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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

FINAL REPORT

on Workshop on Co-products and By-products of the Bayer Alumina Production

held in Budapest, Hungary
(25 November - 6 December 1991)

fulfilled by ALUTERV-FKI Ltd

UNIDO Project No UD/UC/GLO/91/148

ALUTERV-FKI Ltd.
Budapest, Hungary

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This report comprises this title page, 22 pages of text and 8 Appendixes (I through VIII) furthermore, as an integrated part a short description of the alumina industries of the countries represented on the Workshop.

ALUTERV-FKI Ltd.
Budapest, Hungary

1992.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

CERTIFICATE

This is to certify that

has participated in and completed the

WORKSHOP ON CO-PRODUCTS AND BY-PRODUCTS OF THE BAYER ALUMINA PRODUCTION

organized by the
UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION
and
ALUTERV-FKI
held in
Budapest, Hungary
from 25 November to 6 December 1991

A. Tcheknavorian-Asenbauer
Director
Industrial Operations Technology Division
United Nations Industrial Development Organization

Gy. Keebe
Director-General
ALUTERV-FKI

CONTENTS

I. EXECUTIVE SUMMARY

After several Group Trainings held on behalf of UNIDO in co-operation with ALUTERV-FKI Ltd. in Budapest, Hungary on Alumina Production for participants recruited from developing countries all around the world (in 1979 and 1983) followed by two on site Group Trainings held in the People's Republic of China in ZHENG ZHOU at ZLMKI between 29-10 and 07-12-1984 and in the Socialist Republic of Vietnam in Ho Chi Minh city, Bien Hoa at Bauxite Research Centre (10-30 January 1989), this time a special Workshop was organized on the topics of Co-products and By-products of the Bayer Alumina Production.

The program consisted of the following parts:

1.) The lecture program was focused on Co-products and By-products of the Bayer Alumina Production the applications and development of products containing alumina and/or aluminium trihydroxide, their production technologies, the quality control and material testing, the preparatory works for establishment of new capacities and managing of information. These lectures have prepared the laboratory demonstrations, plant visits and consultations.

2.) Two full days, (MOTIM Works, Ajka Works) and two half days (Alumina Plant of Almásfüzítő, Engineering and Development Centre for Silicate Industry) plant visits were organized in order to give an information about the Hungarian activity in this field.

3.) The laboratory demonstrations were organized in subgroups of 4-5 persons to demonstrate the different measuring methods. The organization of small groups gave an opportunity to learn the details.

4.) The consultations served for the informal discussions of problems arising during the above mentioned programs.

5.) Some social events (opening and closing ceremony working lunch, welcome party, workshop self evaluation, etc.) helped the good cooperations between the staff and the participants.

A Handbook containing the lectures, most important features the Hungarian enterprises and firms, which were visited or in being connection to the topics of the Workshop, some information on laboratory demonstrations, was published. It helps to study of the subject of Workshop on Co-products and By-products of the Bayer Alumina Production.

The representative of UNIDO organized separate discussions with the participants of the Workshop. These discussions were based on the study prepared by the participants on the aluminium industry of their homeland. Finally the participants summarized their opinion about the follow-up activity of this Workshop or about the possibilities of new projects.

The self-evaluation of the group training was carried out filling up the official file of UNIDO related to "Group training Program Evaluation". According to the answers of 17 participants, the training was corresponding to a sufficient extent to their professional needs, the general level was estimated as an adequate one, the general standards of instructors were found rather good, the contents of the program was evaluated as relevant to conditions in the institute to great or at least sufficient extent. It was however, also a common opinion that the total duration of the program was just right.

The participants proposed more group work because they didn't have sufficient time for professional exchange of views with the staff.

II. INTRODUCTION

After several Group Training organized within the framework of the Joint UNIDO/Hungary Program for cooperation in the Aluminium Industry Field held in Budapest in 1979 and 1983 and in China in 1984 in Vietnam in 1989 the present Workshop on Co-products and By-products of the Bayer Alumina Production was organized in Budapest 25. November - 6. December 1991. in frame at UNIDO Project UD/UC/GLO/91/148.

This program can be considered as the continuation of the earlier ones.

The program of the Workshop was focused on the possibilities of the production at higher value added products, which is very important step for the aluminium industry over the world.

III. PREPARATORY WORK FOR THE GROUP TRAINING

UNIDO engaged ALUTERV-FKI (herein after referred to as the "Contractor") to provide services and carry out the Workshop (herein after referred to as the "Project") in Hungary (herein after referred to as the "Project area").

The related contract (UNIDO Project No UD/UC/GLO/91/148 became effective by the end of September 1991 only, therefore the program of the Workshop had to organized in very short time.

The Project Document and the related AIDE MEMOIRE are enclosed to this Report as Appendix I and Appendix II.

The participants of the Workshop have been selected by UNIDO with the assistance of ALUTERV-FKI Ltd. The list of the participants is enclosed to this report as Appendix III.

Due to the very short time for the preparatory work resulted a lot of problems concerning the selection of participants for the Workshop, the transfer of information for them (for example: AIDE MEMOIRE) the location of air tickets), as well as the publication of Handout.

IV. IMPLEMENTATION OF THE GROUP TRAINING

The team of the contractor's personnel were 39 experts from ALUTERV-FKI Ltd. and different Hungarian Alumina Plants and SZIKKTI to prepare the Handout of the Workshop, governed by Mr. K. Solymár team-leader. Above this team a number of scientific workers helped Workshop with the co-production in laboratory demonstrations and plant visits. List of contributors in the preparing of Handout is given in alphabetical order in Appendix IV.

It can be mentioned here that as team-leader of the technical program Dr. K. Solymár has been selected by UNIDO and ALUTERV-FKI Ltd. Considering his advises and recommendations Dr. L. Gillemot has undertaken the job of the chief-organizer and editor of the Handout, too, and Dr. T. Kálmán was assisting at the organization of the technical program mainly in connection with lab demonstrations and plant visits.

The program was carried out essentially according to the provisional Agenda sent to the candidates as a part of the AIDE MEMOIRE, however, some changes were carried out in order to include the half-day plant visit to Almásfűzítő Alumina Refinery, to make the laboratory demonstrations more sufficient and to assure sufficient time for the evaluation of the Workshop.

The detailed final program of the Workshop is given in Appendix V. Sometimes the daily schedule had to be changed in order to precede the plant visits by the relevant lectures. Consequently, sometimes full-day lecture program or full-day plant visit or laboratory demonstrations were requested.

Considering the character of the Workshop examinations were not performed, only discussions were organized regularly to check the efficiency of the Workshop time-by-time.

A Handout, a printed material, which contains the topics of lectures, laboratory demonstrations, plant visits and the

detailed program, could be distributed only before the closure of the program only due to the very late finalization of the financing of the Workshop and the last minute contracting, however, this fact did not disturb to the successful fulfilment of the Workshop.

An other related publication, Oxides and Hydroxides of Aluminium was mailed by ALUTERV-FKI Ltd. for all the participants in January 1992 as one of the follow-up actions, in order to be more acquainted with the main topics of the Workshop.

The participants of the Workshop had to prepare a short review (study) on the aluminium industry of their fatherland by country to facilitate the discussion on the potential follow-up actions. These short reviews are collected in original or re-typed form without any editing in Appendix VI.

The scheduled program was performed without any significant difficulties due to the very good co-operation between the organizing staff and the contributors of the lecturers, plant visits and laboratory demonstrations (mostly the employees of ALUTERV-FKI Ltd. on the one hand, and the participants, the representatives of the Hungarian UNIDO Committee and the representatives of UNIDO on the other hand.

The only, but **expected inconvenience** was arisen by the limited transfer of the special knowledge (know-how) on behalf of the related Hungarian Alumina Plants, first of all Almásfüzítő Alumina Plant, where the visit of some plant facilities were also prohibited. Although these measures were disturbing to the otherwise very good atmosphere of the Workshop, however, the main goals of participants - i.e. to gain a realistic comprehensive information of the related fields and possibilities and pick up the basic knowledge in order to organize the further activity in their home countries - could be very well fulfilled.

V. EVALUATION AND COMMENTS

The Workshop can be evaluated from three different points of view, namely:

1.) Based on the opinions of the participants by filling in the official file of the UNIDO concerning Group Training Program Evaluation.

2.) Judgment of the members of the executing team (lecturers, contributors and participants on the Evaluation Meeting, first of all that of the team leader and chief organizer).

3.) Fulfilment of the goals of UNIDO including the follow-up actions (opinion of the UNIDO representatives).

The first two approaches will be discussed below in this chapter.

A.) Evaluation of the participants

All the 17 participants filled in the official file of UNIDO attached as Appendix VII. This attached file contains the summarized numerical opinions of the participants without any special remarks. The most important results of this evaluation will be discussed below in details:

1.) Pre-course information:

- The pre-course information was qualified mostly (13 of the 17 participants) as sufficient. It means that the Project Document and the Aide Memoire contained sufficient detailed information.

- The participants were more or less satisfied with the time of delivery of this information (5 weeks before the

beginning of the Workshop in average), however, they **very sharply** criticized the last minute acceptance of their candidates (sometimes 4 days before departure and only 1 week in average) to the Workshop.

2.) Program content and organization

- The total duration of the Workshop was estimated mostly just right (14).
- The daily schedule was find by 30 % of the participants (5) too heavy, by others just right (11) and for one person only too light.
- Relating to the recommended changes the following common opinion was expressed:

  1.) The Workshop material (Handout) should be distributed at the very beginning of the course.

  2.) Little groups are requested at the lab demonstrations and the maximum 5 persons in a group at plant visits.

  3.) More time to spend with plant visits.

  4.) More detailed plant visits.

  5.) More detailed and more practical and technological information instead of the too much general aspects.

  6.) Selection a more homogenous group for the Workshop is suggested.

- 2/3 (11 participants from 17) of the participants evaluated the training corresponding to a sufficient extent to their professional needs (2 participants to a very large extent, 3 participants to a large extent and only one (1) to a small extent.

Recommendations: more information on World's trends and details on technologies (1-1 participant was especially interested in gallium recovery and zeolite production, respectively).

- The plant visits were evaluated as very good ones in general, especially in Ajka Alumina Plant. The tube digestion was also mentioned as very valuable new information. More time, more detailed and focused on technology plant visits are requested. The participants want to see much more relating to the specialty alumina production facilities (and in details), instead of plant laboratories and general information. Small special groups are recommended during the plant visits according to the special interest.

- The general level of the training was found as adequate (15 from 17) and only 2 participants evaluated it as too low.

- The following subjects were mentioned as most valuable: gallium recovery (5), special aluminas (5), V_2O_5 production (3), co-products and by-products (3), tube digestion (2), ceramic aluminas (2), fine-ground hydrate (1), zeolite (1), RX lab (1) - according to the specialty of the participants and potential establishment of a related facility.

- As the least valuable topics were mentioned the following: lectures and demonstrations of chemical analysis (3), some laboratory visits (3), plasma materials (1), alumina ceramics (1), aluminium-sulphate (1).

- 10 participants from 17 did not mention any relevant subjects which were not adequately covered in the program. 7 participants wish more information on the technological aspects of the production specialty aluminas and more detailed information in general (transfer of technology).

- Relating to the lectures 7 participants do not wish changes, 4 of them wish more, 6 wish less lectures. The majority of them needs **more group work** (12) and the opinions are also

different relating to the demonstrations (no changes 5, more 7, less 5).

Recommendation: small groups to form at group work, demonstrations and plant visits, too.

- The general standards of the instructors relating to command of English was found very good by 2 participants, rather good 8, fair by 4 and poor by 3. It was mentioned that the level of instructors in English was quite different and four them was really poor in English language. The opinions relating to the method of instructions were better (very good 1, rather good 9 and fair 7). In general the average standards of instructors can be evaluated as adequate.

- The common opinion of the participants (with 2 - 3 exceptions only) that they have sufficient time for professional exchange of views both with the program staff and fellow participants.

- The benefit of the a.m. exchanges of views with the program staff was evaluated a great deal by 4, much 9, somewhat 3 and little by 1 of participants. Less effective was the exchanges of view with fellows participants (great deal 1, much 3, somewhat 7, little 3, not at all 3).

3.) Relevance and applicability

- It was found that the contents of the program was relevant to the connections in the company/institute of the participants to a very good extent at 2, to a great extent at 5, to a sufficient extent at 9 and small extent at 1 participant according to their special interest (job) and the expected development in the related fields at their companies (institutes).

- All of the participants evaluated the Workshop program point of view of their professional benefit very useful (to a very

great extent 1, to great extent 10, to a sufficient extent 6).

- The same opinion were expressed relating to the opportunity to apply the newly acquired knowledge and experience in the present job of the participants.

- The participants declared that they are in position to transfer the newly acquired knowledge to others in their home country (to a very great extent 7, to great extent 5, to a sufficient extent 5).

- This a.m. transfer will be done mostly in a day-to-day work to colleagues and subordinates at 11 participants in specific training activities inside and outside the present employment is expected at 5/3 participants.

4.) Social aspects of the program

- The participants very highly evaluated the leisure time programs activities organized by the program staff during the available very short time. They expressed their many thanks for welcome party, sight-seeing, excursion and organized shopping. As further opportunities and recommendations were mentioned by 1 - 2 participants only optional visits to music hall, concert, theatre and museum, however all participants were perfectly satisfied in this aspects. The central position of the Hotel Crown and very well organized services of it gave a great chance to organize private programs, too.

- Majority of the participants found the questionnaire very detailed, covering all aspects of the Workshop. As a recommendation was expressed to prohibit the smoking very strictly in the conference rooms , laboratories and on the bus. (In the printed information material everybody was asked to avoid smoking in that places).

5.) Main recommendations of the participants (summarizing)

1.) Final decision should be made on participation at least 3 weeks before the expected departure.

2.) The Workshop materials (Handout) should be distributed in the first day .

3.) The good English knowledge of the expected lecturers and contributors should be controlled.

4.) The Workshop should be much more concentrated to the technological aspects.

5.) More time to spend with plant visits where also more detailed information are requested.

6.) Small groups should be formed for the group works and plant visits according to the special interest.

B.) Evaluation of the Executing Team

According to the judgment of the Executive Team the Workshop was beneficial to the participants in several aspects:

- The knowledge transfer is directly relevant to the professional need of the participants independently on their actual job. They could be acquainted with (although with limitations) one of the most important fields of the new materials and new technologies which at least partly can be applied in their home countries in order to produce products with significantly higher added value.

- They have the opportunity to study the up-to-date chemical, physical, physico-chemical and texture investigations (materials and equipments) can be used at the new product development and at the quality control of the products.

- The participants could study the production technology of some special products during the plant visits and could

discuss some special related topics directly with the well experienced plant experts.

- They could be acquainted with some latest results of the technical development of the Bayer process made in Hungary, e.g. tube digestions, instrumentation and process control, which can be benefited at their companies.

- The Workshop material (Handout) is available even for further studies for each participants. This handout can be used as a training material at the transfer of knowledge in specific training activities will be organized in the home countries of the participants by themselves.

