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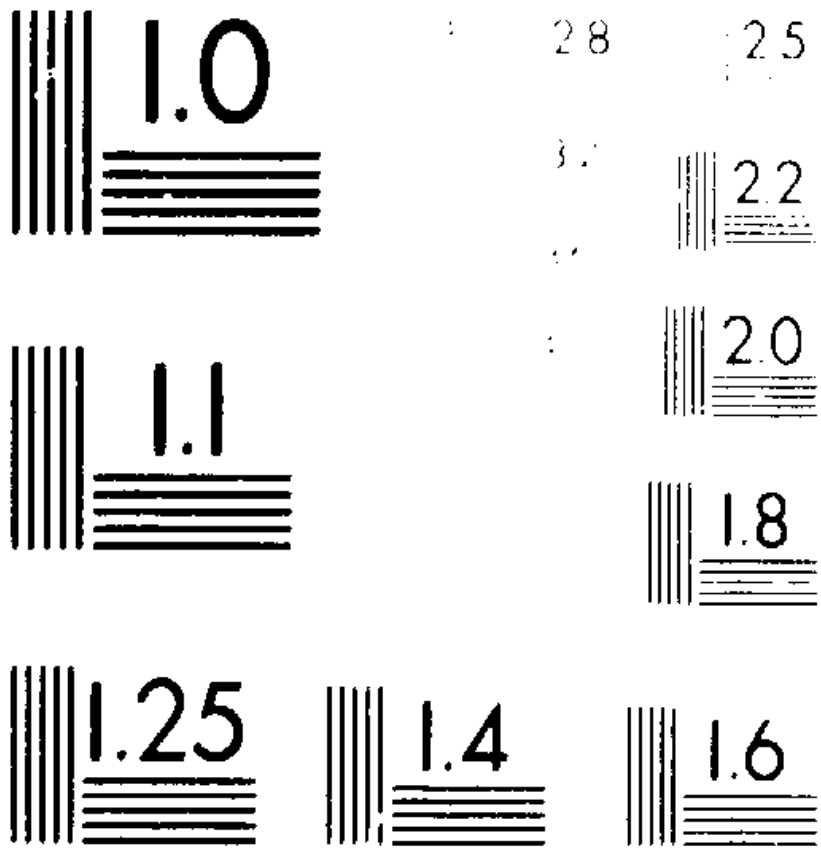

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Yugoslavia.

REPORT

on a mission as

Consultant in Actual Trends in Applied Aluminium Industry Research

Number: DP/YUG/75/022/11-55/31.8.A
Date: 8.9. to 16.9 1984
Expert on mission: Dr. János Zámbó

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (VIENNA)

CONTENTS

1. INTRODUCTION

I visited the Aluminium Institute for Research and Development in Titograd (under establishment) and in accordance with an advance consent of UNIDO, Vienna I have fulfilled the duties laid down in points 1(a) to (c), 2 and 3 of my Job Description. In accordance with this consent points 1(d) to (g) shall be fulfilled by another expert.

The duties to be fulfilled were - according to the Job Description the following:

"1. Give information on actual trends in applied aluminium industry research with particular emphasis on problems related to:
   (a) correlation of bauxite properties and alumina technology;
   (b) extraction of additional useful components of the bauxite Ga, V, In; beneficiation of red mud;
   (c) production and utilization of special alumina.
2. Review and comment upon the research programme of the Institute, particularly concerning the appropriate utilization of methods of modern material science.
3. Deliver a lecture to the engineers of KAT on actual trend in applied aluminium industry research."

2. CHRONOLOGY OF ACTIVITIES DURING THE MISSION

8.9.1984 Saturday	Departure from Budapest by car to Belgrade
9.9.1984 Sunday	Arrival to Titograd; in the evening: meeting with Director Dr. Branislav Radonjic.
10.9.1984 Monday	Fixing of the programm of activities. - Meeting and consultation with the experts of the Titograd Alumina Plant
11.9.1984 Tuesday	Getting acquainted with the organisation and the activity of the Research and Development Institute of KAT; meeting and discussion with the leading experts of said Institute
12.9.1984 Wednesdav	Discussion with Mr. Bogdan Cosovic, the technical director of KAT Lectures and discussion on the following subjects: - The present situation of the world aluminium industry - Basic trends of development of the aluminium industry - Aimes and duties of research and development in the aluminium industry
12.9.1984 Thursday	Visit of the laboratory of the Institute under construction Lectures and discussion on the following subjects: - The exploitation of by-products in alumina plants with special emphasis on V and Ga - Problems concerning red mud - Special aluminas

