turn means that the B.O.F. shop can pour either billets or ingots and produce usable tonnage.

The basic economic advantage of continuous casting to any steelmaking operation is an increase in yield of finished product from a given billet weight. In most instances this yield appears to be 90 to 92 percent of billet weight which represents a sizeable gain in yield over fully killed small ingot practice.

In the case of a plant such as Malayawata which produces small ingots for direct rolling, cast billets offer certain other distinct economic prospects.

(i) An improvement in product quality.
(ii) An increase of productivity in rolling mills.

SEAISI Quarterly April '76
p35-42

Start-Up of a Continuous Casting Machine. Emilio Menzel, Eduardo Andrés Guida and Roberto Villanueva. Present and Future Technology of Steel Fabrication in Latin America. 1974, 207, 205-214 + 1 plate (Met. A., 7505-72 0031) [in Spanish].
A three-strand continuous casting machine installed at the Aceros Bragado plant in the city of Bradado, Argentine, for the production of 75 × 75 to 140 × 140 mm billets of killed C steel is described. The major problems during start-up and the first year of operation and subsequent operating practice are discussed.–S.M.

52 0522 Laboratory Work with Continuously Cast Billets. Lajos Tóth and Károly Pintér. Neue Hütte, Feb. 1974, 19, (2), 83-85 [in German].
Work is described using a small rolling mill to determine the most suitable reduction programme to secure acceptable levels of mechanical properties in rolled bars made from 0.22, 0.28 and 0.68% C steels continuously cast in billets. Graphs showing the effects of degree of reduction on longitudinal and transverse mechanical properties are given. 7 ref.–J.D.H.

621.746.047;
669.14-412

Johnson, D.

Concast plants in Europe. (Iron Steel, 1972, 45, Aug., 420-421).

A number of continuous casting plants for billets, blooms and slabs have recently been designed and installed in Europe by Concast AG and associated companies. This article brieflymm outlines the design, construction, capacity and function of some of these plants.

621.746,047; 669.14-41

Mulhauser, R.S., Lamar, C.C.

Continuously cast high quality coarse-grain and fine-grain billets (Iron Steel Eng., Dec. 1973, 50, (12), 48-53)

Carbon steels with 0.05-0.70% C are continuously cast into high-quality coarse-and fine-grain billets on a four-strand casting machine with straight $7\frac{1}{2}$ in. moulds. An in-line rolling mill can reduce the as-cast bloom to 6,5 or 4-in. billets. A BOP shop with three 200-ton vessels and a PH degassing system supply molten steel to the caster. Detailed product quality tests have shown that the ductility, tensile strength, chemical uniformity, yield strength and microclean-liness of the strand-cast billets compare favourable with values for ingot cast steels.

621.746.047;
669.14-412

Use of the Rotary Nozzle for the Continuous Casting of Billets. P. Mutsaarts. Cent. Doc. Sidér. Cir. Inf. Tech., 1976, 33, (6), 1385-1391; discussion, 1391-1396 [in French]. The limitations of conventional systems for pouring steel from ladles feeding continuous casting machines are reviewed. The advantages of employing rotary nozzles are presented, and conditions for their use in some Japanese steelworks examined. The speed of casting is controlled by constriction of the jet or by complete open-

621.746,047
669.14-412

Yamaga, M. et al

Centrifugal Continuous Caster Operation at NKK. (Iron Steel Eng., Aug. 1976 53, (8), 26-32)

Facility operations have shown steady improvements in processing techniques which are now producing high-C and mx low-C steel billets with improved surface quality. Billets so produced are meeting production requirements for a wider range of pipe grades. Increased pipe production and simplification of the seamless pipe production processes are specific contributions of this new billet continuous casting process. Process operating parameters, such as temp. vs. time relationships, and comparison, such as the number of conventional billet defects vs. the number of cast billet defects, are documented in the study with appropriate tables, charts, graphs and photographs.

621·746.047:
669.14-412

Continuous casting plant for wide slabs. Iron and Steel, 41, No.2, February 1968, p.44

Two model S continuous casting machines of Concast design have been installed at the Hattingen works of Rheinstahl Huttenwerke AG, West Germany. Capable of casting some of the largest slabs in the world, the plant is working smoothly to give a product that is suitable for further processing with a minimum of surface dressing. A monthly output of 35,000 tonnes will be achieved this year but if sufficient steel were available this figure could be pushed up to 50,000 tonnes by using sequence casting techniques.

621·746.047:
669.14-412

Sakamoto, E.

Continuous casting at Nippon Kokan, (AIME Open Hearth Proceedings., 1971, 54, 58-67).

An installation casting slabs 200 x 1620 mm at 20,000 tons/month with rapid changing equipment for the tundish is described.

621·746.047:
669.14-412

Pongia, V.J. and Swarr, H.D.

A speciality plate producer's experience with continuous slab casting. (Iron Steel Eng., 1972, 49, Oct. 33-50)

Details are given of the construction, preparation and start-up of the continuous slab casting installation at Lukens Steel Co. The casting machine reached capacity ahead of schedule and during the first year of production all the grades of steel planned for continuous casting were cast successfully. It is concluded from the experience gained that strand casting has made a significant contribution to the speciality plate business and will play a more important role in the future.

