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UNITED NATIONS

INTERREGIONAL SYMPOSIUM ON THE APPLICATION OF MODERN TECHNICAL PRACTICES IN THE IRON AND STEEL INDUSTRY TO DEVELOPING COUNTRIES

11-26 NOVEMBER 1963

D03594

STEEL SYMP.1963/
Technical Paper/B.22
26 September 1963

ENGLISH
Original: FRENCH

PROBLEMS RAISED BY THE ESTABLISHMENT OF AN IRON AND STEEL PLANT

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United Nations Interregional Symposium on the Application of New Iron and Steel Techniques in Developing Countries, 11 - 26 November 1963, Technical Paper/B.22

I. INTRODUCTION

The problems raised occur in varying degrees in all countries, namely:

A - Countries where industrial development and technical training facilities are very weak, and which have no iron and steel production at present.

B - Countries already more or less technically advanced, but where the industrial background and technical training are inadequate.

- some possessing only an embryo steel industry,
- others, more developed, with an appreciable iron and steel production.

C - In very advanced countries where, however, questions are almost continually arising with regard to the establishment of additional iron and steel plants or the replacement of old ones.

Case A countries require the services of advisers and planners with wide experience, who can be responsible, as far as the steel industry is concerned, for all problems from the initial economic and social studies to the starting up of the works, ranging over engineering and construction, and including questions of training of personnel and education. The local applicants for aid, responsible for the general interests of their country, are then almost exclusively at Government level.

Case B countries imply technical aid at a generally higher level. Economic and social information is supposed to be already known to a large extent by the local interested parties. The aid consists of supplying the most up-to-date technical information appropriate in various cases, of aiding the interested parties in taking technical decisions and of giving assistance where necessary with regard to planning and to the equipment not obtainable locally. These applicants for aid are either public or private.

Case C countries need no comment: they keep abreast of all innovations and introduce them themselves; they apply them in their new installations in order not to fall behind technically. They are advisers for case A and B countries.

II. REASONS FOR ESTABLISHING IRON AND STEEL PLANTS

Two main reasons occur most frequently:

A - The existing or expected market, i.e. the satisfaction of the estimated requirements of steel consumers:

a) either revealed by market surveys in countries already industrialised to a greater or lesser extent,

b) or estimated, in less developed countries, as a result of economic, political, demographic and social studies carried out in order to promote and to plan production. This implies that the steel industry is considered as a lever favouring the general development of a country or a region.

In any case the solution of these problems is never obtained directly and numerous factors must be considered before any decision is taken:

- the categories of iron and steel products required:
  merchant bars, sheets, etc. and the tonnages of each category,
- the calculated production costs, taking into account all the necessary supplies and the global cost of transport of raw materials and finished products, and finally charging the cost of the latter delivered to the consumers.

These studies must make it possible to judge whether it is preferable:

- to have these products supplied by existing works,
  perhaps by developing them,
- to establish new plants in suitable locations,
- to resort to imports, perhaps by exporting other products or manufactured articles in return for the necessary foreign currency.

B - The exploitation of local natural resources:

This mainly concerns iron ore, which may be rich and valuable on the world market, but obviously subject to market fluctuations. It may be too poor in quality for the world market but capable of being used on the spot to produce steel at a reasonable price. In both cases it is interesting to consider using this iron in its natural state to make steel products which can either be exported, although also subject to the fluctuations of world markets, or which can preferably be consumed in the country.

This production must of course be considered in conjunction with the use of the energy resources available: coal (and coke), liquid or gaseous hydrocarbons, electricity, even if necessary special resources such as wood which can be carbonised into charcoal. Imports may be necessary.

In practice case B is similar to case A.

It will be noted that among the local iron resources account must also be taken of scrap which may be regularly available and which can easily be converted into steel products in open hearth or electric furnaces.

C - Other reasons

The concern for "prestige" which is believed to be found in developing countries is generally a concern for security which requires in each sector the minimum of autarchy enabling total subjection to imports to be avoided. This may lead to local production costs apparently higher than the cost of imported products, also apparent and too much subjected to market fluctuations.