14.9.1984 Friday	Summing up of the experiences Discussion of questions related to the future work of the Institute
15.9.1984 Saturday	Departure from Titograd to Belgrade
16.9.1984 Sunday	Arrival to Budapest
5.10.1984 Friday	Debriefing at Vienna

3. SUMMARY OF THE LECTURES

The content of both lectures had been proviously discussed with Dr. Branislav Radonjic. Hence, they were not limited to the questions contained in the Job Description, but were also extended to those requested by Dr. Radonjic.

I.Lecture (12.9)
Situation, development, trends, aimes and duties of research and development (R and D) in the aluminium industry

1.) The present situation of the world aluminium industry
   - Characteristics of the crisis of the aluminium industry (fluctuation of consumption; fluctuation of prices; unutilized capacities; accumulated stocks, etc.)
   - Consumption prognosis
   - Economic conditions for setting up new capacities
   - Improvement of the efficiency of existing capacities; reducing production costs
   - Increasing the value of aluminium products by improving their quality and by widening their assortment

2.) Review and evaluation of new alumina and aluminium manufacturing processes and consideration of their prospects.

3.) Main questions of R and D in aluminium smelters:
   - Stable cathodes
   - Non consumable anodes
   - Heavy duty automated environment friendly pots and operations

4.) Detailed survey of the R and D projects of alumina production:

- Process liquor purification (reducing of the carbonate and organic material level)
- Production of sandy alumina
- High temperature digestion (tube digestion)
- Processing of medium quality bauxites
- Other possibilities of energy conservation (e.g. calcination)

II. Lecture (13.9)

Theory and praxis of by-products in alumina manufacturing; the complex exploitation of bauxites; special aluminas

1.) By-products

- Effects of bauxite contaminants
- Possibilities of processing bauxites with increased $CaCO_3$ contents
- Removal of sodium carbonate salts in practice
- Crystallizing evaporators
- Complex caustification
- Dissolution and build-up of vanadium in the process liquor
- Methods of extraction of vanadium salts
- Possibilities of vanadium extraction in case of addition of CaO
- Possibilities of vanadium salt processing in alumina plants
- Enrichment of Ga and methods of its extraction

2.) Complex exploitation of bauxites

- Methods for iron removal from bauxites
- De-ironing of the Crna Gora low iron content bauxites

- Siderurgical utilization of red muds
- Other possibilities for the utilization of red muds (roadbuilding, brick production, soil amelioration)
- Red mud disposal

3.) Special aluminas

- Review of different kinds of special aluminas on the basis of their:
  - utilization
  - properties
  - manufacturing processes
- The market situation of special aluminas
- Production possibilities of special aluminas in Yugoslavia and at Titograd

4. PROBLEMS IN KAT's ALUMINA PLANT AND SUGGESTED SOLUTIONS

Carbonate problem

The Titograd Alumina Plant was designed for processing bauxite with a maximum limestone content of 0.3 % (expressed as CaO). It is supplied with an ore containing up to 1.5 % CaO at present. The carbonate removal system of the plant can not cope with the high amount of sodium carbonate formed during the processing of this high-carbonate ore. Consequently the sodium carbonate concentration of the process liquors has significantly increased and is further increasing. As a result, the caustic concentration of the strong liquor had to be reduced from 225 g/l to about 200-205 g/l Na_2O_k (otherwise the sodium carbonate precipitating from the liquor would block the evaporators), consequently the capacity of the digestion dropped by some 10 %. The increased carbonate level in the process liquors has also caused some problems in the precipitation (by reducing the grain size of the precipitated hydrate) and in other plant units (where sodium carbonate precipitating from the liquor forms scales reducing the heat transfer and is blocking pipes and equipment).