- The participants (or majority of them) definitely advanced in professional skills according to their self-evaluation.

- The Workshop accelerates the development of the production of the by-products and co-products of Bayer alumina production interested (participating) developing countries by means of the establishment of related new facilities. The Workshop gave a good general knowledge in this field which can initiate further activities and promote the decision making.

- The Workshop promoted the continuing education and self education both in professional field and in English and justified the necessity of the professional exchange of views regularly.

Finally some difficulties occurred during the implementation of the project should also be mentioned:

- The related contract became effective by the end of September 1991 only, therefore the Workshop had to be organized in a very short time.

  This fact caused difficulties at selection of candidates, the ordering and location of air tickets, at the final acceptance of the candidates (last-minute decisions,

sometimes 4 days before departure) and at the preparatory work had to be made at ALUTERV-FKI Ltd. and Hungary.

- The special Workshop requested preparing a perfectly new training material (Handout). In contrary of the heroic efforts made by the authors and editor the Handout was available only by the end of the lecture program. Although the critical remarks of the participants accepted, neither the authors, nor the editor and team-leader are responsible for the delay.

- The requirements and wishes of the participants to gain knowledge, especially related to the details of the production technologies of special products and to be acquainted with the related plant facilities in details can be understood, however, it is clear that no any firm all over the world is ready to disseminate his special knowledge (know-how) in this field. this fact explain the attitude of the plant managements of MOTIM Works and Almásfüzítő Alumina Plant. It should be emphasized, however, that they are ready to co-operate with the potential partner companies (institutes or organizations) of the given developing country under the usual normal conditions of a secrecy agreement. We are convinced that ALUTERV-FKI Ltd. and the related HUNGALU plants were much more open than any others in the given field.

- The organization of more small groups during the group works, lab demonstrations and plant visits and to follow the special requests of the individual experts have been expressed also as a willingness of the participants. Although these wishes are also clear, they can not be realized easily or not at all. The question is here the availability at a large number of the highly qualified experts speaking English adequately furthermore the involvement of much more high level experts in the program means extreme increase of the costs, as well. The situation would be rather bad at the plant visits. The group trainings

(Workshops too) are organized for relatively large groups. Relating to the special reports fellowships, individual training programs can be organized and ALUTERV-FKI Ltd. is ready to investigate each such kind of requirements as far as possible in the framework of the co-operation with UNIDO. Relating to the group work we have to find a good compromise in order to limit the number of persons in a group.

- The request of the participants relating to the adequate knowledge of lecturers and demonstrators in English is perfectly right. The very wide range of the topics requested at this Workshop was the main reason why we could not find adequate experts both in professional experience and in English for each lecture. We have to consider this request in the future anyhow.

VI. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Based on the critical remarks of participants and the experiences of the Executive Team with consideration of the preliminary evaluation of the representatives of UNIDO the following measures can be recommended:

A.) Recommendations

1.) The organization of Workshop (Group Trainings) should be started in due time.

2.) The acceptance of the candidates as a participant should be reported at least 3 weeks before the expected departure time.

3.) The Handout writing should be started in due time. The related contract should be effective at least a half year before the start of the Workshop.

4.) The pre-course information for the participants should be reported 4 - 8 weeks before beginning of the training.

5.) Adequate English knowledge is requested on behalf of both participants and instructors.

6.) The organization of smaller groups at lab demonstrations, group works, lab practices and as far as possible also at plant visits is reasonable.

7.) On site (preferably regional) Workshops on co-products and by-products of Bayer alumina production in selected developing countries are recommended in a co-operation of local experts, UNIDO representatives and few experts (limited number of experts) of ALUTERV-FKI Ltd.

8.) The on site regional Workshops can be combined with the common preparation of a techno-economic (pre-feasibility or opportunity) study dealing with the production of a selected (interested) co-product or by-product.

B.) Follow-up activities

Relating to the potential follow-up actions of the Workshop a special Questionnaire was prepared and distributed to the participants on 5th December by the representative of UNIDO, Dr. T. Gróf. The Questionnaire and Document of UNIDO concerning with these topics are attached a Appendix VIII.

The potential follow-up activities of the Workshop are summarized below, together with all existing and expected projects relating to the alumina production in the given country independently on the UNIDO assistance:

Brazil:

1.) Development of zeolite production (in co-operation with San Carlos University). First step: Prefeasibility Study.

2.) Construction of ALUNORTE Refining (in progress already) 850.000 tpy.

3.) Development of advanced ceramics South American regional program at San Carlos University.

4.) Tube digestion, energy savings, maintenances, alumina plant expansion.

5.) High purity gallium production at CETEM, (Brazil). Training in this field.

China:

1.) Improvement of soda recovery from red mud by hydrothermal treatment.

2.) Replacement of the combined Bayer-sinter process by Bayer process.

3.) Improvement of red mud disposal.

Egypt:

1.) Establishment of an aluminium-sulphate pilot plant for paper industry.

2.) Production of aluminium zeolite supported catalyst for petrochemical industry.

3.) Workshop on production of rare metals.

4.) Training program on alumina production from bauxite.

5.) Establishment of an alumina plant with 1.000.000 tpy capacity.

6.) Establishment of an alumina pilot plant.

India:

1.) Organization of a national Workshop on special aluminas in India at Nagpur Research Centre.

Iran:

1.) Production of ceramics for spark plugs (at MERC Institute).

2.) Feasibility Study for production of special aluminas (at IDRO).

3.) Establishment of pilot plant for special alumina.

Jamaica:

1.) Application of tube digestion, energy savings at APPART.

Saudi Arabia:

1.) Feasibility Study for alumina plant.

2.) Special alumina production.

Turkey:

1.) V_2O_5 pilot plant.

2.) Gallium production.

3.) Conversion of floury alumina production to sandy (investment).

4.) Aluminium-sulphate project.

Venezuela:

1.) Plant expansion to 2.0 million tpy at Interalumina has been finished.

2.) Next step of expansion to reach 3.0 million tpy capacity combined with some improvement, e.g. red mud disposal. Technical assistance is requested on behalf of UNIDO.

3.) Ceramic aluminas (refractory, activated aluminas). UNIDO training program is requested.

4.) Zeolite production.

5.) Aluminium trihydrate gel.

6.) Development of XRD Lab.

7.) Soft-gamma-ray lab model settler.

VII. ACKNOWLEDGEMENTS

Herewith we express our gratitude to the representatives of UNIDO, especially to Mr. J. V. Krouzek and Dr. T. Gróf further to Dr. T. Sömjén and Dr. Zs. Zöldág for their successful organizing activities and to UNIDO Hungarian National Committee for the financial support and kind assistance. Special thanks for the management headed by Gy. Keebe of ALUTERV-FKI Ltd. for the kind contribution and good technical conditions assured. Last but not least many thanks for all contributors at HUNGALU plants and at ALUTERV-FKI Ltd., especially to authors, lecturers and technical assistants.

Budapest, 28.03.1992.

Dr. K. Solymár
team-leader

Dr. L. Gillemot
chief-organizer

Appendix I

Project Document

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Project Document

Title: Workshop on Co-products and By-products of the Bayer Alumina Production Budapest, Hungary, October 1991

Number: UD/UC/GLO/91/148 Country: Global

Total UNIDO budget: US$119,500 (equiv. to Ft 8,843,000)
(excl. support costs) US$21,000 (convertible)

Estimated starting date: September 1991

Planned duration: 6 months

Backstopping section/branch: Metallurgical Industries Branch (PE code: J 13207)

Government Implementing Agency: ALUTERV-FKI, Budapest, Hungary

Official Government request: Hungarian Government offer to host the Workshop:

1. - Telefax Dr. Susan Zoldag/ Mr. J.V. Krouzek dated 14 May 1991 - Attachment 1.

   - Minutes of discussion of the Annual Session of the Joint UNIDO/Hungary Committee for Co-operation, Budapest, 21-23 January 1991 - Attachment 2.

2. Interest of developing countries (see page 4 of Project Document).

Endorsement by the UNDP Resident Representative:

I. Background and Justification

a) Background information

Two elements, oxygen and silicon constitute about three quarters by weight of the earth's crust. Aluminium is the third most abundant element followed by iron. Aluminium is a constituent of many rocks and minerals. Amongst them bauxite is the main raw material for the production of alumina, aluminium metal and aluminium chemicals.

Most of the bauxite resources are in the developing countries (Guinea, Brazil, Suriname, Viet Nam, China, Indonesia, etc. and only one of the developed countries (Australia) has really significant high-quality bauxite reserves. Most of these countries convert at least part of their bauxite into commercial grade alumina or even into aluminium.

Alumina is the most important compound of aluminium. The commercial process for the extraction of alumina was invented by the Austrian chemist Bayer in 1887. The principles of the Bayer process have remained unchanged for a century; however, continual improvements have been made to the process, particularly with respect to energy consumption.

There are three main grades of alumina - metallurgical, refractory and chemical. Some 90% of the approximately 35 million t/y of alumina produced world-wide is used for aluminium smelting (metallurgical grade). The remaining part of the annual production finds application in areas which utilize the high melting point, excellent mechanical strength, electrical resistivity, or chemical inertness of aluminium oxide.

These, sometimes "high-tech" alumina products are not produced in the developing countries.

There is a significant regional shift of the alumina industry from North America, Japan and Europe to Australia and to the developing countries of Latin America and Asia. As of today thirty alumina plants (nearly half of the total 67) are situated in developing countries. A part of the alumina plants in Europe, USA and Japan were shut down, and due to low profits of metallurgical grade aluminas, some of them were converted from metallurgical grade to the production of high price speciality aluminas and hydrates, giving up the manufacture of metallurgical grade commodities entirely.

This trend clearly indicates that one of the most effective means to increase the competitiveness of the alumina refineries seems to be the manufacturing of higher value, new products in the alumina cycle. Gallium, vanadium-pentoxide, alumina hydrate filling and fire retarding materials, special aluminas, fused corundum, mullite and special refractories, abrasive materials, Al_2O_3 based fibres, Al_2O_3 ceramic insulators and integrated circuit substrates, sodium-silicate (water glass), zeolites (detergents), aluminium-sulphate (water treating agent), catalysts and composites can be mentioned among them without completeness.

The value of the mentioned special co-products and by-products exceeds two to ten times that of the metal-grade alumina, while the production cost of these products is increased less significantly only. It is also important that the price of these products is more or less stable and is not affected by the fluctuation of stock-exchange manoeuvres.

Some of these products are used in a relative huge quantity in the developing countries (aluminium sulphate, ceramic aluminas, aluminium-hydrate, etc.) but most of them have to be imported nowadays. Therefore, the domestic production of these chemical grade aluminas is highly recommended.

It should be mentioned that not only the non-metal grade alumina producing capacity (about 3,000 kt/a) is concentrated mainly in the developed countries but the availability of the relating technolgical know-how is also very limited.

Several developing countries (Venezuela, Jamaica, India, Yugoslavia, etc.) showed interest in the production of special aluminas and communicated it to UNIDO during various staff member missions (e.g., during attendance at the Regional Expert Group Meeting on the Development of the Non-ferrous Metals Industry in Latin America and possibilities for Complimentarity, Cordoba, Argentina, March 1989 and during subsequent missions to Latin America and the Caribbean, March 1991 and India, May 1991).

b) Justification

Considering the above-mentioned circumstances, a Workshop on co-products and by-products in Bayer alumina production is considered the best way to acquaint specialists from the developing countries with the production process of special aluminas, with their properties and fields of application. The participants will be invited from countries having important bauxite/alumina industry but lacking experience in the production of special alumina. The Workshop will highlight the possibilities of the establishment of new

facilities beside and/or in the alumina refineries for the production of special products. These new production units are designed for the domestic manufacturing of goods of higher added value instead of their import. This will also facilitate better utilization of natural resources of the developing countries and efficent application of the co- and by-products in different fields of industry.

This Workshop will be in line with the priorities of several developing countries (introduction of new materials, increase of added value of goods manufactured in these countries). The Workshop could explore new fields of technical assitance and identify new large-scale programmes and projects.

2. Special Considerations

The planned activities will be undertaken within the framework of the Joint UNIDO/HUNGARY Programme for Co-operation in the Aluminium Industry Field, concluded between UNIDO and the Hungarian Government in October 1976, with the main objective of making available to developing countries the wide experience of the Hungarian aluminium industry. The main source of financing will be the Hungarian Forint contribution. The Hungarian Aluterv-FKI R&D Centre which is providing in kind contribution to the project has already organized several successful UNIDO training programmes in the alumina industry.

II. The Project

1. Objectives

a) Immediate objective

The immediate objective of the project is to provide assessed information in the field of research, development, production, testing, quality management and application of some selected high value added alumina co-products (e.g., special aluminium hydroxides, activated aluminas, industrial chemicals, zeolites, etc.) and by-products (e.g., gallium) with the aim to assist the countries represented in the Workshop in establishing the manufacture of the above products

2. Outputs and activities

Output 1

Lectures and other training materials on the production, properties and application of special aluminas.

Activities for Output 1

1. Activities in preparation of Workshop

		Duration
1.1.1	Selection and recruitment of Short-term consultants to prepare papers for the lectures (programme attached)-UNIDO.	
1.1.2	Preparation of the aide-memoire training materials by the international expert/UNIDO.	3 months

Output 2

15 experts from different developing countries will be acquainted with the theory and technology of the production, characterization, quality management and application of co- and by-products of the Bayer alumina production.

Activities for Output 2

		Duration
1.2.1	Invitation of participants having experience in the bauxite/ alumina field-UNIDO.	2 months
1.2.2	Implementation of Workshop according to the attached tentative programme-UNIDO/ALUTERV.	0.5 months

2. The Workshop

1.2.3 Duration: 2 weeks

1.2.4 Dates: IV. Quarter 1991

1.2.5 Place: Budapest

1.2.6 Countries invited to participate:
China (2 persons), India (2 persons), Jamaica (2 persons), Brazil (2 persons), Venezuela (2 persons), Iran (2 persons), Guinea (1 person), Yugoslavia (1 person), Turkey (1 person).

1.2.7 Workshop programme attached.

Output 3

Technical assistance draft project documents prepared for further discussion and finalization.

		Duration
	Activities for Output 3	
1.3.1	Identification of technical asisstance needs in the production and application of special aluminas and hydrates in the countries represented, by the consultants and participants	1 month
1.3.2	Collection of data and information for the project formulation	2 months
1.3.3	Formulation of draft project documents and submission of them to the Governments and UNIDO for further discussion and finalization	3 months
3.	Post Workshop activities	
1.2.8	Distribution of the training course materials to the participants and other interested countries	2 months
1.2.9	Checking the effectiveness of the training by preparation of a report by the trainees after their return to work-UNIDO/ participants.	2 months

3. Inputs

3.1 Government inputs

The Governments of the selected countries will nominate and delegate appropriate participants for the Workshop in Hungary. The participants should speak fluent English and be trained and experienced in, and associated with the production/application/R&D/quality control/testing of alumina and/or its by- or co-products. The Governments will make efforts to utilize and disseminate the acquired knowledge of the trainees.