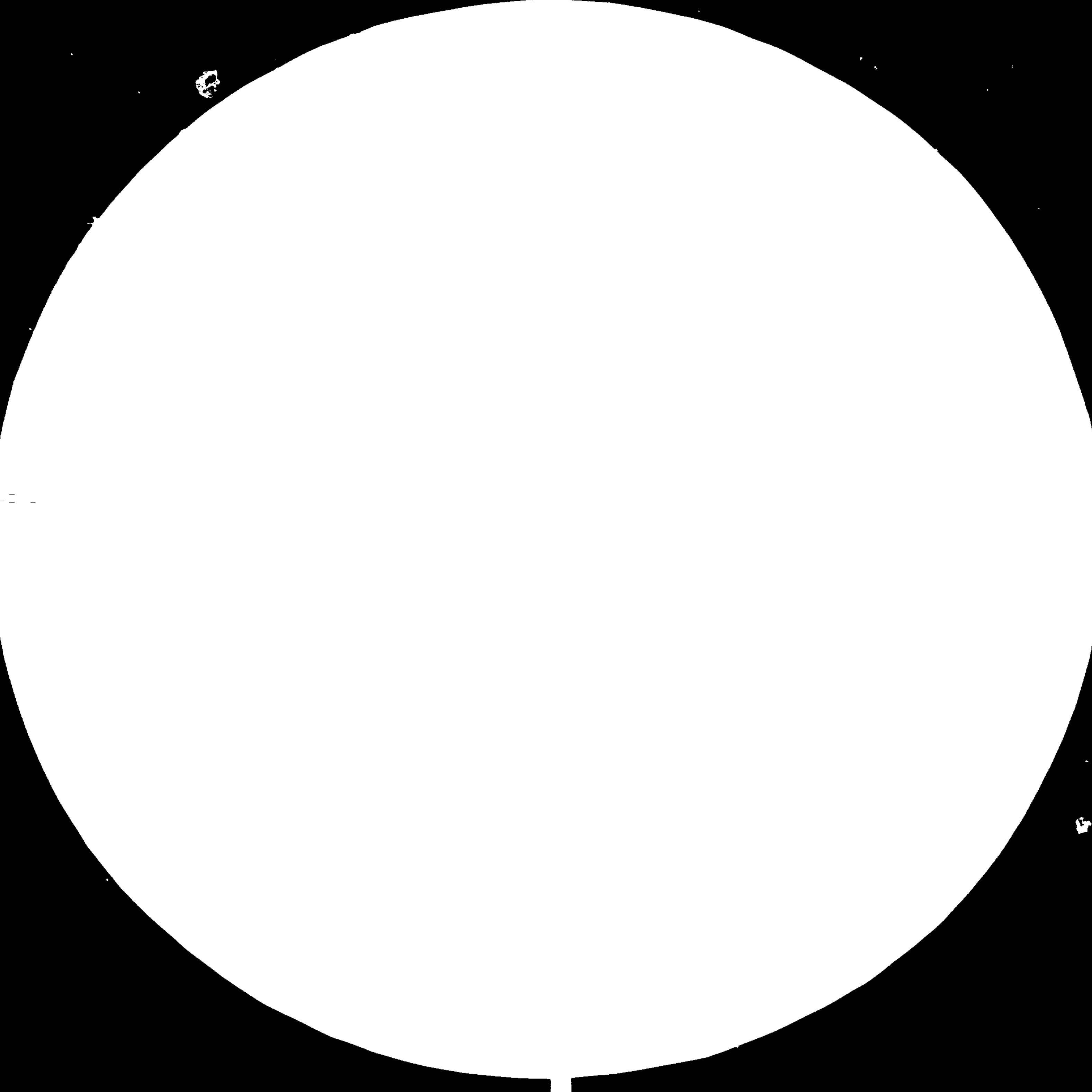
621·746.047:
669.14-412

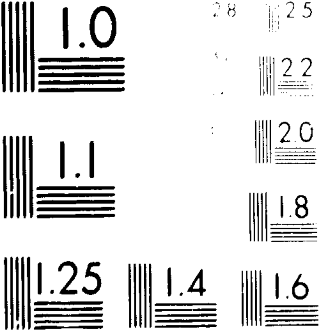
Leshay, A.M.,

The technology behind the worlds record. (Iron Steel Eng., 1973, 50, May (5), 33-39).

The author describes the technical effort behind the record breaking casting achievement of the plant installed at US Steel's Gary Works. The single strand slab caster continuously cast 22,391 net tons of steel in one continuous string and nearly doubles the previous world record.

83.06.30

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621.746.047:
669.14 -412

Construction and Operation of a Continuous Casting Plant for Slabs. Rudolf Kunz. Thesis, Tech. Univ. Aachen, 1976, 85 pp [in German].
The planning, construction, and commissioning of a continuous slab casting plant is described. The casting machine, mould design, slab transport, hydraulic plant, quality control, electrical equipment, and costing are discussed in detail. 33 ref.—H. S.

621.746.047:
669.14-412

YOSHIO SETTAI

Production of Slabs at N.K.K.

The Fukuyama and Keihin Works of NKK have a capacity of producing 19,000,000 tons of crude steel a year, and 85% are flat products made from slabs. 30% of slabs are made by four continuous casting machines, one of which operates at Keihin Works to make slabs for steel plates, and three at Fukuyama Works to make slabs for steel plates and sheets.

Rigid control is maintained at the continuous casting operation, that continuously cast materials now lose nothing by comparison with ingot-cast materials, and the continuous casting method not only saves on the manufacturing cost but also improves the quality of products.

NKK slabmaking processes have already proved to be of value in steel making operations such as the manufacturing of slabs from bottom-poured capped steel for the production of steel sheets, the efficient operation of slabbing mills, the non-stop casting and the production of defect-free slabs, and the manufacture of cast slabs for the production of high grade steel products.