We say "apparent", because on the one hand production costs include labour which would otherwise be a burden on the national budget, and on the other hand imports require foreign currency which must often be obtained at great expense and by sacrificing the national reserves. The more the amount is reduced, the more important this is.

We are only mentioning these factors in taking a decision, but they must be taken into consideration.

III. THE STUDY OF THE ESTABLISHMENT OF AN IRON AND STEEL PLANT

Whatever the reasons behind such a study, the main steps to be taken, chronologically, are as follows:

A - Study of markets and fixing of categories and tonnages of products to be considered,

B - Preliminary economic study of conditions regarding supplies and transport,

C - Study of the possible technical solutions (based on the general considerations which will be developed at the end of this report),

D - Summing-up and construction programme.

A - Study of markets and fixing of categories and tonnages of products to be considered

The present and future requirements of the country will be estimated and also the possibilities offered for export to neighbouring countries rather than on the world market, which should be considered only in special cases.

In less developed countries the chances of development of consuming industries will be estimated by comparison with other countries, and an examination will be made of projects for small industrial complexes based on the steel works.

The types and quantities of products to be made will vary considerably in different cases:

- Sometimes, a simple small production of ordinary steels (reinforcing rods, angles, etc.) on a semi-craft scale, making available to each inhabitant only about 4 to 5 kg. of steel a year (i.e. 4,000 to 5,000 tons per million inhabitants), may lead to appreciable progress which will be further increased by the presence of some forging facilities for the production of tools, particularly for agriculture. However, it is difficult to produce less than 40 to 50 tons of steel a day.

- At the opposite end of the scale there is the works (of 500,000 to 2 million tons) intended:

either to constitute for a group of fairly well populated countries a centre of supply producing steel under good conditions with regard to average costs, for delivery to various consumers;

or to exploit a poor-quality ore which cannot compete on world markets saturated with high-grade ores, by proceeding in fact to convert the ore into steel for export.

In this case the study of the markets is of major importance, for while the variations of the world ore market are reflected in the profitability of investments in mining, it is even more serious to place the additional burden of the uncertainties of demand on the very costly equipment of the iron and steel industry.

The two cases quoted concern mainly integrated works which must produce possibly semi-finished products for further conversion, but also the whole range of products necessary to satisfy the demands of the markets.

It should be noted finally that these projects will generally be carried out in stages, the first being of a size which is already reasonable and economically viable.

However a preliminary stage can sometimes be considered, which consists of building in the first place rolling mills and forges intended to satisfy specific requirements. This implies a supply of imported semis and therefore a good situation with access to a port, but there is also a certain vulnerability. Such a stage can be only provisional and should be quickly supplemented by production of steel on the spot.

B - Preliminary economic study of conditions regarding supplies and transport.

A comprehensive inventory must be made of the raw materials available in the country (essentially ores and different forms of energy - coal and substitutes such as charcoal, hydrocarbons, hydro-electricity or other electricity), and the comparative costs of these materials will be estimated.

The sources of other materials, such as refractories (clay, dolomite) and limestone must also be carefully prospected.

If some of these materials are not available locally, the possibilities for importing them will be studied.

It should be noted that as a source of iron it is possible in some cases to consider the availabilities of scrap, either in the country itself, or on the world market if the works is in a favourable coastal location.

The study of communications and transport is very important and is decisive for the location of works, especially in countries where the population and activities are widely scattered. The total cost of transport per ton of product delivered to the consumer must be kept to a minimum, and this cost covers both raw materials and delivery to the consumer. This may sometimes lead to the consideration of a number of small-sized works rather than one large central works.

In all cases, while trying to make use of indigenous raw materials, a study will be made of all the reasonable combinations of supplies by neighbouring countries or even by imports from a distance. It is essential that iron and steel works should not be placed at the start in difficult technical and economic conditions, under the pretext of using at any price local resources which are badly situated or of unsatisfactory quality. On the other hand, coastal works importing their raw materials can be viable (as for example in Japan).