3.2 UNIDO inputs

		US$ convert.	Hungarian Forint equiv. to US$	Hungarian Forint (at UN ROE US$1=Ft74)
BL 16-00	Participation of UNIDO staff in the Workshop preparation and implementation	1,500	1,000	74,000

		US$ convert.	Hungarian Forint equiv. to US$	Hungarian Forint (at UN ROE US$1=Ft74)
BL 17-01	National exp. on preparation of Workshop handouts		6,000	444,000

BL 35-00

1. Airticket costs in US$

From	Number	Total US$
China	2	6,000
India	2	2,600
Jamaica	1	3,100
Egypt	1	1,100
Saudi Arabia	1	1,700
Brazil	2	7,600
Venezuela	2	5,600
Mexico	1	3,100
Iran	1	1,700
Guinea	1	2,100
Yugoslavia	1	400
Turkey	1	900
Ghana	1	1,900
Indonesia	1	3,400
	18	41,200

40% payable in convertible currency;
60% payable in Hungarian Forints

		16,500	24,700	1,827,800
2.	Provision for forced stop-overs (at ad hoc rate $100)	2,000		
3.	Pocket money $40 x 13 days/ participant		9,360	692,640
4.	Hotel + full board + local transportation US$160 x 14 days/ participants (incl. provision for early arrivals/late departures due to airline schedules		40,320	2,983,680
5.	Plant visits		4,500	333,000
6.	Lecturers, laboratory personnel, conference room, cost of laboratory, demonstrations, administrative, charges, communication costs,overheads		32,120	2,376,880
	Sub-total BL 35-00	18,500	111,000	8,214,000

	US$ convert.	Hungarian Forint equiv. to US$	Hungarian Forint (at UN ROE US$1=Ft74)
BL 51-00 Miscellaneous	1,000	1,500	111,000
GRAND TOTAL	21,000	119,500	8,843,000

3.3. In kind contribution of Aluterv-FKI

Use of conference room, laboratory facilities, consumables for the laboratory demonstrations, organization of plant visits, administrataive assistance.

III. Reporting and Evaluation Requirements. Expected Follow-up

The participant of the Workshop will prepare a study tour report reflecting the topics of main interests for their country related to the field of the Workshop. In the report the participants will include possible development areas of production and application of alumina co- and by-products.

A Group Training Project Evaluation Report will be prepared upon completion of the training programme by the host organization.

The proceedings of the Workshop will be sent to UNIDO for further dissemination of non-classified information to other developing countries. In addition, an ex-post survey using questionnaires sent to ex-participants will be carried out in accordance with UNIDO guidelines.

TENTATIVE PROGRAMME

1. day: Lectures

- Main trends of the further development of the alumina production: geographical and product restructuring.
- Co-products and by-products in Bayer alumina production.
- General overview of the techniques of quality control in the field of special products.

2. day: Lectures

- Development and production of non-metallurgical aluminas. Hungarian experiences.
- Ceramic aluminas. Ceramic and technological properties of low soda special aluminas.
- Production of aluminium-sulphates.

3. day: Lectures

- Problems and techniques of phase analysis of transition aluminas.
- Demonstration of the techniques of the structure/phase/analysis: X-ray diffraction, data banks, thermal analysis, infrared spectroscopy.

4. day: Plant visit to MOTIM Works

Alumina plant with tube digestion, aluminium-sulphate plant, special alumina as abrasive polishing material, fused corundum products.

5. day: Lectures

Major, minor and trace element analysis by instrumental chemical methods:

- X-ray fluorescence analysis.
- Atomic emission and absorption spectroscopy.
- Inductively coupled plasma technique.

Demonstration of the instruments in the instrumental chemical analysis laboratory.

6. day: Lectures: By-products of the Bayer process

- Gallium recovery from the Bayer cycle.
- Production of vanadium pentoxide.

Discussion

7. day: Lectures

- Production of fine-grained aluminium-hydroxide products.
- Production of zeolites.

Discussion

8. day: Plant visit to the Ajka Works: Alumin plant, production of fine-grained alumina hydrate, gallium recovery, production of zeolites.

9. day: Lectures:

- Morphological features and surface analysis of special products.
- Porosity, grain size analysis and surface area determination.

Demonstration of the instruments in the laboratory for electron-microscopy.

10. day: Visit to Engg. and Reg. Centre for Silicate Industry, Budapest. Lecture and demonstration: Aluminium-oxide ceramics.
Evaluation tests of basic materials and ceramic products.

Discussion of the Workshop results, follow-up possiblities. Evaluation of the usefulness and future benefits of the skills acquired by the trainees.

Appendix II

Aide Memoire

AIDE MEMOIRE

Workshop on Co-products and By-Products of the Bayer Alumina Production

organized by

THE UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

to be held in Budapest, Hungary
25 November - 6 December 1991

I. Background Information

Two elements, oxygen and silicon constitute about three quarters by weight of the earth's crust. Aluminium is the third most abundant element followed by iron. Aluminium is a constituent of many rocks and minerals. Amongst them bauxite is the main raw material for the production of alumina, aluminium metal and aluminium chemicals.

Most of the bauxite resources are in the developing countries (Guinea, Brazil, Suriname, Viet Nam, China, Indonesia, etc. and only one of the developed countries (Australia) has really significant high-quality bauxite reserves. Most of these countries convert at least part of their bauxite into commercial grade alumina or even into aluminium.

Alumina is the most important compound of aluminium. The commercial process for the extraction of alumina was invented by the Austrian chemist Bayer in 1887. The principles of the Bayer process have remained unchanged for a century; however, continual improvements have been made to the process, particularly with respect to energy consumption.

There are three main grades of alumina - metallurgical, refractory and chemical. Some 90% of the approximately 35 million t/y of alumina produced world-wide is used for aluminium smelting (metallurgical grade). The remaining part of the annual production finds application in areas which utilize the high melting point, excellent mechanical strength, electrical resistivity, or chemical inertness of aluminium oxide. Refractory, wear resistant ceramic parts, equipment for chemical processing and high voltage insulators are the classical products. Newer applications include substrates for integrated circuits and reinforcing fibres for polymer and metal-based composites. Surface oxides on aluminium and its alloys play an important role in corrosion and protection from corrosion, in adhesive bonding, coating and laminating of metal. They are also applied in the manufacture of capacitors and electronic devices such as MOM (Metal Oxide Metal) transistors. The unique surface properties of the structurally and stoichiometrically disordered transition aluminas are utilized in catalysis and separation technology.

Many of these applications were driven by an increasing scientific understanding of the chemical; structural and surface properties of aluminium hydroxides and oxides.

These, sometimes "high-tech" alumina products are not produced in the developing countries.

There is a significant regional shift of the alumina industry from North America, Japan and Europe to Australia and to the developing countries of Latin America and Asia. As of today thirty alumina plants (nearly half of the total 67) are situated in developing countries. A part of the alumina plants in Europe, USA and Japan were shut down, and due to low profits of metallurgical grade aluminas, some of them were converted from metallurgical grade to the production of high price speciality aluminas and hydrates, giving up the manufacture of metallurgical grade commodities entirely.

This trend clearly indicates that one of the most effective means to increase the competitiveness of the alumina refineries seems to be the manufacturing of higher value, new products in the alumina cycle. Gallium, vanadium-pentoxide, alumina hydrate filling and fire retarding materials, special aluminas, fused corundum, mullite and special refractories, abrasive materials, Al_2O_3 based fibres, Al_2O_3 ceramic insulators and integrated circuit substrates, sodium-silicate (water glass), zeolites (detergents), aluminium-sulphate (water treating agent), catalysts and composites can be mentioned among them without completeness.

The value of the mentioned special co-products and by-products exceeds two to ten times that of the metal-grade alumina, while the production cost of these products is increased less significantly only. It is also important that the price of these products is more or less stable and is not affected by the fluctuation of stock-exchange manoeuvres.

Some of these products are used in a relative huge quantity in the developing countries (aluminium sulphate, ceramic aluminas, aluminium-hydrate, etc.) but most of them have to be imported nowadays. Therefore, the domestic production of these chemical grade aluminas is highly recommended.

It should be mentioned that not only the non-metal grade alumina producing capacity (about 3,000 kt/a) is concentrated mainly in the developed countries but the availability of the relating technological know-how is also very limited.

Several developing countries (Venezuela, Jamaica, India, Yugoslavia, etc.) showed interest in the production of special aluminas and communicated it to UNIDO during various meetings (e.g., at the Regional Expert Group Meeting on the Development of the Non-ferrous Metals Industry in Latin America, Cordoba, Argentina, March 1989; and during subsequent missions to Latin America and the Caribbean, March 1991 and India, May 1991).

Considering the above-mentioned circumstances, a Workshop on co-products and by-products in Bayer alumina production is considered the best way to acquaint specialists from the developing countries with the production process of special aluminas, with their properties and fields of application. The participants will be invited from countries having important bauxite/alumina industry but lacking experience in the production of special alumina. The Workshop will highlight the possibilities of the establishment of new facilities beside and/or in the alumina refineries for the production of special products. These new production units are designed for the domestic manufacturing of goods of higher added value instead of their import. This will also facilitate better utilization of natural resources of the developing countries and efficient application of the co- and by-products in different fields of industry.

This Workshop will be in line with the priorities of several developing countries (introduction of new materials, increase of added value of goods manufactured in these countries), could explore new fields of technical assistance and identify new large-scale programmes and projects.

The planned activities will be undertaken within the framework of the Joint UNIDO/HUNGARY Programme for Co-operation in the Aluminium Industry Field, concluded between UNIDO and the Hungarian Government in October 1976, with the main objective of making available to developing countries the wide experience of the Hungarian aluminium industry. The main source of financing will be the Hungarian Forint contribution to UNIDO. The Hungarian Aluterv-FKI R&D Centre which is providing in kind contribution to the project has already organized several successful UNIDO training programmes in the alumina industry.

II. Objectives

The aim of the Workshop is to contribute to the better utilization of the comparative advantages/mineral resources of developing countries already producing or planning to introduce the production of bauxite and/or alumina.

The immediate objective of the project is to provide assessed information in the field of research, development, production, testing, quality management and application of some selected high value added alumina co-products (e.g., special aluminium hydroxides, activated aluminas, industrial chemicals, zeolites, etc.) and by-products (e.g., gallium) with the aim to assist the countries represented in the Workshop in establishing the manufacture of the above products.

III. Programme

The ten working days of the Workshop will consist of the following parts:

- lectures delivered by consultants of ALUTERV-FKI Ltd. and of different Hungarian alumina plants;
- plant visits;
- consultations with the lecturers (discussions of the existing problems and possible means for their resolution);
- demonstrations in laboratories.

IV. Participation

Participants to the meeting are being invited by UNIDO. The latter will finance travel and daily subsistence allowance for 18 participants selected by UNIDO in accordance with the UNIDO rules and regulations (see para. VII).

Up to ten further participants are accepted for a preferential fee of US$3,000/person which include Workshop charges, hotel accommodation with full board and local transportation in Hungary. Travel costs of these participants should also be paid by the participants.

The Governments of the selected countries are requested to nominate and delegate appropriate participants for the Workshop in Hungary. The participants should speak fluent English and be trained and experienced in, and/or associated with the production/application/R&D/quality control/testing of alumina and/or its by- or co-products. The Governments are asked to make efforts to utilize and disseminate the acquired knowledge of the trainees.

The participants of the Workshop should undertake to prepare and submit to UNIDO a study tour report reflecting the topics of main interests for their country related to the field of the Workshop. In the report the participants will include possible development areas of production and application of alumina co- and by-products. The report should reach UNIDO not later than 15 January 1992.

The participants of the Workshop will be requested to make a presentation of the present status of the sector in their home country with the aim of developing better understanding of the problems and initiate professional debate on technical development. The representations should be submitted in written form on the first day of the venue.

V. Location and Date

The Workshop will be held in the ALUTERV-FKI Ltd., Budapest, Hungary from 25 November - 6 December 1991.

VI. Working Language

The working language will be English. All the lectures and discussions will be held in English. A good working knowledge in English will enable participants to take an active part in the Workshop.

VII. Travel and Financial Arrangements

For participants from various countries invited by UNIDO, the latter will provide the round trip air transportation following the most direct and economical route between the airport of the capital town of departure in the home country and the airport in Budapest. Tickets will be issued through the local airline office. Participants should not purchase their own tickets and should wait for the notification that their tickets may be collected. Participants are not entitled to excess luggage. Participants are requested to indicate their exact address and preferably home and office telephone numbers on the Nomination Form for the purpose of being notified.

UNIDO will pay the pocket money (US$40 in non-convertible Hungarian Forints for a maximum of 13 nights in Hungary) for the 18 free participants of the Workshop on the first day of the meeting. UNIDO will book and cover hotel accommodation as well as meals, not only for the working day but for the weekend spent in Hungary too. To cover incidental expenditures, stopovers, transfers, airport taxes, etc. UNIDO will pay for non-European participants US$100 reimbursement upon their arrival in Budapest. No additional reimbursement will be considered by UNIDO or Aluterv-KFI due to delays not envisaged, connection difficulties, changes in flight reservations, etc. It is expected that participants will arrive in Budapest generally one day prior to the meeting, i.e. 24 November 1991. They will be free to depart in the evening, 7 December 1991. The flight reservations for the homeward journey will be arranged well in advance by ALUTERV-FKI Ltd.

Participants are kindly requested to inform by telex or cable of their acceptance of this invitation, not later than 30 September 1991. Communication should be addressed to:

Mr. L. Gillemot
Head of Department for Materials Science
ALUTERV-FKI Ltd.
Fehervari Str. 144
Budapest, Hungary

H-1389 Budapest, P.O. Box 128
Hungary

Telex: 22-6029 fki bp
Telefax: (00361) 185-0153
Tel. (00361) 185-0153

Copy to:

Mr. T. Grof
Metallurgical Industries Branch
United Nations Industrial Development Organization
Vienna International Centre
P.O. Box 300
A-1400 Vienna, Austria

Cable: unido vienna
Telex: 135612
Telefax: 232156
Tel.: 21131-4714

The participants' Government employers or the participants themselves will be required to bear the following costs in connection with their attendance at the Workshop:

a) All expenses in the home country incidental to travel abroad, including expenditure for passport, visa and other such miscellaneous items as well as internal travel to and from the airport or departure in the home country.

b) Salary and other benefits for the participants during the period of their attendance at the Workshop.

Visa and vaccination requirements

Participants must possess valid passport or travel documents. Before leaving home countries for Hungary, participants are urged to contact the nearest diplomatic or consular office of Hungary to obtain information on visa and custom regulations, as well as health and possible vaccination requirements in connection with their trip. The Letter of Award should be presented to the Hungarian Embassy or Consulate concerned.

Hotel accommodation

For the participants, ALUTERV-KFI Ltd. will arrange the hotel reservations and will cover the related costs in a suitable high-level hotel in single rooms.