Presented at the SEAISI Seminar Philippines 1976 P20

621.746.047
669.14-433.5

Continuous Casting of Round Sections with Curved Moulds in Argentina. Jobst Thomas Wasmuht. Stahl u. Eisen, 28 Mar. 1974, 94, (7), 296-299 [in German].
The continuous casting of round sections of low-alloy steel with a casting radius of 4 m at a works in Argentina is described. Casting dimensions up to 140 mm dia. are employed with the use of a 14 mm nozzle dia. and a withdrawal rate of 2 m (or 240 kg) per min. 10 ref.

621.746.27

Continuous casting plant, U.K. Pat. 928093 (Met. Pat. J.3(26), 1963, pp.7:Met.2)

Relates to a continuous casting plant in which the moulds are arranged in more than one row and the billet axes of each row of billets lie in a plance extending parallel to the billets, all appliances for carrying out the casting operation, up to and including the dividing of the billeters into lengths, being arranged in several superposed stages and disposed on one side of or in that one of the planes lying closest to the ladle, whereas the latter is located on the other side of such place. In the plant now proposed, all the rows of billets are arranged close to one another and are commonly surrounded by partition walls from the point at which the billets emerge from the mould outlets to the points at which they are cut to length, the moulds and billets being located within the walls, while other appliances are least partly located outside the walls and extend through the latter to act on the billets.

621.746.27

Baumann, H.G. and Faber, H.D.

Continuous casting plants for steel-operating techniques and utilisation times (Wire World Internat., 1971, 13, Sep/Oct, 129-137)

The influence of operating technique on plant utilization times and the possibilities of increasing efficiency by the use of suitably designed plant and equipment are discussed. Fully continuous casting calls for changing the tundish as quickly as possible after several heats have been cast. Plants should be equipped with appropriate devices for receiving the casting ladles and tundishes. These devices are described.

621.746.047
669.12

Steel production and continuous casting. Relative considerations on the possibilities of their synchronisation. (Rev. Mét., 1973, 70, Feb., 127-142) (in Eng./Fr.)
PETERSEN, U., vom ENDE, H., HORST, R. A description is given of the present potentialities of the LD process and the continuous casting of steel and of the problems of synchronising them. -

621.746.047
669.18

The Present Position and Future Prospects of Steelmaking by Continuous Casting. S. Basevi. Met. Ital., Jan. 1975, 67, (1), 18-20 [in Italian].
The advantages of continuous-casting procedures in rationalizing steel-works plant layout and increasing capacity are described and the differences between the four principal casting systems compared. Examples are given of detail improvements in casting-machine design being introduced, and of improvements likely to be made.-

621.746.047
669.184.244.62

Incorporation of Continuous Casting into BOP Steelmaking Plants. Fritz [illegible]. Stahl u. Eisen, 27 Feb. 1975, 95, (5), 169-175 [in German].
The introduction of continuous casting strands into BOP steel-making plants is discussed with particular emphasis to the material flow rate and the general plant and auxiliary transportation layout. Suggestions are made in respect of plant design to provide the most satisfactory operation.--P. V.

621.746.27

Fastert, H.

Continuous casting - design and operating Innovations (Iron Steel Eng., 1972, 49, Jan, 64-69)

A brief review is given of the design and operating features of continuous casting machines in current use and their advantages and disadvantages are discussed. The features described are ladle cars; turret type equipment; and arrangement for the quick removal of a unit comprising the first zone, mould table and mould; and the use of cavity-type dummy bar head. A closed-loop spray control system is also described. These various features result in saving and yield improvements.

621.746.27

Bauer, K.H. et. al

Operating characteristics of a high-productivity continuous casting plant. (Rev. Met., 1973, 70, Feb., 115-125). (In Engl./Fr.)

The paper describes the slab continuous casting installations at Dillingen in 1961 and 1964 and describes the results obtained since 1968 when the plant became part of a new melting shop and was operated as a high performance plant in conjunction with the steelmaking facilities.

621.746.27

Heck, K. and Fastert, H.

Metallurgical considerations in the design of continuous casting plants. (Iron Steel Eng., 1973, 50, Feb., 33-38).

The related equipment ahead of the continuous caster is reviewed. Parameters of tundish, mould, lubrication and strand guiding are discussed. The importance of cooling and its effects on the products are described. The delivery equipment and subsequent conditioning are reviewed relative to some end products.

621.746.27

Bauer, K.H. etal

Present state of continuous casting. (Stahl Eisen, 1973, 93, 15, Mar., 235-242). (in Ger.)

Types of continuous casting plant, design factors, operational requirements and metallurgical concepts are reviewed. Particular attention is paid to the casting of wide slabs. Details are given of plants and products in the Federal Republic of Germany. Finally, some development tendencies are discussed including aspects of automation.

621.746.27

Bertram, R. et al

The production cycle of the steel shop and the new continuous slab casting installation at the Ruhrort steelworks of the August Thyssen-Hütte AG. (Rev. Mét., 1973, 70, Feb., 143-153). (in Engl./Fr.)

The paper deals with the production cycle in the converters and continuous slab casting plant at Ruhrort. Special attention is given to methods of increasing output of the continuous casting plant.

621.746.27

United States Steel Corporation

Method and apparatus for the continuous casting of metal. Government of India. Patent specification No. 91491.