C. Study of possible technical solutions

The choice of processes and equipment will obviously depend on the results of the preceding studies A and B. A choice will have to be made with regard to the treatment of raw materials, the production of pig iron and steel, the casting of the metal, and the shaping of the crude steel into finished products.

The choice of production process, while taking account of the most up-to-date technical knowledge, must avoid solutions not yet sufficiently proved. Whenever possible, it will be a good idea to carry out tests in the works and pilot plants of the advising countries on the methods envisaged with the raw materials which are to be used.

Besides, it cannot be said that there are specific solutions for regions in course of development and for other regions. There is only for each typical case one or several solutions more appropriate than the others.

Moreover, highly mechanised and automated equipment may be considered despite the long and difficult training of first class specialists which is required. In fact such equipment may make it possible to save a much larger number of routine technicians whose training is also long. The hopes of employment of labour must be placed far more in the industries which will grow up around the steelworks, rather than in the steelworks itself.

In the final chapter of this paper we shall refer to a number of "general considerations" which may assist in the choice of solutions. In the agreed plans it will be best to provide for the later introduction of the most up-to-date techniques which are still however in course of development at that time.

We shall also point out that one should not ignore the possibilities offered in some cases by the construction of semi-integrated works producing their steel in open hearth or electric furnaces from purchased scrap.

This solution assumes a regular supply of scrap, either collected in the country, or found on an international market which is favourable at the time.

In this case the works must be at a port.

A study to appear shortly 1/ includes valuable information on this subject, and in particular it shows that the electric furnace, for example, can operate only in the slack hours when current is cheap.

D. Summing-up and construction programme

Preliminary project

The combination of the preceding studies (A, B and C) should make it possible to draw up a well-reasoned preliminary project for works whose location will also have been determined according to the overall optimum transport conditions.

Construction

The preliminary project thus drawn up should then pass into the hands of the planning engineers who, in addition to the actual production equipment, will have to deal with all related problems such as civil engineering, water circulation, handling, etc. It will be desirable that these planning engineers, while consulting if necessary the equipment suppliers, have no direct link with them. However, after drawing up the plans, they will present the projects and lists of consultations to be carried out with the selected suppliers.

The construction and assembly of the equipment, preceded by the general preparatory work, will then take place, followed by the starting-up of the works, which should be carried out by teams of specialists.

Technical training assistance for developing countries

(a) Management personnel in the countries advised will be kept informed of the detailed reasoning behind each partial conclusion, in order to gain an understanding of the decisions taken.

(b) Future senior technical staff must be instructed and trained in the advising countries, both in technical colleges and in works using equipment similar to that projected. Until technical colleges of a sufficiently high level are set up locally, this training must be continued.

(c) Supervisory personnel and specialists on the production side and in mechanical and electrical maintenance should certainly follow abroad the same training as the preceding group, but efforts must be made to organise quickly proper vocational training on the spot, which implies sending instructors for a fairly long time at least.

(d) Workers will be able to get part of their training on the spot, but experience shows that it is always worthwhile letting them participate abroad in the operation of existing installations.

1/ By P. Scheraschewsky of the United Nations Mission (Singapore)

GENERAL CONSIDERATIONS WHICH MAY ASSIST IN THE CHOICE OF SOLUTIONS

The many interesting papers presented at this symposium provide valuable information on the most up-to-date techniques which can be applied in the iron and steel industry. We refer the reader to them and have formulated below only observations and conclusions of a general nature:

Equipment of mines and works: The iron and steel industry is a heavy industry using large quantities of crude raw materials extracted from the earth, and gradually a certain complexity developed in the works, where the blast furnaces themselves combined all the operations necessary to absorb directly crude ores coming often from a number of mines.

Appreciable progress was achieved in breaking down the operations and in freeing the blast furnaces from a number of functions which were transferred to t mines, such as preparation (with enrichment as far as possible) and homogenisatio of the ores. The result was a saving in transport and at the same time a lighten of the tasks of the blast furnaces with increased productivity.

Going further, the question now arises, in cases where cheap energy is available at the mine, for example natural gas, whether not only pelletisation or sintering should be carried out there, but also under certain conditions some reduction of the iron oxides.