Local transportation

The local transportation during the official programme, including everyday transfer from the hotel to the venue of the Workshop and return will be arranged by ALUTERV-FKI Ltd.

The public transportation system (taxi, bus, tramway, underground) of Budapest is of high international standard, reliable and relatively cheap.

Climate

The climate of Hungary at this time of the year is generally rather cold (about or somewhat below 0 °C). Snow is possible.

Exclusions

Neither UNIDO nor ALUTERV-FKI Ltd. will assume any responsibility for the following expenditures in connection with participants' attendance at the activity:

a) Costs incurred by participants with respect to any insurance, medical bills or hospitalization fees in connection with their attendance at the Workshop.

b) Purchase of personal belongings and compensation in the event of damage caused by somebody, by climatic or other conditions.

c) Compensation in the event of death, disability or illness of the participants in connection with attendance at the Workshop.

d) Loss of, or damage to, personal property of participants while attending the Workshop.

Miscellaneous

In case of questions, participants are kindly requested to contact: Mr. L. Gillemot and/or Mr. T. Grof - address see page 5.

NOMINATION FORMS SHOULD BE COMPLETED BY PROSPECTIVE CANDIDATES AND SENT TO UNIDO IN TRIPLICATE NOT LATER THAN:

10 October 1991.

PROVISIONAL AGENDA

25 November 1991	Monday
0900 - 0945	Opening of the meeting - Statements of the representatives of UNIDO. - Statements of the representatives of the Hungarian Committee for UNIDO - Statements of the representatives of HUNGALU Rt - Statements of the representatives of ALUTERV-FKI Ltd.
1000 - 1200	Lectures Main trends of the further development of the alumina production: geographical and product restructing
1200 - 1400	Lunch break
1400 - 1630	Lectures Co-products and by-products in Bayer alumina production General overview of the techniques of quality control in the field of special products
26 November 1991	Tuesday
0900 - 1200	Lectures Development of the production of non-metallurgical aluminas. Hungarian experiences. Ceramic aluminas. Ceramic and technological properties of low soda special aluminas.
1200 - 1300	Lunch break
1300 - 1600	Lectures Ceramic aluminas. Ceramic and technological properties of low soda special aluminas (cont.) Plasma materials for ceramics Production of aluminium-sulphates
27 November 1991	Wednesday
0900 - 1200	Lectures Problems and techniques of phase analysis of transition aluminas Major, minor and trace element analysis by chemical methods - X-ray fluorescence analysis - Emission and atomic absorption spectroscopy - Inductively coupled plasma technique
1200 - 1300	Lunch break
1300 - 1600	Lectures . Major, minor and trace element analysis by chemical methods (contd.) - X-ray fluorescence analysis - Emission and atomic absorption spectroscopy - Inductively coupled plasma technique Consultation on material testing
28 November 1991	Thursday
0800 - 1800	Plant visit to MOTIM Works

29 November 1991	Friday
0900 - 1200	Demonstration inlaboratories
1200 - 1300	Lunch break
1300 - 1600	Demonstration in laboratories (contd.)
2 December 1991	Monday
0900 - 1200	Lectures Gallium recovery from the Bayer cycle Production of vanadium pentoxide Production of fine-grained aluminium hydroxide products
1200 - 1300	Lunch break
1300 - 1500	Demonstration on test system of model grinding system
1500 - 1600	Consultation on technologies
3 December 1991	Tuesday
0900 - 1200	Lectures Production of zeolites Morphological features and surface analysis of special products
1200 - 1300	Lunch break
1300 - 1500	Lectures Porosity, grain size analysis and surface area determination
1500 - 1600	Consultation
4 December 1991	Wednesday
0800 - 1800	Plant visit to the Ajka Works
5 December 1991	Thursday
0830 - 1200	Visit to Engineering and Developing Centre for Silicate Industry Lectures Aluminiumoxide-based ceramics and their testing methods
1200 - 1330	Lunch break
1330 - 1630	Demonstration in laboratories
6 December 1991	Friday
0900 - 1100	Consultation
1100 - 1200	Closing session
1200 - 1400	Lunch

Appendix III

List of participants

LIST OF PARTICIPANTS

Mr. Ricardo Rodrigues de Carvalho
Alcoa Alumino S. A.
Rua Comendador J.A.Junqueira, 92.
Pocos de Caldas, MG 37700
Brasilia

Mr. Plinio Eduardo Praes
CETEM/CNPQ
Rua 4. Quadra D.-CID Universitaria
CEP 21949 Ilha do Fundao
Rio de Janeiro
Brasilia

Mr. Yang Siming
Shandong Aluminium Plant
Zhangdian, Zibo
Shandong 255052
China

Mr. Chen Wankun
Zhengzhou Light Metals Research Institute
Shangjie
Zhengzhou 450041
China

Mr. Zaki Abdo Basuoni
The Aluminium Company of Egypt
48 Abd El Khalek Sarwat Str.
Cairo
Egypt

Prof.Dr. Adel Kamal Ismail
Central Metallurgical R&D Institute
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Aluminium Company of Egypt
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Puerto Ordaz
Venezuela

Ms. Maritza **Faneitte Martinez**
CVG Interalumina
Zona Industrial Matanzas,
Ciudad Guayana
Edo.Bolivar,Apartado 289
Puerto Ordaz
Venezuela

Mr. Franqui Jose **Patines Moco**
Instituto de Ingenieria
Apdo.40200
Caracas 1040-A
Venezuela

Appendix IV

List of lecturers and authors of Handout

LIST OF LECTURERS AND AUTHORS OF HANDOUT

Mrs. Márta Altrichter, MSc.
ALUTERV-FKI Ltd.
Research Engineer

Completed her studies at University of Chemical Engineering, Veszprém in 1974. She worked for Almásfüzitő Alumina Plant from 1976 to 1984 as head of laboratory for special aluminas. She has been working for ALUTERV-FKI since 1984 where her main topics are as follows: Bayer precipitation, technological testing of bauxites, developing new technologies for special alumina production, application of different chemicals in the Bayer-process.

Mr. György Baksa, BSc, MSc, PhD.
Hungalu Ajka Aluminiumindustrial Ltd.
General Manager

After finishing his studies he got his MSc degree on chemical engineering at University of Veszprém in 1968. Later on he took part in a postgradual education at Budapest Technical University and got his second MSc degree on economical engineering in 1982. He has been working for HUNGALU AJKA ALUMINIUMINDUSTRIAL Ltd. since 1968. His special fields were the development of alumina production technology especially the lime chemistry of Bayer process and the precipitation of aluminium-trihydroxide. This latter was the subject of his dissertation for PhD.

Mr. Zoltán Balogh, BSc.
Hungalu Ajka Aluminiu mindustrial Ltd.
Head of Products' Development Department

graduated at University of Chemistry in Veszprém in 1980. He has been working for Hungalu Ajka Aluminiumindustrial Co., Ltd. since 1981. His special field has been the development of alumina technology.

Mr. György Bánvölgyi BSc, MSc.
ALUTERV-FKI Ltd.
Senior Process Engineer

Got MSc. degree at the University of Chemical Engineering, Veszprém, Hungary in 1972. He was involved in the optimisation of the process technology of the Hungarian alumina plants and took part in the elaboration of several relating Feasibility Studies.

Mrs. Magdalena Borsodi, BSc, MSc, PhD.
ALUTERV-FKI Ltd.
Research Fellow

Graduated at ELTE University, Budapest as a chemist. She has different tasks of researching, developing and data service in the AAS Laboratory of the Department. She is engaged in chemical and analytical examination of different materials, including determination of main and impurity components of bauxite, red mud, alumina, pure and alloyed aluminium metal.

Mrs. Ágnes Csanády, BSc, MSc, PhD, CSc.*
ALUTERV-FKI Ltd.
Scientific Councillor

Graduated at ELTE University in chemistry. She is experienced in material science as well as in aluminium and aluminium based alloys, as in the morphology structure and composition of bauxites, ATH, and aluminium oxides. Recently her special fields are the surface reactions of bulk and thin film materials. Member of the board of the International Federation of Electronmicroscopic Societies and some other international and Hungarian Scientific Committees.

Miss Anna Csordás Tóth BSc, MSc, PhD.
ALUTERV-FKI *Ltd.*
Head of the Laboratory for Electron Microscopy

As physicist her main activities are the investigation non-metallic materials, SEM and TEM, microanalysis and image analysis of particular materials. In 1990 she was elected secretary of the Hungarian Society on Electron Microscopy.

Mrs. Margarita Dimitrova-Lukács, BSc, PhD.
Central Research and Design Institute for Silicate Industry (SZIKKTI)
Senior Researcher

In 1969 graduated as engineer in powder metallurgy at the Kiev Technical University (Ukraina). She studied the influence of rare earth oxides on the magnetic and electrical properties of some soft and hard ferrites. She has been working as a senior researcher at the Special Ceramics Department (SZIKKTI) in the field of zirconia based advanced ceramics and high temperature ceramic superconductors. Field of interest: advanced ceramics.

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* CSc. = Candidate of Sciences, special Hungarian scientific degree between PhD. and DSc.

Mr. Attila Farkas M.Sc.
ALUTERV-FKI Ltd.
Head of Instrumental Chemical Laboratory

Graduated at Budapest Technical University on Chemical Engineering Faculty in 1970. Since 1988 he has been working for the ALUTERV-FKI in Instrumental Laboratory. His tasks were here: analyses of slurries by ICP-OES technique, investigation of microwave digestion, the control of producing Standard Reference Materials from highly alloyed aluminium.

Mrs. Judit Fekete BSc.
ALUTERV-FKI Ltd.
Research Fellow

Graduated Heavy Industrial University, Miskolc, as metallurgist. Her main interesting fields are the morphology of different powders and surface chemistry. She is involved the development of ceramic powders.

Mrs. Krisztina Fodor, BSc, MSc.
Ajka Aluminiumindustrial Co., Ltd.

Graduated at Chemical University of Veszprém in 1978. She is interested in the instrumental material tests out of the analytical methods. She directs the research work as a group leader at the Laboratory of Ajka Aluminiumindustrial Co., Ltd.

Mrs. Mária Földvári, BSc.
Ajka Aluminiumindustrial Co., Ltd.

Mr. László Gillemot, BSc, MSc, PhD.
ALUTERV-FKI Ltd.
Head of Department for Material Science

Graduated at Technical University of Budapest, as mechanical engineer. His special fields are mechanical testing and forming of semis, and application of aluminium products. Acting as short term expert for UNIDO.

Mr. József György, BSc, MSc, PhD.
Szikkti,
Head of Department

He graduated for chemistry at ELTE TTK, Budapest. From 1965 on he has been fellow researcher with Szikkti. His area of activity has been the development of aluminium oxide basic materials in order to produce ceramics of predetermined properties.

Mrs. Éva Hidvégi, BSc, MSc, PhD.
ALUTERV-FKI Ltd.
Head of Information Centre

Mechanical engineer, received her PhD in 1970 in metallurgy and material testing at the Technical University of Budapest. As the organiser of the Information Centre, her present main field of interest is the collection and evaluation of technical and trading information.

Mr. Aladár Imre BSc, MSc, PhD, CSc
ALUTERV-FKI Ltd.
Head of Laboratory

Chemist, head of the Research Department of New Materials and Technologies. Main fields of activity: surface chemistry of products of the aluminium industry, production of vanadium chlorides and aluminium chloride, production of special alumina.

Mr. Róbert Jelinkó BSc, MSc, PhD.
Research Institute for Technical Chemistry of the Hungarian Academy of Sciences, Veszprém

Graduated at University of Chemical Engineering, Veszprém, Hungary in 1978. His special fields were chlorination of aluminium-oxide at high temperature and mobilizing and mixing of solid systems. He made a procedure to determine local concentration and rate of flowing solid systems. Recently he has been investigating new inorganic processes, use of zeolites and properties of intensive gas-solid/gas-liquid systems.

Mrs. Erzsébet Juhász, BSc
ALUTERV-FKI Ltd
Research Fellow

Chemical engineer, experienced in halogen metallurgy and in plasma technologies. Main fields of activity: production of metal chlorides, chlorination of aluminouos ores, preparation of ceramic raw materials in plasmas.

Mrs. Éva Kálmán, BSc, MSc. PhD.
ALUTERV-FKI Ltd.
Head of the Laboratory for Wet Chemistry and Ion-chromatography

Since 1975 she has been working at ALUTERV-FKI in the Materials Science Department. Her main activities are the investigation of trace element analyses, developing of Spectrophotometric and Ion-chromatographic methods. In 1990 she was elected as the secretary of Analytical Chemistry Section of the Hungarian Society of Chemists.

Mr. Tibor Kálmán, BSc, MSc, PhD.
ALUTERV-FKI Ltd.
Head of Department for the Development of Specialty Aluminium Hydroxide/Oxide Products

Graduated in 1965 at Veszprém University of Heavy Industry in Chemical Engineering (inorganic chemical technologies). He has been engaged in research on alumina production technology. He received his PhD. in 1981 in bauxite digestion technology from Veszprém University.

Mr. Péter Lukács, BSc, PhD, CSc.
ALUTERV-FKI Ltd.
Head of Department for New Materials and Technologies

Graduated on metalphysics and powder metallurgy at the Kiev Technical University (Ukrania). His CSc dissertation work was on the influence of rare earth metaloxides on the behaviours of soft ferrites. Main fields of interest are plasma technologies, advanced ceramics and high purity metals.

Mrs. Eleonóra Molnár, BSc
ALUTERV-FKI Ltd.
Senior Process Engineer

Graduated at the University of Chemical Engineering, Veszprém, Hungary in 1972. 3. She took part in the detailed engineering and process design works of the reconstruction of the digestion of Lauta Alumina Plant, GDR, and in Ajka Gallium Plant, 1985. She was involved in preparing various feasibility studies on different alumina plants, in energy conservation projects and in several studies for the improvement of the alumina production technology.

Mrs. Zsuzsanna Porkoláb, BSc, MSc,
ALUTERV-FKI Ltd.
Head of Economics Section

Got MSc. degree the Industrial Faculty of the University for Economics, Budapest, Hungary in 1970, and a degree as a system organizer in 1977. Mostly she prepares economic studies of domestic and foreign investments in aluminium industry. She prepared feasibility studies for different alumina plants, a gallium plant, and different aluminium products.

Mr. István E. Sajó, BSc.
ALUTERV-FKI Ltd.
Research Fellow

He graduated from the Science University of Budapest [ELTE] in 1973. As an X-ray crystallographer works in the Materials Science Department of ALUTERV-FKI Ltd. He is involved in the development of phase analytical methods.

Mrs. Judit Sasvári, BSc, PhD.
ALUTERV-FKI Ltd.
Head of Laboratory for X-ray diffraction

Physicist, she has been working in X-ray field. Her main activities are the investigation of poly- and single-crystal materials (qualitative and quantitative phase analysis of minerals, bauxites, red muds, high temperature superconductors etc.).