Accordingly the present invention provides a method of starting continuous casting which comprises threading a starter bar upwardly between pinch and guide rolls into the bottom portion of an erect tubular mold, said starter bar being composed of aligned lengths joined by connector blocks therebetween, teeming liquid metal into said mold, lowering the bar with the casting formed by solidification of metal in the mold and severing said blocks successively as they descend to a predetermined level below the mold, thereby freeing the lowermost length for removal from the path of the lengths remaining thereabove and the end of the descending casting.

621.746.27

Thrower A.

Continuous Casting Plant at Lackenby, Teesside. (Iron and Steel Internat., Dec. 1975, 46, (6), 515-525)

The design, construction, and operation of a slab casting machine, and an eight strand bloom casting machine are described. Both machines employ a curved mould with a nominal casting radius of 10.0m and are supplied with steel from B.O.S. Furnace. The rated output of both units is 38,000 tons/week of which 17,800 tons will be produced from the bloom caster. Schematic illustrations of both casters are presented. Details are given of the bloom machine start-up, and the training programme initiated. Close temperature control and accurate mould location are considered to make the main contribution to the excellent quality achieved.

621.746.27

Some Aspects of Small-Scale Continuous Casting Plants. Eiro Takehara and Osamu Nishimura. [UN-IDO] Third Interreg. Symposium Iron Steel Ind. Brazil, Preprint, Oct. 1973, [ID/WG.146/45], 25pp [in English].

Continuous casting provides small section billets of uniform quality, and is accepted as the successor to the conventional bottom-poured ingot process. To obtain the max. advantage from the process, well trained operators, and an improved system of sequence casting are necessary. The introduction of fully-automatic control systems, and an in-line reduction mill can improve the technical and economic aspects, and help to make the process even more advantageous.—J.W.

621.746.27

Increasing the Productivity of a Basic-Oxygen Steelmaking Shop and Continuous Casting Machines at the Novo-Lipetsk Iron and Steel Works. S. V. Kolpakov and L. I. Teder. Stal', Jan. 1975, (1), 20-25 [in Russian]. (x)

Measures taken to improve the productivity of a plant composed of three 100-110 tonne capacity basic O-furnaces, and six twin-strand vertical continuous casting machines are outlined. They include, increasing the rate of blast injection, increasing the charge weight from 104 to 150 tonne, improving the life of the furnace linings, increasing the number of heats melted per day, and the introduction of improved melting techniques. Improvements in the casting technique are: the mechanization of ladle re-lining and the introduction of slide-gate nozzle pouring, developments in continuous casting practice, and the use of computers in controlling production.—J.W.

621.746.27

The Continuous Casting Installation of T.M.M. [Thy-Marcinelle et Monceau] at Monceau. R. Jacobs, L. Philippe, and A. Rosa. C.R.M. Metall. Rep., June 1975, (43), 23-32 [in English].

A four-strand continuous-casting machine for billets is described. The machine can produce square sections from 80 to 130 mm at a total planned output of 700 tonnes/day. The machine is fed from five OBM convertors each of 40 tonnes capacity operating with a metal of high phosphorus content. A brief outline of the steelmaking practice is also given.—M.G.

The Continuous Casting of High Carbon Steel and Alloy Steel by the use of Mitsubishi-Olsson Type Continuous Casting Machine

MASUTARO AZAMI

In 1966 the first Mitsubishi-Olsson Type Continuous Casting Machine was established at the Hachinohe Works of Tohoku Ironsand Steel and Manufacturing Company in Northern Japan. This paper reviews the salient features of our long experience with this machine in the continuous casting of high carbon, medium carbon and low alloy steels. Description, operational procedure, mechanical design and theoretical considerations have been intentionally left out because they are readily available in the literature

Basically the difference in the continuous casting of billet and the conventional production of billets is in the rate of reduction of area. There is a large reduction of area of the latter during the rolling process resulting in a more homogeneous structure. It is therefore necessary to have a homogeneous structure as much as possible in the as cast C.C. billet in order to attain sufficiently acceptable metallurgical properties after subsequent rolling. For this purpose rigid temperature control is necessary during the whole casting period. For instance in the case of 0.80 mm thick metal sheet or the 0.12 mm φ piano wire cord used as cords for automobile tires which have to be cold drawn after heat treatment, size and content of non-metallic inclusions must be strictly minimized. For such kind of steel, the choice of deoxidation process, control of oxygen dissolved in steel, kind of refractory materials used, prevention of reoxidation during teeming must all be very seriously considered to avoid unnecessary trouble during casting and consequently avoid unfavorable defects in the final product.

SEAISI QUARTERLY APR '76 P45
p43 - 66

Continuous Caster Tundishes. J.C. Bradley. Iron Steelmaker, June 1976, 3, (6), 18-24. [in English].
Continuous casting has placed increased demands on the capability and reliability of steel pouring refractories which are subjected to high steel temps. for long exposure times. Since the heart of the casting process is the tundish, refractory selection and installation are very important. Corrosion resistance improves with increasing alumina content, thus minimizing the possibility of nonmetallic inclusions in the steel. Resistance to the erosive influence of steel flow requires refractories with high strength at elevated temp. Lack of high strength allows separation of coarse grains from the matrix at the hot face and contributes to accelerated wear and hence a higher probability of inclusions in the steel.—R.C.D.

RAMON NAVARO

The Operation of Continuous Casting Machine at Philippines Blooming Mills Co. Inc.

PBM's Continuous Casting Machine (CCM) complementing its Electric Arc Furnace (EAF) started operations in November, 1974. Although no major changes have yet been done on the Machine's structures, mechanisms and electrical controls, several instruments, devices and machine parts were installed for the improvement of operations in the later part of 1975.