In any case the partial transfer of operations to the iron ore mine leads also to the transfer to the mine of part of the complexity hitherto reserved for the blast furnaces and the installations which follow them.

It can reasonably be concluded that if large iron ore deposits are available for exploitation, it is desirable to equip the mine extensively; its ore will be higher value for export and it may also permit a reduction in the size of steelwor to be established within a certain radius. Moreover for these works, freed from many problems thanks to the quality and the uniformity of raw materials, it will b possible to envisage plants of relatively small size but largely automated vertica i.e. from the blast furnace to the finished product.

It should be noted that in some cases of complex ores, more extensive treatme at the mine can be considered, permitting the recuperation of other metals in addition to iron.

If the steel works has to be supplied from a small mine, it is desirable that the ore should be rich and homogeneous, to reduce transport, and to avoid costly

ore-treatment installations. The less rich the ore, the nearer the consuming works should be to it. If this location is bad, it will be better to import good ore prepared in a large mine some distance away, but it will be necessary to be on the coast like the Japanese.

Iron and steelmaking (from the ore to the ingot)

It will be noted that the improved blast furnace (prepared burden, various injections, very hot blast enriched with oxygen) is regaining ground from the electric low shaft furnace and does not consume any more coke than the latter. It is very flexible, it can be adapted to all levels of production and, by the partial or total replacement of coke, to the use of very different fuels (hydrocarbons, coal and charcoal).

The electric low shaft furnace, however, is making progress thanks to pre-reduction (ELKEM, Strategic Udy). Its use depends on the relative cost of electricity and coke. To refine the pig iron made in these furnaces, we now envisage in practice, except in particular cases, only the oxygen converter steelworks in preference to open hearth or electric steelworks.

Rotary furnaces, such as those of the RN type, still use carbon as a reducing agent, and the product made, separated magnetically, must be melted in an electric steel furnace. Capital costs are high.

The processes of reduction by gases at low temperature, such as: by fluidisation - H - Iron and Novalfer; in a shaft - the Wiberg and Myl processes, have serious disadvantages. They require very rich ores and well defined granulations. The products made must be converted into steel in electric furnaces.

Other processes are being studied, such as the Pegab process (France), using only hydrocarbons and electricity, but they have not yet reached an industrial scale.

One should therefore guard against excessive enthusiasm when departing from traditional solutions and the technical and economic proposals advanced must be backed up by tests on existing installations.

The types of steelmaking plant to be considered are limited:

Only the electric steelworks can, as mentioned above, use solid products reduced by various processes.

The electric steelworks and the open hearth steelworks are perfectly suitable for remelting scrap in medium-sized works using scrap as a source of iron. They are not perfectly suitable for the refining of liquid pig iron.

For the latter, converter plants of the acid or basic Bessemer type can be considered only in certain very special cases.

On the other hand, oxygen converter plants appear to be suitable for all the possible requirements of refining liquid pig iron. They imply the simultaneous construction of an oxygen production plant, which in a developing country can also supply other local industries.

Casting of liquid metal: The simplifications and savings in capital costs which can result from continuous casting, which is making continual progress, make this process extremely attractive. It simplifies the subsequent rolling installations, especially in works producing a small tonnage. It presents enormous advantages compared with some problems such as difficult technology.

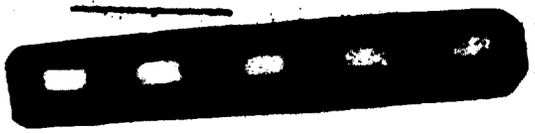
In steel finishing, i.e. shaping the ingots into finished products, the whole range of known rolling mills is available, some of which are versatile and are particularly suitable for medium-sized works. In some cases innovations can be considered such as hot planetary mills and extrusion processes, but only to a limited extent.