Mr. Károly Solymár, Bsc, PhD.
ALUTERV-FKI Ltd.
Head of section of Alumina Technology

Graduated as chemical engineer (Inorganic chemical technologies, specialized for electrochemistry) in 1957 at Veszprém University, Hungary. Main fields of activity: gallium recovery, Bayer process development, especially digestion with catalytic additives and lime chemistry (causticization procedures), co- and by-products, contribution to preparation of techno-economic studies for alumina plants. Short term consultant for UNIDO. Organizer (lecturer and supervisor) of technical programs of UNIDO Group Trainings on alumina production held in Hungary in 1979 and 1983, in China in 1984, in Vietnam in 1989.

Mr. István Somogyi, BSc.
Ajka Aluminiumindustrial Co., Ltd.
Technical Specialist

Finished his studies at Chemical University of Veszprém in 1970 as a chemist engineer, since he has been working for Ajka Aluminiumindustrial Co., Ltd. He was the head of Ajka Gallium Plant for years.

Mr. István Somosi, BSc, MSc, PhD, CSc.
Ajka Aluminiumindustrial Co., Ltd.
Supreme Councillor

Has graduated at Natural Science Faculty of Kossuth Lajos University, Debrecen (Hungary) as a chemist engineer. He got PhD degree with "Study of features of the impurities at the recovery of gallium by electrolysis from aluminate liquor", and CSc degree with "Intensification of home production and refinement of gallium".

Mrs. Éva Szabados, BSc, MSc.
ALUTERV-FKI Ltd.
Economic Councillor

Got M.Sc, degree at the Industrial Faculty of the University for Economics, Budapest, Hungary, in 1975 and a degree as specialist in finance in 1985. As analytical economist her job is to prepare economic and financial analyses for various investments in the Hungarian aluminium industry. She prepared the economic and financial calculations of various Feasibility Studies on alumina plants for foreign countries.

Mr. Bálint Szabó BSc, MSc
HUNGAMOLA Ltd.
Director

Mr. István Szabó, BSc, PhD, CSc.
Research Institute for Technical Chemistry of the Hungarian Academy of Sciences, Veszprém
Scientific leader of Dep. Chemical Processes

Graduated at University of Chemistry in Veszprém. His special field was the intensification of organic reactions. Subject of his CSc paper was the haloid-metallurgical processing of metal-oxides. His research areas are developing and intensification of inorganic technologies, gas-solid processes, haloid-metallurgy and production of zeolites and fillers.

Mr. Tibor Szalai, BSc.
Magyaróvár Alumina and Fused Alumina Mfg.Ltd.
Plant Unit Manager

Graduated fcr technology of inorganic chemistry at Veszprém University for Chemical Industry in 1964. Initially he has been engaged as research engineer in the Research laboratory. From 1972 on he has been taking care of the production of the vanadium pentoxide and the aluminium sulphate plant units as Chemical Plant Unit Manager.

Mr. Géza Szalay, BSc, MSc.
Ajka Aluminiumindustrial Co., Ltd.
Technical Director

Got his degree on chemical engineering at the Chemistry University of Veszprém and another degree on electrical engineering at Budapest Technical University. His special fields have been the mathematical modelling and the computerized process control of the alumina production and the aluminium electrolysis in Hungary. In his activity special importance is given to the improvement of the quality of alumina for metallurgical purposes and the development of the product based Al2O3 for non-metallurgical purposes.

Mrs. Mária Tóth, BSc, PhD.
HUNGALU ALOXID (Almasfuzito Alumina) Ltd.
Head of Research and Quality Control Department

Graduated in 1969 at Faculty of Natural Sciences of ELTE University, Budapest, as chemist. Employed as research chemist at Almasfuzito Alumina Plant since 1969. At present she works as leader of research and development activities of special aluminas. Leading member of the local organization of Hungarian Mining and Metallurgical Society (OMBKE)

Mrs. Mariann Tóth-Gyutai, BSc.
Ajka Aluminiumindustrial Co., Ltd.

Graduated at Dep. Chemical Technology of Veszprém University. Her special field was the production of special aluminium-hydroxides and gallium. Recently she deals with development of zeolite production and forming.

Mr. Ferenc Valló, BSc, MSc, PhD.
Ajka Aluminiumindustrial Co., Ltd.
Head of Technical and Innovation Dept.

Graduated at University of Chemistry in Veszprém. He is leader of the company's R&D activity. His special fields are Bayer alumina technology, development of production technology of silica based products, mainly zeolites. He is member of several scientific societies.

Mr. János Vitéz, BSc. MSc, PhD.
Ajka Aluminiumindustrial Co., Ltd.
Head of Laboratories

Got his degree at Leuna-Meseburg Chemical Faculty of the Technische Hochschule für Chemie "Carl Schorlemmer" in 1965. He got PhD degree at Chemical University of Veszprém with "Study of spectrometric testing results in aluminium industry". He is interested in material tests, production of high purity gallium.

Mr. József Zábráczki, BSc, PhD.
HUNGALU ALOXID (Almasfuzito Alumina) Ltd.
Chief Technical Councillor

Graduated in 1971 at Faculty of Natural Sciences of ELTE University, Budapest, as physicist. Formerly university assistant, later research fellow at ALUTERV-FKI and head of laboratory at Almásfüzitő since 1984. Member and legal specialist of Hungarian Mining and Metallurgical Society (OMBKE) and Eotvos Physical Society (ELFT).

Mr. József Zöldi, BSc, PhD.
ALUTERV-FKI Ltd
Head of Alumina Laboratory

Completed his studies at the Budapest Eötvös Lóránd University (ELTE) as chemist. Main fields of research activity: decreasing of caustic soda losses in Bayer-process, removal of different impurities from Bayer-process, precipitation of coarse alumina hydrate, special alumina production, technological evaluation of bauxites.

Appendix V

Detailed program of the Workshop

WORKSHOP
on
Co-products and By-products of
the Bayer Alumina Production
Budapest, Hungary, 25 November - 6 December 1991.
ALUTERV-FKI Ltd.

TIMETABLE

25. Nov 1991 Monday

8.30 Start from the Hotel to ALUTERV-FKI Ltd. (return about 17.30)

26. Nov 1991 Tuesday

8.30 Start from the Hotel to ALUTERV-FKI Ltd. (return about 19.30)

27. Nov 1991 Wednesday

7.30 Start from the Hotel to MOTIM (return about 18.30)

28. Nov 1991 Thursday

8.30 Start from the Hotel to ALUTERV-FKI Ltd. (return about 16.30)

29. Nov 1991 Friday

8.30 Start from the Hotel to ALUTERV-FKI Ltd. (return about 16.30)

30. Nov 1991 Saturday

13.30 Sightseeing (start from the Hotel, return about 17.30)

1. Dec 1991 Sunday

9.00 Visit to Danube curve (all day excursion) (start from the Hotel, return about 18.00)

2. Dec 1991 Monday

8.30 Start from the Hotel to ALUTERV-FKI Ltd. (return about 16.30)

3. Dec 1991 Tuesday

7.30 Start from the Hotel to AJKA Works (return about 18.30)

4. Dec 1991 Wednesday

8.00 Start from the Hotel to Research for Silicate Industry. (return about 18.30)

5. Dec 1991 Thursday

8.30 Start from the Hotel to ALUTERV-FKI Ltd. (return about 16.30)

6. Dec 1991 Friday

8.30 Start from the Hotel to ALUTERV-FKI Ltd. (return about 16.00)

WORKSHOP
on
Co-products and By-products of
the Bayer Alumina Production
Budapest, Hungary, 25 November - 6 December 1991.
ALUTERV-FKI Ltd.

TIMETABLE

25. Nov 1991	**Monday**
9:00 - 9.45	Opening of the meeting - Statements of the representatives of UNIDO - Statements of the representatives of UNIDO Hungarian National Committee - Statements of the representatives of HUNGALU Rt - Statements of the representatives of ALUTERV-FKI Ltd.
10:00 - 12:00	**Lectures** Main trends of the further development of the alumina production: geographical and product restructuring
12:00 - 14:00	Lunch brake
14:00 - 17:00	**Lectures** Production, use and market for co-products and by-products in connection with Bayer alumina production General overview of the techniques of quality control in the field of special products
26. Nov. 1991.	**Tuesday**
9:00 - 12:00	**Lectures** Development and production of non-metallurgical grade aluminas in Hungary Ceramic aluminas and their characteristics Production of aluminium sulphate and vanadium pentoxide
12:00 - 13:00	Lunch brake
13:00 - 16:00	**Lectures** Plasma materials for ceramics. Production of special aluminium-hydroxides and aluminas based on the Bayer cycle Consultation.
17.00 - 19.00	WELCOME party
27. Nov. 1991.	**Wednesday**
7:30 - 18:00	**Plant visit to MOTIM Works**

28. Nov. 1991.	**Thursday**
9:00 - 12:00	**Lectures** Phase analysis of tne transition aluminas Major, minor and trace element analysis by chemical methods:
12:00 - 13:00	Lunch brake
13:00 - 16:00	**Lectures** Major, minor and trace element analysis by chemical methods: (cont) - X-ray Fluorescence Spectrometry - Atomic Absorption Spectrometry - Analytical spectroscopy **Consultation** on material testing
29. Nov. 1991.	**Friday**
9:00 - 12:00	**Demonstration in laboratories** (X-ray, AAS, Information Centre)
12:00 - 13:00	Lunch brake
13:00 - 16:00	**Demonstration in laboratories** (cont.) (ICP, Ioncromatograph+wet chemistry, test evaluation)
2. Dec. 1991.	**Monday**
9:00 - 12:00	**Lectures** Gallium recovery from the Bayer cycle. Production of zeolite in Ajka Production of aluminium trihydroxide based products at the Ajka Aluminiumindustrial Co. Ltd
12:00 - 13:00	Lunch brake
13:00 - 15:00	**Demonstration** on test system of model grinding system (grinding system, Technological Laboratories for Alumina and Special Alumina Production)
15:00 - 16:00	**Consultation** on technologies
3. Dec. 1991.	**Tuesday**
7:30 - 18:00	**Plant visit** to the Ajka Works

4. Dec. 1991.	Wednesday
8:30 - 11:15	Visit to Engineering and Developing Centre for Silicate Industry Lectures Ceramic aluminas and their characteristics
11:45 - 12:30	Lunch brake
12:30 - 18:00	Plant visit to Alumina Plant of Almasfuzito
5. Dec. 1991.	Thursday
9:00 - 12:00	Lectures Some aspects of engineering in a development project: a case study Surface analysis and morphological studies of special products
12:00 - 13:00	Lunch brake
13:00 - 16:00	Lecture Porosity, grain size analysis and surface area determination. Demonstration in laboratories (SEM, Laboratory for Ceramics, particle size analysis)
6. Dec. 1991.	Friday
9:00 - 11:00	Consultation
11:00 - 12:00	Closing session
12:00 - 15:00	Lunch

Appendix VI

Short reviews on the aluminium industry of the countries represented at the Workshop, prepared by the participants

1 - BRAZIL ALUMINA AND ALUMINUM PRODUCTION

Brazil has one of the biggest Bauxite reserves in the world and natural energy generation sources (hydroelectric power) still available to future expansions.

This way, Alumina and Aluminum production in Brazil has been growing significantly in the last ten years and still have a good potential to grow. The production capacity now a days is:

Alumina - 1,900,000 MT/Year

Aluminum - 1,150,000 MT/Year

2 - ALUMINA BALANCE (MT/YEAR)

	TO ALUMINUM PRODUCTION	TO INDUSTRIAL CHEMICALS APPLICATIONS
LOCAL PRODUCTION	1,814,850	85,150
IMPORTED	433,400	4,050
TOTAL	2,248,250	89,200

3 - INDUSTRIAL CHEMICALS MARKET SHARE (MT/YEAR)

3.1 - CALCINED ALUMINAS

	REFRACTORIES	CERAMICS	FUSED	OTHER
LOCAL PRODUCTION	5,100	4,000	33,000	4,950
IMPORTED	1,400	2,300	-	350
TOTAL	6,500	6,300	33,000	5,300

3.2 - HYDRATED ALUMINAS (MT/YEAR - ALUMINA BASIS)

	ALUMINUM SULPHATE	ALUMINUM FLUORIDE	CATALYSTS	OTHER
LOCAL PRODUCTION (DOMESTIC MARKET)	16,000	6,500	4,600	4,500
LOCAL PRODUCTION (EXPORT)	6,500	-	-	-
TOTAL	22,500	6,500	4,600	4,500

4 - MAIN TECHNICAL AREAS OF INTEREST

We believe that the main technical areas for future developments in Brazil are the Zeolites and Gallium production.

RECOVERY OF GALLIUM FROM SODIUM ALUMINATE LIQUORS: A OPORTUNITY TO BRAZIL

JULIANO PERES BARBOSA *
IVAN O. C. MASSON *
PAULO P. BORGES *
PLINIO E. PRAES *

* *reseachers of Center for Mineral Technology (CETEM/CNPq) - Brazil*

1 - INTRODUCTION

Gallium is an increasingly important material in the fields of semiconductors and energy transfer.

A prime source of Gallium is the aluminate solution that remains after the purification of bauxite by the Bayer process. As the Brazil has a big bauxite resources it's very important for us to develop technological know-how in the manufacturing of gallium in pure form.

U.S.A., France and Germany are known to be producing gallium along with Hungary, USSR and Japan coming up with small productions. Brazil, with its heavy reliance on aluminium as a major non-ferrous metal and a fortunate position regarding bauxite resources is bound to expand the existing operations to aluminium production. Consequently, the recovery of gallium as a valuable by-product is a natural development that can be looked for.

The Table 1 shows the world production of gallium in the period of 1984 to 1987:

TABLE I

WORLD PRODUCTION OF GALLIUM PRIMARIUM (Kg)

MAJOR COUNTRY	1984	1985	1986	1987
CHINA	3500	5000	6000	6000
FRANCE	8500	9500	15500	14000
W.GERMANY	6000	5500	7000	7000
U.S.A.	0	0	750	-
NORWAY	-	-	-	500
HUNGARY	3000	2800	3200	3000

II - GALLIUM PROJECT

The CETEM (Center for Mineral Technology) has been developing a project to recovery of gallium from Bayer process liquors (sodium aluminate) by the use of solvent extraction's and electrodeposition's techniques. We intend to produce gallium with 99.9999 % of purity. This process is shown in the flowsheet of Fig 1.

Preliminary results obtained in bench scale have showed promising in the concentration of gallium from Bayer-process liquors. The next step of the project involves the obtaintion of pure gallium by electrodeposition. Thus, we're interested in studying and knowing about all the parameters involved in this process that have been studied by others reseachers.