621.746.27.005.1

Methodical Calculation of Continuous Casting Plants. Hans G. Baumann *et al.* Stahl u. Eisen, 27 Feb. 1975, 95, (5), 183-188 [in German].

Digital calculation programmes for evaluating temp. profiles, contraction, bending moments, nonsteady multi-dimensional heat transfer processes, thermal stress considerations, and the general layout of plant sections are detailed with ref. to continuous casting strands. The importance of a systematic analytical approach to the complex engineering problems involved in the design of this type of plant is stressed.—P. V.

621.746.27:
62-52

Automation of Continuous Casting. T. Kataoka. Tetsu-to-Hagané (J. Iron Steel Inst. Jpn.), 1975, 61, (4), S62 [HB Translation No. 9602].

A brief report is presented on the automation of a Japanese steel continuous casting plant. The casting machine as a whole and three concurrent automatic controls for tundish weight, level of steel in mould and evenness of feeding of powder over the surface of the metal in the mould are described.—AA

621.746.27:
621.746.3:
669.14

Controlling the Pouring of Steel into the Mould in Continuous Casting. Eduard Bernart and Ivo Bernart. Hutn. Listy, Mar. 1976, 31, (3), 164-169 [in Czech].

Methods for regulating the out-flow of steel from the tundish as well as the filling of the mould in the continuous casting of steel are described, and their effects on teeming and drawing rates discussed.

621.746.27:
669.14-412

The Continuous [Slab] Casting Plant at Fried. Krupp Huttenwerke A. G., by P. G. Oberhauser and V. Schiel, *Stahl und Eisen*, Vol. 92, No. 4, 1972, pp 169-171. Report on the new twin-strand curved mold, heavy slab caster commissioned in July 1971 at the Krupp Rheinhausen plant and primarily intended for casting low-carbon unalloyed steels. Details on slab width, slab thickness, length and weight ranges. Monthly production of caster: 80,000 metric tons now, 120,000 later. BOF heat weights cast: 300 metric tons. Data on turret able to handle two ladles at the same time. Particulars on various plant components. (Brutcher 8750 - $4.30)

621.746.27:
669.14-412

New Developments in Continuous Casting of Wide Slabs, G. Vogt and K. Wünnenberg. Klepzig Fachber., Oct. 1973, 81, (10), 412-416 [in German].
Features of some of the continuous casting plant in use to-day are compared and the quality of the product discussed. Particular points are the rate of heat extraction from the mould, the oxidation gradient and the effect of bending strands which have molten cores, both in the case of straight and curved moulds. Distortion of the product can be minimised by matching ingot guides to the shrinkage. When possible it is recommended that distance pieces be used to prevent rolls crushing ingots with molten cores. Indispensible to good quality is the use of multiple-roll apparatus to draw the strand from the mould as gently as possible. 7 ref.—AA

621.746.27
669.14-412

Graf, H. et al

Continuous Casting Plant at F. Krupp Huttenwerke AG. (Stahl. U. Eisen, 18 July 1974, 94, (15), 664-675) (In Ger)

A new high-duty double-strand continuous slab casting installation with a space saving ladle turning power is described. The plant has a casting rate of 1.6 m/min with an output/strand of 3.5 tons/min. At present operation only one strand, 110 ton melts are supplied from a top blown BOP plant. This will be increased to 300 tons, when the two strands are operating. Capacity is presently 80000 tons/month. Prime products are Al-killed, deep drawing, and Ribard grade steels.

621.746.27;
669.14-412

YOSHIO SETTAI

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Presented at the SEAISI Seminar Philippines 1976 P 20

621.746.27;
669.14-412

Continuous-Slab-Casting Plant with a Short Dummy Bar at Stahlwerke Peine-Salzgitter AG: Technical Conception and Operating Results. Gerhard Böcher and Werner Resch, Stahl Eisen, 9 Oct. 1975, 95, (21), 982-987 [in German].
A technical survey is given of a continuous-steel-slab-casting plant with short dummy bar system and driven rollers in the roller apron including a description of plant installations, dummy bar setting and operating methods, roller-system design, flame-cutting machinery, and cooling-water-circulation system. Operating results for the first 750 000 tonnes of crude steel throughput are discussed. Further development to more than 100 000 tonnes/month is foreseen.—P. V.

621.746.27
669.14-412

The Engineering of High-Duty Continuous Slab Casting Plant. Ralf Schneider *et al.* Stahl u. Eisen, 27 Feb. 1975, 95, (5), 176-182 [in German].
Current practice for optimizing the through-put from continuous slab casting strands is discussed. Modern plant design and ancillary equipment modifications allow a material production rate of 3-4 tons/min. strand.—P. V.

621.746.27:
669.14:
66.04

Heat Transfer in Continuous Casting of Steel. K. S. Misra. Mecon. J., July 1974, 1, (1), 45-49 [in English]. (Received 1975)

The mechanics of heat removal in continuous-casting machines is examined. Math. relationships are developed for the heat transfer taking place in various zones of the machine. Approx. 54% of the heat input remains in the steel at the straightener entry. Most of the heat is removed by radiation and convection in the air-cooling zone and least in the water-cooled moulds. 9 ref.--R. E.

621.746.27:
669.14.018.2/.8

Installation for Continuous Casting of Special Steels at S.R.B. [Stahlwerke Röchling-Burbach.] H. Jung. Centre Document. Sidérurgique Circul. Inform. Techn., 1975, 32, (1) 32-43; discussion, 43, 44 [in French].