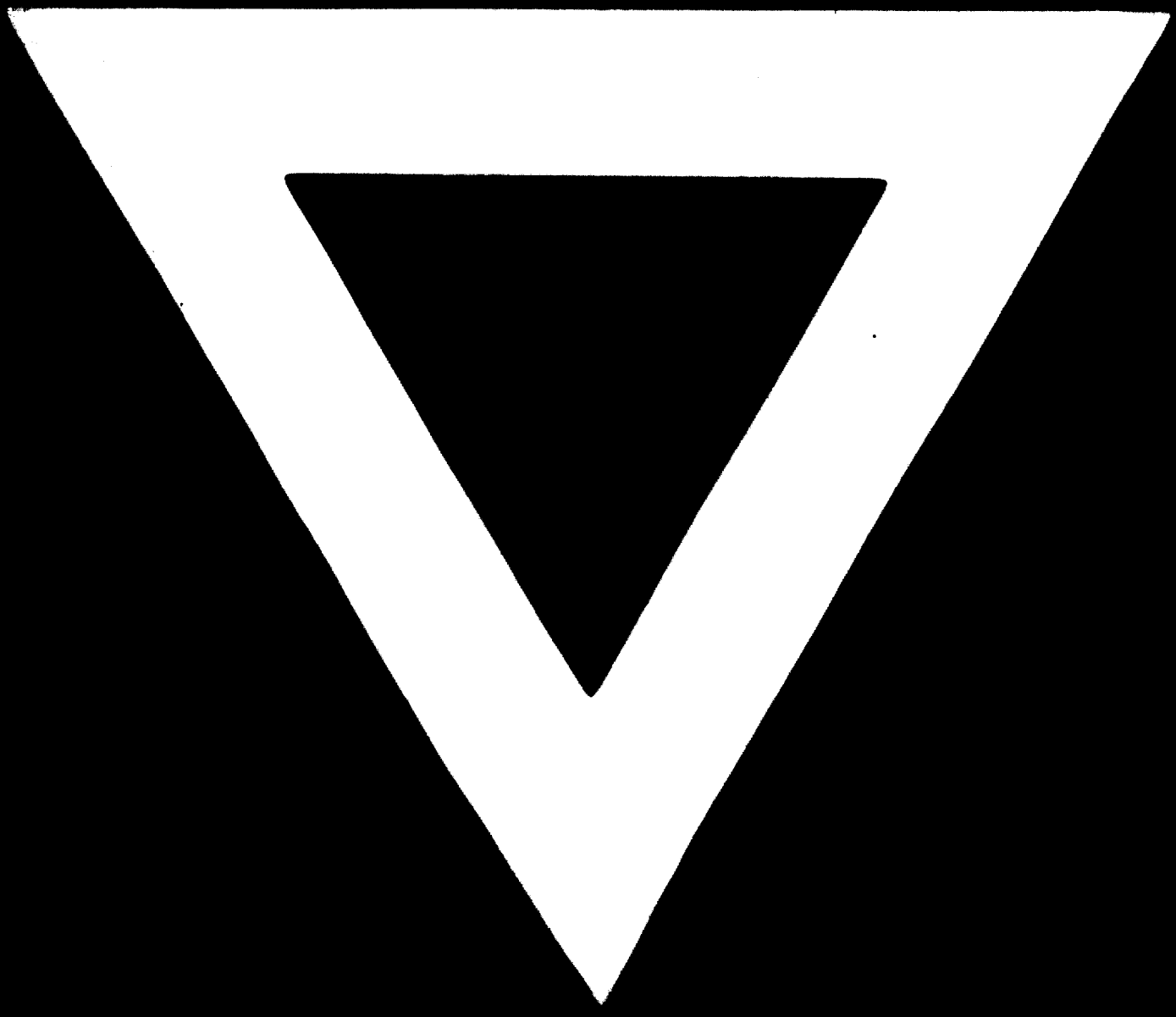
Finally we must stress the necessary development of control methods throughout the production processes with, ultimately, quality control of the products.

The general trend is towards automation of processes, and it is desirable, mainly in small works, to control and to link the different stages of production, from the plant producing the primary metal to the finishing mills, in order to obtain as far as possible well-regulated homogeneous, vertical units.

To conclude, we must stress that with techniques as they are at present, universal solutions should not be expected either for the developing countries or for the others.

Each case should be studied in detail, but before any study it is worth ensuring that the problem is correctly stated.





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