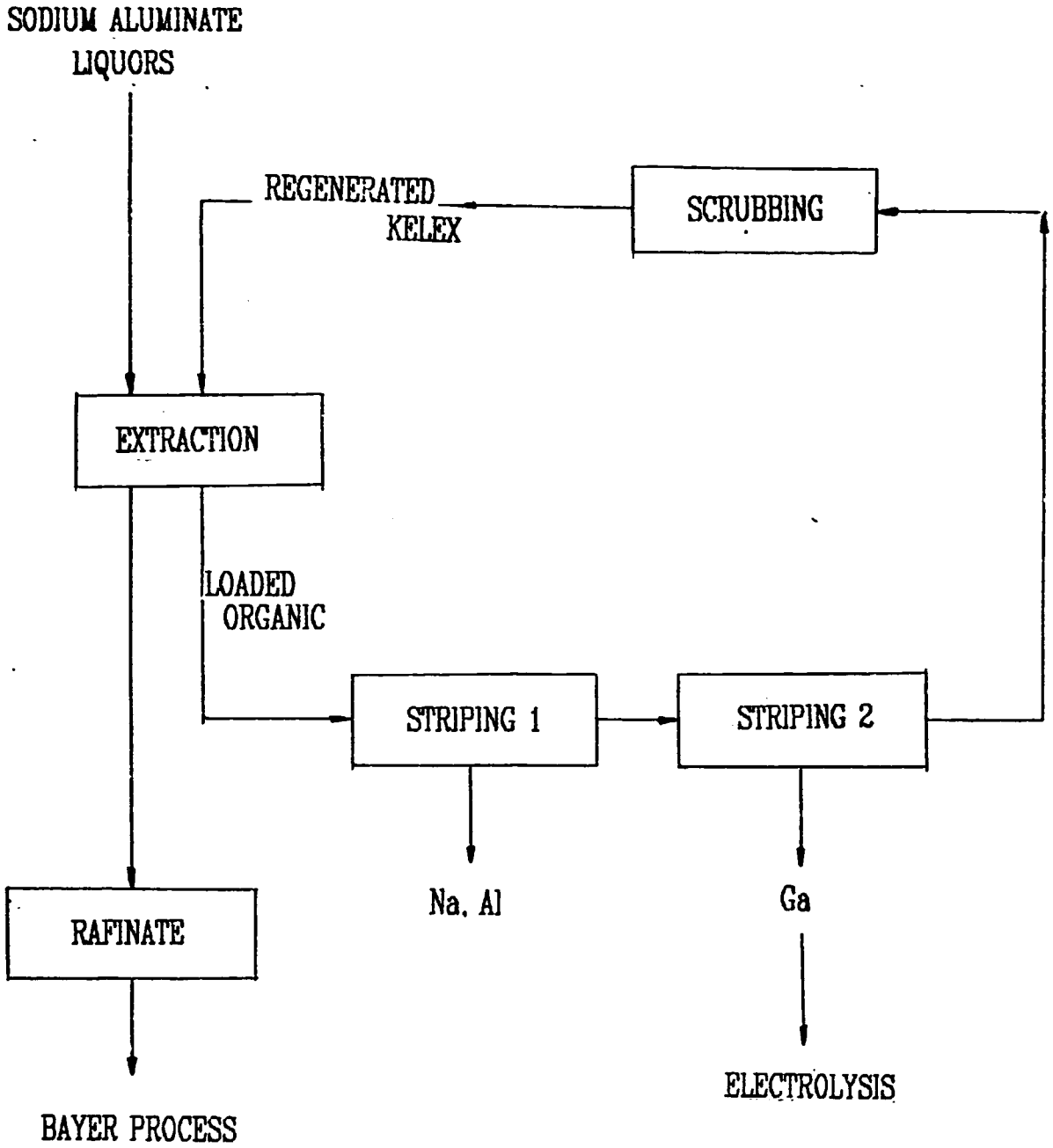

FIGURE 1 - PROCESS FLOWSHEET

ALUMINA PRODUCTION IN CHINA

Chen Wankun
(Zhengzhou Light Metal Research Institute, Zhengzhou, P.R.China)

Yang Siming
(Shandong Aluminium Plant, Zibo, P.R.China)

It's an honour to take part in the "Workshop on Co-products and by-products the Bayer Alumina Production" organized by UNIDO. By this Chance we'd like to give a Brief introduction to the alumina production in China.

I. History

China began to produce alumina in 1950s. Shandong Aluminium plant, the first alumina refinery in China, put into operation in 1954 with a capacity of 35,000 t/y, processing lower grade bauxite by the soda lime sintering process. Zhengzhou Aluminium Plant put into operation in 1966 with a capacity of 200,000 t/y, processing the medium grade bauxite by the Combined Process. Guizhou Aluminium Plant, set up in 1978 with a capacity of 200,000 t/y, processed high grade bauxite by the Bayer process. Shanxi Aluminium Plant, put into operation in 1989 with a capacity of 200,000 t/y, processed low grade bauxite by the soda-lime sintering process. Zhongzhou Aluminium Plant, 200,000 t/y, producing alumina by the soda-lime sintering process, and Pingguo Aluminium Plant in Guangxi with a 300,000 t Bayer plant, are under construction.

Chinese alumina industry, through 40 years' development, has an annual total production capacity of 2 million tons.

China is rich in bauxite resources, but most of them are of lower quality (with high silica content, the A/S is 4-7) and of diasporic type which is hard to digest. These bring about a lot of difficulties to commercial production. In this case, the Bayer-sintering combined process can be economic to the bauxite of this type. Guizhou Aluminium Plant adopted this process, Shanxi Aluminium Plant and Zhongzhou Aluminium Plant will also adopt this process. Chinese bauxite is Characterized by low organic and iron contents (excepting that in Pingquo, Guangxi) and high alumina (>60 %), favourable for alumina production. For example, we can produce sandy alumina with this material. Alumina Products from this bauxite are with high whiteness. We can produce alumina from the bauxite by combined process.

II. Major technical improvements

According to the characteristics of Chinese diasporic bauxite with high silica, we have developed the soda-lime sintering. Process and the combined process with an alumina extracting rate of more than 90 % and an soda consumption (as Na_2CO_3) of less than 80 kg/t Al_2O_3. Further more we have achieved a great progressing the aspects of gallium recovery, the comprehensive utilization of the red mud from the sintering process plant and in the aspect of products varieties of alumina and aluminium hydroxide.

The Bayer process plays an important role in Chinese Alumina industry. China has been using the directly steam heating autoclave digestion technology which consumes 1-2 times more energy compared with that in developed countries. In order to solve this Problem, we have been researching the indirect heating Bayer intensive digestion in the past 10 years. The tube-retained tank intensive digestion technology has the advantages of both the tube digester and autoclave avoiding the defects of them both, suitable to treat the diasporic bauxite in China. This technology has been adopted to treat Pingguo bauxite in Guangxi, Henan Bauxite and Shanxi bauxite with good results. A 10,000 t/y pilot plant of alumina has successfully operated for 2 years by this technology. In the same time, we bought Bayer digestion technologies from Pechney Aluminium limited and VAW. So the backward Bayer process in China is expected to be improved soon.

Shandong Aluminium Plant recovers gallium from the mother liquor in the soda-lime sintering process, the gallium output and varieties has been increasing since it was put into production in 1975. Except for gallium oxide, it also produces metal galliums with purities of 99,99 %, 99,999 % and 99,9999 %. We also successfully invented a new technology to recover gallium from Bayer liquor.

China began to research non-metallurgical alumina production in the beginning of 1960s. Shandong Aluminium Plant and Wunzhou Chemical Works are two main producers. The total capacity in China amounts to 80,000 t/y with the varieties as α-alumina, Γ-alumina, high purity alumina, low sodium superfine alumina, activated alumina, aluminium hydroxide gel, micropoder of aluminium hydroxide, pseudoboehmite, fire retardant fillers and so on.

III. Main problems

Some technical and economic indexes are in low level due to the low quality bauxite and the backward equipments, especially the energy consumption (>8000000 KCal/t Al_2O_3) and low automation level and productivity.

Additionally, the variety and output of non-metallurgical alumina can't meet the demand of Chinese industry development.

At last, the red mud pollution still remains a big problem. Now we can produce cement, silicon and calcium contained red mud fertilizers, the shielding slug for steel smelting and plastic fillers, etc. from red mud. But this volume is only a small portion of the total discharged red mud so much as 1,500,000 tons. If this problem can't be solved reasonably, it will do great harm to the environment as well as the development of Chinese alumina industry.

THE ALUMINIUM COMPANY OF EGYPT

(1)

ALUMINIUM IS ONE OF THE MOST IMPORTANT METALS IN ALL SEGMENTS OF THE WORLD ECONOMY . BECAUSE ITS QUANTITATIVE APPLICATION AS A VALUABLE ENGINNERING MATERIAL EXCEEDS ALL OTHER METALS EXCEPT IRON. HOWEVER. OWING TO THE CAPITAL - INTENSIVE NATURE OF HALL-HEROULT ALUMINIUM EXTRACTION (ITS LOW PRODUCTIVITY PER UNIT AND INTENSIVE ELECTRICAL ENERGY CONSUMPTION).EGYPT HAD ESTABLISHED ITS ALUMINIUM INDUSTRY BY A REVERSE INTEGRATED ROUTE SINCE THE END OF THE SIXTIES. DURING 1989 THERE WERE NO MAJOR CHANGES IN THE ALUMINIUM INDUSTRY OF EGYPT, EXCEPT WHAT WAS ACHIEVED IS DESCRIBED LATER ON BY EGYPTALUM.

THE ALUMINIUM COMPANY OF EGYPT (EGYPTALUM)IS THE ONLY ALUMINIUM SMELTING ESTABLISHMENT IN EGYPT. THE SMELTER AND CASTING SHOPS OF EGYPTALUM ARE LOCATED IN NAG-HAMMADY(550 KM SOUTH FROM CAIRO, CONNECTED TO THE MEDITERRANEAN SEA - ALEXANDRIA - VIA CAIRO BY RIVER AND LAND ROADS AS WELL AS RAILWAYS, AND TO THE RED SEA- SAFAGA - BY ROAD AND RAILWAY TRANSPORTATION).

EGYPTALUM STARTED ITS PRODUCTION OF PRIMARY ALUMINIUM IN OCTOBER 1975. THE MAXIMUM DESIGNED CAPACITY OF 166000 T/Y WAS ACHIEVED IN THE MIDDLE OF 1984. THE REDUCTION PLANT OF EGYPTALUM COMPRISES TEN POTROOMS OF 460 CELLS,WHICH ARE ARRANGED END-TO-END. EACH 460-CELLS LINE IS LOCATED IN A ROOM 750 METERS LONG. THE POTLINES OF EGYPTALUM USE VERTICAL SOEDERBERG CELLS OPERATING AT 155 KA, WITH AN AVERAGE ANODIC CURRRENT DENSITY OF 0.637 AMPERE/CM.

(2)

IN SHORT, THE HISTORY OF PRIMARY ALUMINIUM PRODUCTED BY EGYPTALUM CAN BE SUMMARIZED AS FOLLOWS: THE FIRST MILLION TONS WERE PRODUCED BETWEEN OCTOBER 1975 AND AUGUST 1984, AND THE TWO MILLION T MARK WILL BE ACHIEVED IN MARCH 1990.

SINCE THE EARLY 'EIGHTIES, EGYPTALUM HAS FORMALIZED ITS RESEARCH AND DEVELOPMENT ACTIVITIES BY COLLABORATIVE RELATIONSHOP WITH NATIONAL AND INTERNATIONAL INSTATUTIONS AND AUTHORITIES. THESE ASSOCIATIONS HAVE LED TO IMPROVEMENTS OF THE CELL ELECTROLYTE, THE INCORPORATION OF A CENTRALIZED AUTOMATIC CONTROL SYSTEM, AND BETTER UNDERSTANDING AND STABILITY OF THE TECHNO-ECONOMIC VARIABLES OF THE SMELTER. COMPARATIVE FIGURES SHOWING THE MAXIMUM POSSIBLE PRODUCTIVITY FROM THE PRESENT HARDWARE AND FUTURE DEVELOPMENTS OF THE NAG-HAMMADY SMELTER ARE COMPILED IN THE TABLE BELOW.

THE ALUMINIUM COMPANY OF EGYPT

(3)

TABLE: STATE AND PROSPECTS OF THE EGYPTALUM SMELTER

TAFEL: GEGENWARTIGER STAND VON TECKNIK UND PRODUKTION SOWIE AUSBAUVORHABEN DER EGYPTALUM- SCHMELZHUTTE

ITEM	AS DESIGNED 1969	AS ACHIEVED 1989	AS OROJECTED 1989
CELL TYPE	VSS*)	VSS*)	CFPB**)
CELL SIZE(KA)	150	155	200
MAIN VOLTAGE(V)	4.6	4.463	402MAX.
CURRENT EFFICIENCY(%)	84	88	92 MIM.
ELECTRIC ENERGY CONSUMPTION(KWH/T AI)	16 347	15240	13 500 MAX
CARBON CONSUMPTION (KG/T AI)	565	500	440 MAX
FLUORINE SALTS (KG/T AI)	70.55	43.00	15.00 MAX
ANNUAL PRODUCTION(T)	166 000	181 000	240 000
AVERAGE CELL LIFE (DAYS)	1260	1800	---

*) VERTICAL STUD SOEDERBERG CELL

**) CENTER-FED PERBAKED ANODE CELL

(4)

DURING,1989 EGYPTALUM BEGAN TO PUT ITS STRATEGIC INTEGRATION PLAN INTO ACTION. THE INTEGRATION PLAN OPERATES AT THREE LEVELS AND HAS BOTH HORIZONTAL AND VERTICAL BENEFITS. FIRST OF ALL IT IS INTENDED TO CHANGE OVER FROM THE EXISTING VERTICAL STUD SOEDERBERG CELLS(VSS) TO CENTER-FED PREBAKED ANODE CELL(CFPB)OTHE PROJECTED CHANGEOVER IS TO BE ACHIEVED BY OPTIMIZING THE UTILIZATION OF THE EXISTING FACILITIES WITH MINIMUM HARDWARE CHANGE. THE PROJECTED OUTCOME IS ILLUSTRATED IN THE TABLE. THE BASIC AND DETAILED ENGINEERING DESIGN OF THE PROJECT NEW CELLS WAS DONE BY EGYPTALUM ENGINEERS IN COLLABORATION WITH BOTH VAMI (USSR) AND THE RESEARCH TEAM OF THE ENGINEERING FACULTY OF CAIRO UNIVERSITY. THE STUDIES AND DESIGN ARE BASED ON MATHEMATICAL MODELLING FOR PREDICTING ENERGY BALANCE MAGNETICS AND HYDRODYNAMICS OF THE 200 KA-CELLS. IT IS ALSO INTENDED TO EMPLOY A TWO-LEVEL CONTROL SYSTER (A MICROPROCESSOR FOR EACH CELL, AND IN ADDITION A CENTRALIZED COMPUTER INTERFACED WITH ALL THE POTS UNDER CONTROL). SINCE AUTUMN 1989, THE CONSTRUCTION AND ERECTION OF SIX EXPERIMENTAL POTS WITH THEIR REQUISITE ANCILLARRIES HAS BEEN IN PROGRESS IN ORDER TO START UP THE PROTOTYPE EXPERIMENTATION AT THE END OF 1991. THE PLANNED DURATION FOR THE EXPERIMENTAL PROGRAM IS IN THE ORDER OF TWO YEARS, DURING WHICH OPTIMIZATION OF THE OPERATING VARIABLES AND TECHNOECONOMIC PARAMETERS ARE TO BE ACHIEVED. SECONDLY, AS SMELTER- GRADE ALUMINA IS ONE OF THE LARGEST ITEMS IN THE COST OF

THE ALUMINIUM COMPANY OF EGYPT

(5)

ALUMINIUM PRODUCTION, EGYPTALUM HAS SIT IN MOTION EXPLORATORY STUDIES ON THE POSSIBITIES AND TEVHNO-ECONOMICS OF PRODUCING ITS ALUMINA REQUTREMENTS LOCALLY. FINALLY, EGYPTALUM ALSO INTENDS TO DIVERSIFY AND INTESIFY THE DOWNSTREAM SIDE OF THE ITS PRODUCTION BY CONSTRUCTING THE CONSTRACTED ROLLING PLANT, WHICH WILL IN TURN MAXIMIZE THE TOTAL ECONOMICAL OUTPUT.