The principle of construction and the dimensions of an installation for continuous casting are outlined, and the types of steel produced listed. Six lines are used to cast 240 mm × 240 mm section billets at a rate of ~0.7 m/min. Metallurgical problems are described, especially those concerning the quality of the metal skin. Segregation is absent in steels with C <0.5 and can be reduced in steels with C >0.5% by heat treatment. Mechanical properties are equivalent to those of conventionally cast material. Most continuously cast metal is alloy structural steel.--J. M. S.

621.746.27:
669.14:241.2

Production of Clean Steel on a Continuous Casting Machine. S. Mitsushima, T. Ohnishi, S. Ito, C. Nakai and Y. Suzuki. Tetsu-to-Hagané (J. Iron Steel Inst. Jpn.), 1973, 59, (4), S91 [IIB Translation No. 9100]

Ways of avoiding large nonmetallic inclusions in Al- or Al-Si killed continuous-cast steels were investigated, including the use of cleansing agents and large TM-type nozzles between ladle and tundish. A number of inclusions >300 μm from the specimens of S43C steel decreased by ~60% when a cleansing agent was used. The bottom sample contained a considerably greater number of inclusions than the middle or the top samples in both the Al- and the Si-Al-killed steels, indicating that the use of a cleansing agent alone is not sufficient so that other means are necessary. The use of the cleansing agent decreased the alumina precipitation at the tundish nozzle and the submerged-entry nozzles, improving the steel quality and operational problems.--AA

MASUTARO AZAMI

The Continuous Casting of High Carbon Steel and Alloy Steel by the use of Mitsubishi-Olsson Type Continuous Casting Machine

In 1966 the first Mitsubishi-Olsson Type Continuous Casting Machine was established at the Hachinohe Works of Tohoku Ironsand Steel and Manufacturing Company in Northern Japan. This paper reviews the salient features of our long experience with this machine in the continuous casting of high carbon, medium carbon and low alloy steels. Description, operational procedure, mechanical design and theoretical considerations have been intentionally left out because they are readily available in the literature

Basically the difference in the continuous casting of billet and the conventional production of billets is in the rate of reduction of area. There is a large reduction of area of the latter during the rolling process resulting in a more homogeneous structure. It is therefore necessary to have a homogeneous structure as much as possible in the as cast C.C. billet in order to attain sufficiently acceptable metallurgical properties after subsequent rolling. For this purpose rigid temperature control is necessary during the whole casting period. For instance in the case of 0.80 mm thick metal sheet or the 0.12 mm ϕ piano wire cord used as cords for automobile tires which have to be cold drawn after heat treatment, size and content of non-metallic inclusions must be strictly minimized. For such kind of steel, the choice of deoxidation process, control of oxygen dissolved in steel, kind of refractory materials used, prevention of reoxidation during teeming must all be very seriously considered to avoid unnecessary trouble during casting and consequently avoid unfavorable defects in the final product.

SEAISI Quarterly April '76

A Contribution to the Planning of Continuous Casting Plants for the Steel Industry, by H. G. Baumann et al., *Klepzig Fachberichte*, (German), 1973, Vol. 81, No. 12, pp 542-545. The present abridged paper supplements the principal author's earlier work on "Flow Pattern of Liquid Steel in Continuous Casting" (Brutcher Translations HB-9197-I and HB-9197II). Factors influencing the withdrawal speed of a strand. Effect of cross-sectional shape and size on withdrawal speed. Casting speed for square-section billets according to nine different investigators. Withdrawal speed for steel billets with various K-values. Interrelations among withdrawal speed, casting output, and meter-weight for square-section billets and also for slabs. Need for matching the quantity of steel produced, the process times, downtimes and stoppages in the melting and casting plants, and some ways of accomplishing this. (Brutcher HB9210-$10.00)

621.746.27:
669.14-41..

Hater, M. et al

Results From a Curved-Mould Continuous Casting Machine Making Pipe and Plate Steel (AIME Open Hearth Proc., 1975, 58, 202-217)

The procedures covered are based on one full year of operation at a German BOF plant. Data are given on plant layout and equipment, including size and capacity of the casting machine proper, the ladle turret, tundish and tundish car, mould and mould drive, strand guide., withdrawal and straightening units. Operating and production figures are given for each month, and yield losses are shown. Some operational problems are discussed. Results are presented in terms of steel grades cast, control of temp. and chemical analysis, segregation, cleanliness, longitudinal cracks and transverse cracks near slab corners.

621.746.27:
669.14-412

Continuous Caster Maintenance—the Key to Quality and Tons Per Hour. G.W. Hodges and H.N. Hubbard, Jr. Iron Steelmaker, Aug. 1975, 2, (8), 17-23 [in English].
Maintenance of the continuous steel slab caster at the Gary Works of U.S. Steel is described. After over five million tons of steel have been cast on this machine since 1967, significant improvements in number of heats per strand start and decreasing maintenance time have occurred with time. Problem areas included bearing and roll breakdown in the curve rack section, electrical engineering systems, rolls and bearings in the vertical rack, burner coolers in the furnace and lubrication systems. A description of continuous-continuous operation, in which ten heats per strand start were achieved, is given. Causes of terminations during continuous-continuous operation were mainly due to BOF furnace problems (2.6 out of 100 heats).—J.B.