There are a number of known methods for liquor purification, e.g. Pechiney's (using barium aluminate), Kaiser's (precipitation of dawsonite), Alcoa's (using magnesium compounds) and the Japanese method of liquor ignition, but most of them are aiming first of all the reduction of the organics content of the process liquor. Since the organics content of the Titograd process liquors is fairly low, these latter processes are irrevelant.

A very low carbonate level can be attained with the [illegible] method, but it becomes very expensive if the amount of carbonate to be removed is high.

Therefore I suggest the crystallization of sodium carbonate from a high concentration strong liquor prepared in a special evaporator to be installed (so-called crystallizing or salting-out evaporator or superconcentrator). The use of such an equipment with the evaporation capacity of some 15 to 20 t/h evaporated water would make possible the reduction of the carbonate level in the process liquors to about 10 to 12 % and its stabilization at this level when processing bauxites with a CaO content of 1.5 % or even slightly higher.

The caustic content of the precipitated sodium carbonate could be recovered by a process called complex caustification, patented and widely used in Hungary.

An other possibility for solving the carbonate problem could be the physical beneficiation of the bauxite. However, predictions on the efficiency of such a method could only be made on the basis of extensive laboratory and pilot-scale beneficiation tests.

By-products

There is a possibility to crystallize a complex salt with a relatively high (10-20 %) V_2O_5 content from the process liquors and to reprocess this salt to pure V_2O_5 or sodium polyvanadate. But the relatively low (0.054 %) V_2O_5 content of the bauxite and the relatively high CaO content of same (the latter makes the crystallization of the complex salt more difficult since it eliminates one of its components, P_2O_5) make the application of this process unattractive. Notwithstanding, the practicability

of V salt extraction can only be decided after preparing a detailed V balance and deciding upon the carbonate elimination technology.

Much more attractive could be the extraction of gallium from the process liquors, since (according to the preliminary information) the spent liquor of the Tatabánya alumina plant contains about 250 mg/l Ga_2O_3, in contrast to the typical Hungarian liquors containing only some 170-180 mg/l of the same, but still making possible a profitable extraction of significant amounts of gallium. Due to the present excellent market possibilities of Ga it would be advisable to make a feasibility study on the basis of known Ga extraction methods.

5. RECOMMENDATIONS FOR THE ACTIVITY OF THE INSTITUTE

The establishment of the Institute was a proper decision, it shows the right judgement of the management. Yugoslavia has a broad and well founded aluminium industry but had not specialized research institute in the said branch.

An extensive development of the aluminium industry (expanding the capacities) is only justified where over and above the favourable raw material basis sufficient cheap energy plus existing infrastructure and technical expertise are also available. In lack of any of these prerequisites only the existing capacities should be intensified. This can happen by reducing the production costs, by producing new products and widening their assortment and thus producing more valuable products. These general trends are well reflected in the programm of KAT and the Research Institute of KAT. In my lectures I have illustrated the possibilities of such improvements by way of examples.

The personnel of the Institute and the equipment are sufficient only to <u>start</u> their activity. In order to reach an efficient activity in the future the following could be recommended:

1.) Simoultaneously with the completion of the construction work and the installation of laboratory equipment
   - the selection, recruitment and attracting of <u>suitable</u> specialists for said work should be continued
   - the training of the researchers in various foreign institutes (e.g. Alusuisse, Pechiney, ALUTERV-FKI, VAMI) should be set forth

2.) Contacts should be set up with other Yugoslavian research and development institutions as well as foreign institutes

3.) The research programm of the new Institute should start with questions of most urgent concern of the plant; They should start on a laboratory scale and the results should be realized on the factory scale. They should revert later to the pilot scale thus jumped over; These research works should be carried out by teams formed from among the research people of the Institute, the specialists of the factory plus researchers from other institutes.

4.) The Institute should also undertake research activities on a contractual basis from other aluminium establishments of Yugoslavia.

5.) A technical-scientifical council should be set up in the Institute on a wide basis. For the discussion of a specific problem a selected group of experts for the said question should only be invited out of the members of the council. The R and D programm should be based on a previous study and this study has to be discussed in the said council.

6.) It would be advisable to invite guest researchers for speeding up the establishment of the best research methods.

7.) Experts of other institutes should be periodically commissioned.