INDIAN SCENARIO ON THE PRODUCTION OF ALUMINA AND ALUMINIUM

G. Balasubramanian
Tawaharlal Nehru Aluminium Research Development and Design Centre, Nagpur, India-440013

India has large Bauxite resources, widespread throughout the country, rich in Alumina. The total alumina production amounts to approximately 1500 k tonnes per annum. This is being produced predominantly by four alumina refineries viz NALCO, BALCO, INDAL and HINDALCO. Of these, the refinary of NALCO at Orissa is producing 800 k tonnes/annum, which is considered to be the most efficient plant in the world. The reason being: rich gibbsitic bauxites used, new refinery plant operating to the maximum efficiency and low maintanance breakdown costs. The other refineries of BALCO, INDAL and HINDALCO produce 200, 300 and 250 k tonnes/annum alumina respectively.

The total non-metallurgical grade alumina production in India is approximately 40 k tonnes/annum alumina respectively.

The total non-metallurgical grade alumina production in India is approximately 40 k tonnes/annum produced mainly by INDAL. All refinaries except NALCO produce Flour alumina.

All the companies listed above BALCO, NALCO, INDALCO & INDAL, have aluminium smelters too. The total production of aluminium in India amounts roughly 600 k tonnes/annum, which is distributed is 200, 100, 150 and 100 among NALCO, INDAL, HINDALCO and BALCO respectively. BALCO smelters used soderberg type anodes whereas others use prebaked anodes.

Although the country's total metallurgical grade alumina requirements are met by the existing refiniaries, there is further need for the expansion in the production of non-metallurgical grade/special alumina.

In order to meet the growing demand I the research, development & design activities in the fields of alumina, aluminium etc., related to Aluminium industries, Tawaharlal Nehru Aluminium Research Development & Design Centre is set up by Giovt of India wites UNDP assistance at Nagpur. This is expected to be ready with full fledged activities, using the modern sofisticated equipments with latest technology, early next year.

GENERAL INFORMATION OF IAAI & RELATED INDUSTRIES IN IRAN

A. Arjangi
Research & Development Expert
Iranian Automotive Assesories Industries
Tehran, Iran

Presently, there are over 5 million cars and motorcycles and other vehicles equipped with internal conbustion engines, in the Islamic Republic of Iran (IRI) and annual demand on spark pugs is 20 million pieces. Of which, IAAI produces 12 million pieces per annum.

The production of spark plugs in IRI is organised at IAAI plant in Kazrin, the company which I work as R & D expert. The ceramic part of the spark plugs (insulators) are imported from abroad (Germany, Yugoslavia etc.) which are fabricated from special grades of Alumina consisting 99.6 % Al_2O_3, with α-Al_2O_3 content as high as 98 % or more, obtained at alumina refinaries from Aluminium hydroxide.

At present, there is no special alumina production is Iran and in the whole reighboughood, while the demand on various special grade alumina is about 10 000 tons/year, and is expected to grow.

To investigate the issue of producing special grade alumina for ceramic insulator, an opportunity study of the project was completed by WAMI, USSR, and a complete technoeconomical feasibility study is due through UNIDO. At the same time an opportunity study is implemented on manufacturing the ceramic materials (insulate by Iranian Ceramic Research Centre MER Also, a complete feasibility study on production of metal grade Alumina in IRI was undertaken by ALUTERV-FKI and the production of metal grade alumina will be implemented in the near future.

AZ ZABIRAH BAUXITE DEPOSIT

In Northeastern Saudi Arabia

It is concluded that the Zabirah bauxite is a palaeolaterite of Cretaceous age, formed in-situ by tropical weathering of kaolinitic arenaceous to argillaceous sedimentary rocks of probable Early Cretaceous age. It is exposed on strike, discontinuously, for 105 km, and dips gently northeast under progressively thicker overburden. The complete palaeolaterite profile averages 6 m in thickness and includes remnant sheets and pockets of economic-grade bauxite that average 3 m in thickness, diagenesis and post-exhumation erosion having altered or destroyed parts of the original profile. The bauxite is a mixture of monohydrate and trihydrate alumina minerals with boehmite and gibbsite predominating and diaspore occurring locally in minor amounts. The major impurities are kaolin, haematite, goethite, anatase and rutile.

Evaluation drilling has delineated a total of nine blocks, in three zones which together are estimated to contain subeconomic indicated resources of 200 Mt at a grade of 57 % Al_2O_3 and 8 % SiO_2. In 10 smaller blocks contained within these indicated resources there are estimated inferred reserves of 94 Mt at a grade of 57 % Al_2O_3 and 6 % SiO_2. The available alumina grade of the inferred reserves is estimated to be approximately 50 %. These resources and reserves are assumed to be amenable to open-pit mining because they lie beneath less than 30 m of overburden.

Exploratory drilling has established that bauxite does continue down dip beneath an increasing overburden thickness; this would necessitate underground mining.

Attention is being paid to finding a beneficiation technique that will reduce the high silica content of the bauxite. The most widely used beneficiation method for bauxite - wet screening and scrubbing - holds most promise and is being thoroughly tested. Results of other methods, involving separation by flotation, gravity and magnetic methods, have been discouraging.

It is concluded that if potential in-situ reserves of the order of hundreds of millions of tonnes are to be considered at Zabirah then a high silica content, in the range of 7 to 10 % SiO_2, must be accepted.

It is recommended that the investigation be continued with an order-of-magnitude study, fill-in and geostatistical drilling, beneficiation-process research, and in-depth studies of the Bayer and possible alternative alumina-extraction processes, with particular regard to their sensitivity to high-silica feed.

Alumina refinery: does not yet exist in the country, but I understand that SABIC is considering one.

Aluminium smelters: there are some in the region e.g. Bahrain, Dubai, Egypt and may be in Saudi Arabia in future.

REPORT OF THE PRESENT STATUS OF THE ALUMINA INDUSTRY OF TURKEY

In 1962 Mineral Exploration and Research Institute of Turkey found available bauxite reserves in Mortaş and Doğankuzu regions in Seydişehir. In 1965 these reserves were turned over to Etibank. Then, Etibank contacted nations with advanced aluminium industries to start an aluminium industry in Turkey. In the end, Etibank signed a trade agreement with Tiajpromexport of USSR. This agreement involved the necessary aid for project equipment and technical assistance to start the Aluminium Works of Seydişehir.

Seydişehir Aluminium Works is an integrated establishment. It includes bauxite mining, alumina and primary aluminium production, and aluminium foundry, rolling plant, sections shop, and auxiliary units.

Rated capacity of the alumina factory is 200,000 tons alumina/year. 120,000 tons of this amount is planned for primary aluminium production, whereas 80,000 tons being a commercial product.

Feasible bauxite reserves are 40 million tons and are mainly boehmitic having 8.2 silica ratio (Al_2O_3/SiO_2 in weight % of dry bauxite).

Envisaged product calcined alumina would have at least 25 % alpha-alumina, and average equivalent particle diameter of 30-40 microns.

European Bayer variant of bayer process is being used in aluminium hydrate production but the degree of calcination is low and calcined alumina contains 25-30 % alpha-Al_2O_3.

In addition to aluminium hydroxide and calcined alumina we are producing aluminium sulphate by the reaction of sulphuric acid and aluminium hydroxide.

Production capacity is 340,000 tons of aluminium hydroxide, 200,000 tons of calcined alumina, and 45,000 tons of aluminium sulphate per annum. But the capacity utilization mainly depends on export facilities and changes with market conditions. In last 3 years, because of high demand, we have been nearly utilizing full capacity in calcined alumina production.

Chemical and physical properties of our products are as follows:

Aluminium Hydroxide (wet)

Moisture	= 10-12 %	
In dry hydrate basis		
Na2O	= 0.3	% max.
SiO2	= 0.015	% max.
Fe2O3	= 0.015	% max.
Bulk Density	= 1.15 gr/cc	
Grain Size 0-10 µ	= 0.5-1.0	%
10-20 µ	= 3-5	%
20-40 µ	= 15-20	%
>40 µ	= 20-30	%

Calcined Alumina (Metallurgical Grade)

L.O.I.		= 1	% max.
Al2O3		= 98.5	% min.
Na2O		= 0.5	% max.
SiO2		= 0.020	% max.
Fe2O3		= 0.025	% max.
alpha-Al2O3		= 25	% min.
Bulk Density		= 1 - 1.1	gr/cc
Angle of Repose		= 32°-36°	
Sieve Analysis (Tyler)			
	+100mesh	= 3-5	%
-100mesh	+200mesh	= 25-35	%
-200mesh	+325mesh	= 30-40	%
	-325mesh	= 20-30	%

Aluminium Sulphate

Al2O3	= 16-17 %
Fe2O3	= 0.02 % max.
Insolubles	= 0.3 % max.
Pb	= Nil
As	= < 1ppm

Domestic calcined alumina and aluminium hydroxide consumptions are 4,000 tons and 3,500 tons respectively. Calcined alumina is mainly sold to ceramic industries, refractory industries ,and glass industries. Aluminium hydroxide is sold to private aluminium sulphate producers.

If the development of Turkish Industry is taken into account, there will be need to produce special grades of aluminium hydroxides and aluminas.

The processed bauxite contains 0.04 % V205 and 0.007 % Gallium. We have been seperating vanadium mixed salt from the process liquor and we have 3,000 tons of crude cake having 10-18 % V205 in it wet basis. Commercial V205 production is under research at present.

Modernization of Aluminium Works of Seydişehir is in progress. One of the calciners of Alumina Factory will be retrofitted by FCB France.

21st of Nov. 1991

STATUS OF THE CERAMIC SECTOR IN VENEZUELA: RESEARCH AND DEVELOPMENT INDUSTRY

Caracas, Venezuela November 1991

STATUS OF THE CERAMIC SECTOR IN VENEZUELA: RESEARCH AND DEVELOPMENT INDUSTRY.

The ceramic area was developed to cover the necessities of two main sectors: steel maker sector which utilizes in an extensive way refractory materials and the technical ceramic and sanitary sector (restroom fixture). This last sector was developed because of the presence of foreign capital and the low energy cost in the country. Presently, the ceramic area in Venezuela is concentrated mainly in traditional applications such as stoneware and restroom fixtures, flag stone and chinaware line or in the production of basic articles for the operation of other industries (refractory, glass, cement, electrical insulators and spark plugs).

Venezuela has around 200 companies related to the ceramic industry; 25 of them can be considered as big companies with an approximate total of 20.000 to 25.000 employees and a gross income of US $ 300 to 600 million per year. As mentioned previously, all these companies were established in Venezuela taking advantage of the raw materials available in the country, low energy cost, mass consumption or a combination of all these factors. Most of the production is dedicated to satisfy the national market. However, some other areas are competing in the international market.

The development of the national ceramic industry will depend on the exploitation of the non-metals resources availables in the country such as:

1.- Exploitation and beneficiation of clays and caolins to obtain homogeneous materials of high quality needed in the traditional ceramic industry.

2.- Exploration and exploitation of circonium minerals for the refractory and ceramic coating industry. In addition, these minerals are the basis for important applications because of the excellent mechanical properties which give an increase in toughness to ceramics.

3.- Beneficiation of alumina "metallurgical grade" to obtain alumina "ceramic grade" with important applications in the ceramic, refractory and abrasive industries. This is an important project of national interest because of the presence of important resources of bauxite mineral and factories which process the bauxite in order to get alumina "metallurgical grade".

The Venezuelan world trade market of ceramics products and ceramics raw materials is increasing because of the development of the steel maker, glass, and petrochemical industries. Table 1 , presents a review from 1984 to 1989 of the Venezuelan international trade market of alumina products.

The anhydrous alumina, has mantained a constant growth in its production in order to satisfy the national market which utilizes this product to obtain electrolitic aluminum. The rest of the production is for exportation purposes. Figure 1 shows the development of the anhydrous alumina national exportation trade market. Alumina is obtained from bauxite mineral by the Bayer process and handle it by a government company "INTERALUMINA". The private sector uses the anhydrous alumina in order to make refractory bricks and synthetic mullite.

In general, the market for the aluminum hidroxide depend on imported raw materials which are utilizes in extensive way by the private sector in applications such as water and effluent treatment, fire retardants fillers, paper making and for pharmaceuticals industries. Recently have been installed a company to produce aluminium sulphate, and its market is growing in the field of others alums. Figure 2 shows the average of imported raw materials (tons), during the last six years.

Another important area of interest in the Venezuelan ceramic industry is the development of the sanitary ceramic sector (restroom fixture), which obtain and uses the most part of its raw materials from national suppliers and some from outside suppliers such as artificial corundum. In this area Venezuela has important factories of flag stone.chinaware line and sparks plugs, which supply the national market and also part of the South American market.

With respect to the R&D sector, there are some projects to obtain activated alumina, because of the important uses in the national market of this product. Differents activated grades are necesary to produce to satisfy the demand of the petrochemical sector, for the production of hydrogen peroxide, polyethylene, polymerisation feed stocks and other chemicals, an another extensive uses such as are to scavenge fluorides, chlorides, sulphides, carbon dioxide, arsenic and trace of heavy metals.

The future of the ceramic industry in Venezuela seems to be very promising. The country has important minerals resources that can be exploited commercially with potentials applications in high development technologies and an extensive use in the industry. In the other hand the country has the fundamental academic orientation, (at the universities and research institutes) and as mentioned before, it has resources and sufficient experience to develop a national technological capacity for the assimilation of new process and product technologies.