621.746.27:
669.14-412

ATH [August Thyssen-Hütte] Introduces New Continuous-Casting Plant for Slabs. ——. Bänder-Bleche-Rohre, Jan. 1975, 16, (1), 27-28 [in German]. (Received 1976)
An account is given of the installation of a new continuous-casting plant. The two-strand machine has a capacity of 100 000 tonnes of rolling slabs per month.—D.B.

621.746.27:
669.14-412

The Initial Stages in the Formation of a Flat Continuous Casting. L.S. Rudoi and I.T. Kushnarev. Metall.Koksokhim., 1975, (47), 72-74 [in Russian].
The initial stages in the formation of a flat continuous steel casting were studied experimentally and the results compared with theory. An improved method of following the motion of the solidification front by introducing a sulphide and subsequently establishing the S distribution in the casting was devised. The effect of the hydrodynamic parameters of the jet of inflowing metal on the progress of solidification and the microstructure of the product was determined. On the basis of these data practical recommendations as to the optimum mode of introducing the metal are made.—G.A.

621.746.27
658.152

A six strand continuous caster producing 500,000 tons needs $45 as cost.

Source: UNIDO/ICIS/15, December 15, 1976, P. 208.

621.746.27; 669.14-147-412
658.152

One ton of continuously cast steel slab costs $9.45 in a three-million ton capacity steelmaking mills at the operating level.

Source: UNIDO ICIS/15, December 15, 1976, P. 213

621.746.27; 669.14-147-412;
658.152

Miller, J.R. Use of direct reduced iron ore and balanced integrated iron and steel operations.

Estimated mill manufacturing cost of 1 ton continuously cast billets through the following processes	Cost in £
(i) Direct reduction - Electric furnace	87.91
(ii) Blast furnace - Basic oxygen furnace	95.44
(iii) Steel-scrap - Electric furnace	108.68

Source: Ironmaking and Steelmaking, 1977, No. 5, P. 261, Table 6.

621.746.27:
658.152

Operating costs of

(i)	Small ingot process	$4.2 - 5.8 per ton
(ii)	Large ingot blooming process	$6.6 - 10.4 per ton
(iii)	Continuous casting process	$3.0 - 4.8 per ton

Source: ID/WG. 146/41, 16 Apr. 1973, P.13

621.746.27:
658.152

The cost of building a continuous casting plant varies widely on many factors including time of construction, size of the plant, and where the plant will be built. It is derived from the figure B-32 ~~in the source mentioned below~~ that a continuous casting plant, producing 300 tons per day might need a capital cost of $800,000; and a continuous caster with the capacity of 400 tons a day might need an estimated cost of $4,000.00.

Source: Arthur D. Little, Inc.
Steel and the environment: A cost impact analyse.
May 1975, Fig. B-46

Continuous casting reference list
(Metal Bulletin, July - Sept. 1975, PP 49-54; 53-63; 41-48)

Continuous casting plants throughout the world are tabulated under the names of countries, with the number of strands, products made, steel type, casting machines (mm), capacity (tpy) and makers name.

621.746.152
658.152

Estimated cost of continuous casting plants and products in different countries.

BRAZIL

A consortium made up of Usiminas Mecânica S.A., USIMEC, Clesid, and Concast AG, will supply a $50 million continuous casting plant with three slab casting machines to Cosipa, Sao Paulo. Scheduled to go into operation by the end of 1979, the 1,4 million ton a year plant will produce slabs 1000 to 1900 mm wide and 160 to 300 mm thick. Source: IAMI, November 1976, P. 14

Cia Siderúrgia de Guanabara will spend $123 million raising its output of steel ingots to 550,000 tons by early 1976... The national steel plan for 1975-1980 calls for spending $1,5 billion annually with a production goal of 25 million tons annually by 1980. Source: IAMI, September 1974, P. 27

EGYPT

CSN, Cosipa and Usiminas have invited international tenders for expanding their integrated steel plants located respectively at Volta Redonda, Cubatao and Ipatingua, to raise their total annual capacity to 11,6 million tons of steel by 1978. The cost of machinery and equipment for the projects is estimated at [illegible] million. Source: IAMI, February 1975, P. 44

GERMANY

August Thyssen-Hütte AG, Duisburg has ordered a 2-strand continuous casting machine for 2600 x 215 mm slabs from Maschinenfabrik Sack GmbH, Düsseldorf. The $72 million installation will go into operation at the end of 1978 and will have an initial capacity of 1,5 million tons a year, bringing Thyssen's continuous cast production to over 30% of total output. Source: IAMI, November 1976, P. 12

GREAT BRITAIN

The BSC will spend $7 million on a new steel foundry at the River Don Works, Sheffield, capable of producing castings of between 10 and 170 tons... Source: IAMI, January 1975, P. 12

[illegible]

A [illegible] million steel mill is being built at Maia, Douro, with a [illegible] annual capacity.

SPAIN

[illegible] companies will join the "Concerted-action plan" for the steel industry, and spend [illegible] million on new installations and [illegible] existing plants. Three companies will raise their combined annual capacity from 3[illegible]6,000 tons of ingot steel and 17[illegible] tons of rolled products to [illegible],000 and 3[illegible] tons, respectively by 19[illegible]. Source: IA[illegible], April 1976, P. 20

U.S.A.

[illegible] Bliss [illegible] Equipment, Southfield, Michigan, will supply a continuous steel slab casting machine to the Kaiser Steel Fontana, California, steel mill with an annual capacity of 7[illegible] tons. The machine will be built to design parameters of [illegible] [illegible] and consultants and is part of a [illegible] million modernization programme which includes replacing an open hearth furnace with basic oxygen steelmaking. Source: IA[illegible], July 1976, P. 20

Infmn. Evaluation Source

1. Subject ______________________________
   ____

2. Source: Name ______________________________
   ____

   Address ______________________________
   ____
   ____

P.T.O.