8.) It would be useful to set up an aluminium marketing service. This service would be the connecting chain link between aluminium customers and the factory.

It would serve well for reflecting the actual needs of the market to be followed by adjusting the production and the product range to such needs.

9.) Getting active in the international scientific life would be useful. At the same time joining to the information exchange network system of R and D institutes should also be achieved.

10.) On course of the lectures some further practical recommendations had been given for possible research activities.

Based on the information gained in the course of the lectures, the discussions with the management and the staff of the plant and the Institute and being aware of the main problems of the plant plus that of the Yugoslavian aluminium industry I consider the fact of setting up the basis of the R and D Institute to be very useful. It is, however, only at the beginning of its activity and UNIDO's further aid would be advantagous in order to reach an efficiant research activity. This could be e.g. in the form of exchange of specialists, in securing training possibilities for the researchers and other ways and means UNIDO can arrange.

6. MISCELLANEOUS

Literature

In order to help the new Institute's information basis I have taken with me 5 books, 8 studies and about 40 published papers which I have handed over to the Institute for inspection.

Acknowledgments

Grateful acknowledments are due to Dr. Balázs and Mr. Watanabe of the Metallurgical Industries Section, Industrial Operations Division of UNIDO, Vienna for initiating the mission and to Dr. Branislav Radjonic, Titograd, for his excellent organization and for securing the perfect circumstances for the fulfillment of my mission.

Budapest, 26.9.1984

Dr. János Zámbó

Appendix

ATTENDANTS OF LECTURES AND DISCUSSIONS

A list (SPISAK) made at Titograd is attached. The English translation of the text of said list is as follows:

" List

of the persons with whom Dr. Zámbó has had contacts

Participants in the discussions:

(here follows a list of 12 names)

There were 22 and 23 persons attending the lectures held by Dr. Zámbó

Besides those mentioned above (with whom he had made contact in the course of the discussions) the following were present at the lectures:

(here follows a further list of names)

(Attachment).

S P I S A K

kadrova koji su imali kontakte sa Prof. Dr. ZAMBO-om

U razgovorima su učestvovali:

1. Dr. Branislav Radanjić, direktor Instituta
2. Bogdan Ćosović, dipl.ing. potpredsj. PO KAT-a
3. Slobodan Vuksanović, dipl.ing. direktor Glinice
4. Pejović Momčilo, dipl.ing. zamj.dir. Glinice
5. Adžić Mijomir, dipl.ing. uprav. proizv. Glinice
6. Rajko Vasiljević, dipl.ing. Viši stručn.sar. Instituta
7. Dr. Miodrag Kaludjerović, dipl.ing. dir. Kontrole Kvaliteta
8. Mirko Mišović, dipl.ing. asistent Instituta
9. Jadranka Pavićević, dipl.ing. asistent Instituta
10. Lidija Nelević, dipl.ing. asistent Instituta
11. Svetislav Nelević, dipl.ing. direktor Livnice
12. Miodrag Mižurović, dipl.ing. savjetnik u Institutu

Na predavanjima koja je održao Dr. ZAMBO bilo je prisutno 22 odnosno 23 čovjeka.

Pored navedenih (sa njima je imao kontakt u razvogorima) predavanjima su bili prisutni:

Dr. Petar Živković, dipl.ing. sa Metalurškog fakulteta
Dr. Slobodanka Vukčević, dipl.ing sa " "
Dr. Dragoljub Blečić, dipl.ing sa " "
Mr. Radomir Vukčević, dipl.ing. sa " "
Dr. Dragutin Draškoviđ, dipl.ing saradnik "GOŠE"
Mr. Vinka Vujošević, dipl.ing. iz KAT-a
Želimir Cerović, dipl.ing. KAT-a
Branko Gujić, dipl.ing. KAT-a
Dragutin Mićković, dipl.ing. KAT-a
Danica Đurović, dipl.ing. KAT-a
Paško Đonović, dipl.ing. KAT-a

J.Mihajlović, dipl.ecc. KAT-a
M.Mišurović, dipl.ing, "
B.Novaković, dipl.ing. "
R.Tomašević, dipl.ing. "
D.Gnjidić, dipl.ing. "
M.Panić, dipl.ing. "
V.Zarubica, dipl.ing. "