VENEZUELAN INTERNATIONAL TRADE MARKET
OF ALUMINA PRODUCTS (Tons)

TABLE 1

YEAR		ANHYDRO. ALUMINA	HIDROXI ALUMINA	ARTIFICIAL CORUNDUM	SODIUM ALUMINATE	OTHERS ALUMS
1984	EXPO	349.113	-	-	-	-
	IMPO	6.425	1.182	1.795	137	304
1985	EXPO	454.881	-	-	-	-
	IMPO	6.479	965	1.299	96	157
1986	EXPO	496.047	-	-	-	-
	IMPO	5.063	1.090	1.179	60	105
1987	EXPO	516.969	-	-	-	-
	IMPO	6.832	2.250	3.960	38	59
1988	EXPO	603.713	-	-	-	-
	IMPO	7.819	2.160	3.034	99	55
1989	EXPO	952.465	428	20	-	-
	IMPO	6.436	798	1.058	19	20

VENEZUELAN INTERNATIONAL ANHYDROUS ALUMINA TRADE MARKET

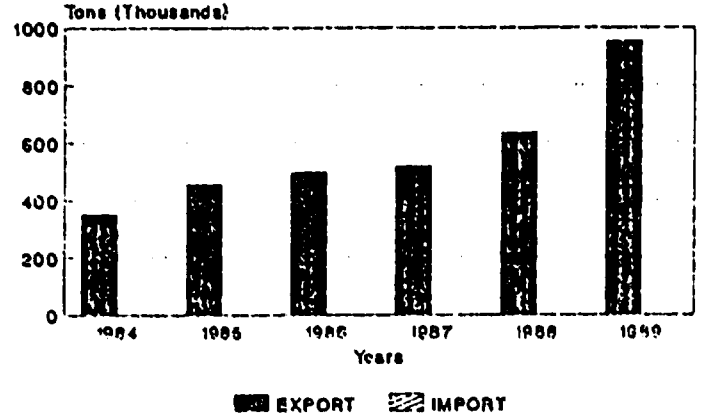

FIGURE 1

VENEZUELAN INTERNATIONAL ALUMINUM HIDROXIDE TRADE MARKET

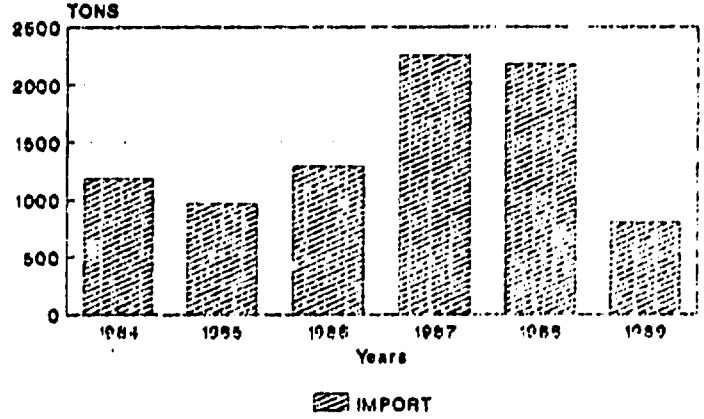

FIGURE 2

C.V.G. INTERALUMINA
PLANT DESCRIPTION

PLANT SITE: Heavy Industry Site at Matanzas,
Ciudad Guayana - Venezuela
This area concentrates main producers
of Hydroelectricity,
Steel, Aluminiun and Iron Ore.

PRODUCT: Metalurgical grade Al_2O_3 (alumina)
Quality as follows:

SiO_2	%	: 0.011
Fe_2O_3	%	: 0.011
Na_2O	%	: 0.45 (0.25 % from ocluded 0.20 % from leachable)
LO.I	%	: 0.73
Area (BET)	m^2/g	: 80
Density	g/cc	: 3.55
Size, < 150mm	%	: 95
< 44mm	%	: 9

COPRODUCT: Low soluble Na_2O Hydrate (aprox. 200t/month)

BYPRODUCT: None

CAPACITY: Original 1.0 x 10^6 MTA (Start up in 1983)
Through optimization of process in 1985 brought up to 1.3 x 10^6 MTA.
Presently undergoing an expansion to 2.0 x 10^6 MTA through improved technology in precipitation and 15% increase of circulating flow. The project is 75% finished.
Production rate of 2.0 x 10^6 MTA will be achieved in January 1992.

PROCESS DESCRIPTION: Grinding throungh impact crushers and ball mills.
Predisilication of bauxite pulp at 100°C for 8 hours in agitated tanks.

Digestion conditions for gibbsitic bauxite and flash expansion heat recovery.
Desanding throungh cyclones.
Red mud separation and washers in flat bottom setlers.
Security filtration in Kelly Filter.

Precipitation with double seeding according to the Alusuisse process in draft tube agitated tanks.
Clasification and seed charge trough a series of hydrosettlers, cyclones and vacuum drum and discs filters.
Calcination through fluid bed calciners.

RAW MATERIALS:

Bauxite: Averge consumption: 2.2 t/t AL_2O_3

TROMBETAS (Brasil)
GOVE (Australia)
CHIMERI (Guyana)
PIJIGUAOS (Venezuela)

The venezuelan bauxite from the mine of Pijiguaos accounts for 30% of total consumption. By the year 1993 the mine should be at full capacity supplying 100% of requirements.

Caustic Soda: Average consumption 80Kg/t Al_2O.

Imported through medium term contracts and spot market.

CONSUMERS: 80% to local Aluminium Smelters, 20% to export.

Appendix VII

Summary of the self-evaluation prepared by the participants

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA INTERNATIONAL CENTRE
P.O. BOX 300, A-1400 VIENNA, AUSTRIA
TELEPHONE: 211 310 TELEGRAPHIC ADDRESS: UNIDO VIENNA TELEX: 135612 uno a FAX: 232156

EVALUATION - GROUP TRAINING PROGRAMMES

Name of participant: 17 participants See Appendix III.

Home country: 9 countries See Appendix III.

Programme: Workshop on Co-products and by-products of the Bayer Alumina Production

Host country: Hungary

Year: 1991. 25. Nov - 6 Dec.

I. PRE-COURSE INFORMATION:

1. How was the introductory information you received in your home country about: (please mark an x in the suitable column)

	Sufficient	Not sufficent	Missing
Aim of the training	/14/	/ 3/	/ /
Content of the programme	/17/	/ /	/ /
Level of the programme	/13/	/ 3/	/ 1/

What, if any, other information do you feel should have been included:

2. How many weeks before the beginning of the training programme did you receive the following information:

Information about the programme	3-7	cca /5/	**weeks**
Being accepted to the programme	4 days - 3	cca / 1/	**weeks**

Comments:

II. PROGRAMME CONTENT AND ORGANIZATION:

3. What is your opinion of the total duration of the course:

Too long	/2/
Just right	/14/
Too short	/ 1/

If not "just right", what, in your opinion would be the most suitable duration for the course?

/ / weeks

Please comment: 1 - 1 1/2 week - 6 weeks (1 participant)

4. State your opinion about the daily schedule:

Too heavy	/ 5/
Just right	/11/
Too light	/ 1/

Comments:

5. Would you suggest any changes in the general nature of the training programme?

6. Do you feel that the training corresponded to your professional needs?

To a very large extent	/2/
To a large extent	/3/
To a sufficient extent	/11/
To a small extent	/1/
To a very small extent	/ /

Please comment:

7. Please give your opinion about the study visits (if any):

Good, More time, more detailed, technology feused

Please suggest other study visits that might have been valuable:

8. What do you think of the general level of the training?

Much too high	/ /
Too high	/ /
Adequate	/15/
Too low	/2/
Much too low	/ /

Comments:

9. Which subjects of the programme did you find most valuable? (Please state reason; for example new subject, my speciality, relevant to my work, new information, etc.).

Subject	Reason

10. Which subjects of the programme did you find least valuable? State why (for example too elementary, inadequate instruction, irrelevant to my work, etc.).

Subject	Reason

11. Were there in your opinion any relevant subjects that were not adequately covered in the programme?

Yes /7/

No /10/

If yes, what did you miss?

12. Which changes would you have preferred in the methods of instructions?

	no changes	more	less
a) lectures	/7/	/4/	/6/
b) group work	/4/	/12/	/1/
c) demonstrations	/5/	/7/	/5/

Comments:

13. How did you find the general standard of the instructors with respect to:

	i) command of English	ii) method of instruction
Very good	/2/	/1/
Rather good	/8/	/9/
Fair	/4/	/7/
Poor	/3/	/ /
Very poor	/ /	/ /

Please comment:

14. Did you have sufficient time for professional exchange of views with:

	i) the programme staff	ii) fellow-participants
Yes	/15/	/14/
No	/2/	/3/

15. How much did you benefit from these exchanges of views with:

	i) the programme staff	ii) fellow-participants
A great deal	/4/	/1/
Much	/9/	/3/
Somewhat	/3/	/7/
Little	/1/	/3/
Not at all	/ /	/3/

Please comment:

III. RELEVANCE AND APPLICABILITY:

16. Did you find the contents of the programme relevant to conditions in your company (institute)?

To a very great extent	/2/
To a great extent	/5/
To a sufficient extent	/9/
To a small extent	/1/

Please state why:

17. Do you feel that by participating in this training programme you have benefitted professionally?

To a very great extent	/ 1/
To a great extent	/10/
To a sufficient extent	/ 6/
To a small extent	/ /
To a very small extent	/ /

Please state why:

18. Do you think you will have an opportunity to apply your newly acquired knowledge and experience in your present job?

To a very great extent	/ /
To a great extent	/ 5/
To a sufficient extent	/11/
To a small extent	/ 1/
To a very small extent	/ /

What difficulties, if any, would you expect to meet?

19. Will you be in a position to transfer your acquired knowledge to others in your home country?

To a very great extent	/ 7/
To a great extent	/ 5/
To a sufficient extent	/ 5/
To a small extent	/ /
To a very small extent	/ /

20. How will this transfer be done?

a) In a day-to-day work to colleagues and subordinates	/11/
b) In specific training activities inside present employment	/ 5/
c) In specific training activities outside present employment	/ 3/

What difficulties, if any, would you expect to meet?

IV. SOCIAL ASPECTS OF THE PROGRAMME:

21. Please state your opinion about the leisure time activities organized by the programme staff:

What additional activities would you have appreciated?

22. Please give any comments you choose on aspects not adequately covered by this questionnaire:

Appendix VIII

UNIDO document on the expected follow-up activites

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA INTERNATIONAL CENTRE
P.O. BOX 300, A-1400 VIENNA, AUSTRIA
TELEPHONE: 211 310 TELEGRAPHIC ADDRESS: UNIDO VIENNA TELEX: [illegible] FAX: 232156

7 January 1992

Dear Dr. Sömjén,

Subject: Follow-up on the Workshop on co- and by-products of the Bayer alumina production (Budapest, 25 Nov. - 6 Dec. 1991)

The aim of our letter is to summarize the results of the subject Workshop organized by Aluterv-FKI utilizing mainly the Hungarian voluntary contribution to UNIDO and to draw your kind attention to the possible follow-up activities.

The Workshop was attended by 17 participants from nine countries. The experts were all experienced engineers, working in different areas of the aluminium industry (production, corporate planning, research, quality control, development, etc.) so the wide range covered by the lecturers gave information for all participants.

Aluterv-FKI prepared a very high-level publication of over 350 pages which was distributed among the participants. The publication gives details on all aspects of the production, quality control, application and market of the alumina co- and by-products.

By the end of the Workshop, Mr. Grof held discussions with each of the participants regarding the Workshop and the possibilities of future technical assistance. The following projects were identified:

Dr. T. Sömjén, Deputy Director
Ministry of International Economic
Relations
att. Mr. S. Zöldág
Budapest V. Honved utca 13
Hungary

..../2

a) *Brazil*

- Study on the establishment of a zeolite plant based on the Bayer process aluminate liquor (possible counterpart: ALCOA, Brazil).
- Regional Latin American programme for advanced aluminium oxide ceramics (possible counterpart: Sao Carlos University, Sao Paolo).
- Application of tube digestion for the upgrading of alumina plants in Brazil (possible counterpart: ALCOA, Brazil and other alumina plants).
- Assistance in the development and introduction of high-purity gallium production in Brazil (possible counterpart: Center for Mineral Technology of Brazil).
- Training programmes in special mineral technologies to upgrade the technical cadre of the Center for Mineral Technology of Brazil.

b) *China*

- Assistance in improvement of soda recovery from red mud (modification of combined Bayer-sinter process to enhanced Bayer process). (Possible counterpart: CNNC, Beijing).
- Upgrading the red mud disposal techniques, reduction of environmental hazards (possible counterpart: CNNC, Beijing).

c) *Egypt*

- Assistance in the introduction of the production of alumina-based catalysts for the petrochemical industries in the Middle East.
- Techno-economic study and 10 tpd pilot plant for paper grade aluminium-sulphate proudction.
- Workshop on rare earth metals.
- Training programme on recent trends in aluminium smelting. The programme could be organized by Egyptalum in the framework of TCDC.
- The establishment of an aluminium R&D centre in Egyptalum (over US$10 million).

d) *India*

- Organization of a national workshop on special aluminas in India (possible counterpart: Jawaharlal Nehru Aluminium R&D Centre).

e) *Iran*

- Feasibility study on spark plug grade special alumina production, establisment of a pilot plant (possible counterpart: IDRO).

f) *Jamaica*

- Application of tube digestion for upgrading the production at ALPART (possible counterpart: JBI/ALPART).

- Study on techno-economic selection of special aluminas to be produced in Jamaica for the markets in the Region (possible counterpart: JBI).

- Establishment of an environment monitoring unit at JBI (counterpart: JBI).

g) *Saudi Arabia*

- Asssistance in the establishment of an alumina plant based on the recently identified Saudi deposits.

h) *Turkey*

- Assistance to the Alumina Plant of ETIBANK in the introduction of vanadium pentoxide and gallium production (possible counterpart: ETIBANK).

- Assistance in aluminium sulphate production (possible counterpart: ETIBANK).

i) *Venezuela*

- Technical assistance in the development of zeolite and ceramic alumina production (possible counterpart: Instituto de Ingenieria, Caracas).

- Introduction of gel production from alumina hydrates (possible counterpart: Instituto de Ingenieria, Caracas).

- Assistance in bauxite/alumina testing (possible counterpart: CVG).

- Modernization of the red mud settling at Interalumina (possible counterpart: CVG/Interalumina).

upgrading of the Interalumina plant to 3 million tpa (possible counterpart: CVG).

The questionnaires completed by the participants as well as their verbal statements demonstrated their satisfaction with the training programme, research facilities and social events, however, some critics were made to the plant visits in the Almasfüzitö and Motim works.

Nevertheless, the Workshop was a great success and opened a wide range of future technical assistance and co-operation possibilities for Aluterv-FKI and SZIKTI through UNIDO and on bilaterial basis as well. Thus it was well in line with the recommendations of the Metallurgical Section of the UNIDO/Hungary Joint Committee. As a follow-up we would suggest to pursue some of the identified new possibilities by utilizing a part of the Hungarian voluntary contribution as a seed money for concrete technical assistance projects.

Once again, let us thank you and Ms. Zöldag for the financial and organizational support and congratulate Aluterv-FKI for their excellent work.

Sincerely yours,

J.V. Krouzek
Head
Metallurgical Industries Branch
Department of Industrial Operations

cc: Dr. P. Keresztes, Director-General
HUNGALU
H-1387 Budapest Pf. 30

Mr. Gy. Keébe, Managing Director
Aluterv-FKI
H-1389 Budapest, P.O. Box 128