3. Nature of source : ______________________________
   ____
   ____

4. Type ______________________________

5. Supply terms

	Cost	Time and receipt of reply
a)	______	______
b)	______	______
c)	______	______

6. The above infmn. filed on ______________________________

(filled in specimen)

Infmn. Evaluation Source 662.7.4[illegible].35

1. Subject Coke making: dry quenching

2. Source: Name Institute of Metallurgy

   Address Cherepovez, U.S.S.R.

P.T.O.

3. Nature of source: Process developed by the Institute and patented by it. Introduced in many Soviet steel and coke plants.

4. Type a) Drawings and description, b) Performance data c) Terms for use of process

5. Supply terms	Cost	Time and receipt of reply
	a) Free	
	b) On payment	6 weeks from receipt of inquiry by the Institute
	c) Negotiable	

6. The above infmn. filed on 15.1.1978

App. 10-1
(ref. para 39, 50a,f)

INTIB, UNIDO: INFORMATION REQUEST FORM *

1. Requesting authority
   - a) Organisation/ Institution ______
   - b) Adress ______
   - c) Respondents Name ______ Designation ______
   - d) Phone ______ Telex ______ Cable ______
   - e) Date of request and ref. if any ______
2. Reply/specifics
   - a) Time when reply wanted ______ b) Language ______ c) Changes: Want Free / Want Estimate / Would Pay
3. Information specifics
   - a) Subject ______
   - b) Territory ______ c) Period ______
   - d) Form ______

* See next card for advice on using this form

P.T.O.

4. Reason and connection ______________________________

____

5. Application ______________________________

____

____

6. Other sources approached ______________________________

____

____

____

7. Follow-up notes by Bank staff ______________________________

____

____

App. 10-2
(ref. para 39, sent)

HOW TO USE
THE INFORMATION REQUEST FORM

1. Fill in the form and send it to INTIB, UNIDO, P.O. Box 707, A-1011 Vienna, Austria.

2. To enable INTIB to send you a reply that will fully meet your requirements, kindly

STATE	Against item 3a of the form as clearly and precisely as possible the subject on which the information is desired. Please limit your enquiry to one process, product, service, activity etc., and use a separate form for each enquiry. If extra space is required, use a separate 8″ x 5″ sheet giving the no. 3a.
	The territory, i.e., countries, regions period to be covered in the reply and the form of the information required, e.g., descriptive statement, tables of figures, sketches, maps, diagrams, charts, photos, flowsheets, reports, surveys, articles, catalogues, trade lists, bibliographies, addresses, advice and or recommendations, etc.
INDICATE	The reason and the connection in which the enquiry is being made and the purpose you hope it will serve.
	The application (circulate, print and distribute, use as a guide to decision and action, hold for record or reference, etc.) to which the reply will be put.
SPECIFY	The time, language and payment choices.
MENTION	The other sources you have approached for this same information and with what results.

App. 10-3 (ref. para 37, 50a,b)

App. 11

(ref. para 50 f)

INTIB, UNIDO: Assessment of Information Supplied

(To be filled in by the recipient of the information from item 3 onwards, and returned to INTIB)

1. Request ref.
   a) Subject ____________________
   b) Organization ____________________
   c) Address ____________________
   d) Ref. No. ______________ Date __________

2. Supply ref.
   a) No. ______________ Date __________
   b) No. ______________ Date __________
   c) No. ______________ Date __________

3. Information quality
   a) Found [Comprehensive] [Incomplete] [Insufficient] [Up-to date] [Dated]
   b) Needs supplementing (specify) ____________________
   ____
   c) Was supplemented (Pl. specify source) ____________________
   ____

4. Information usage:
   a) Extent: [Used in full] [Used in part] ______________ specify part used.
   b) Circulated for information of
      i) ____________________
      ____
      ii) ____________________
      ____
   c) Used to take decision on
      i) ____________________
      ____
      ii) ____________________
      ____
   d) Present status of the decision
      i) ____________________
      ____
      ii) ____________________
      ____

INTIB, UNIDO: INFORMATION SUPPLY FORM

1. Ref. and date of Inf. request ______________________

2. Sent to: (Requesting Authority)
   - a) Organization/ Institution ______________________
   - b) Address ______________________
   - c) Respondant: Name ______________________
     Designation ______________________

3. Information specifics
   - a) Subject ______________________
   - b) Territory ______________________
   - c) Period ______________________
   - d) Form: Statement and App. etc. as given under item
     Brochure Maps charts diagram Microfilm As enclosed

4. Information status :
   - a) Theoretical formulation ☐
   - b) Patent specification ☐
   - c) Laboratory experiment ☐
   - d) Pilot scale operation ☐
   - e) Commercial application ☐

5. Information Authentication: Authenticated by: Source ☐ INTIB ☐ Specialist ☐

6. Moderator/Specialist:
   - a) Name ______________________
   - b) Designate ______________________
   - c) Address ______________________
   - d) Comments: See under item 9.

7. Contact for further information or clarification ______________________

8. Information Statement: ______________________

INTIB, UNIDO: INFORMATION SUPPLY FORM (cont'd)

(Use extra ruled sheets with paginate if required).

INTIB, UNIDO: INFORMATION SUPPLY FORM (cont'd)

9. Specialists comments