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FINAL REPORT ON THE SECOND RETURN MISSION DP/IND/88/015/11-08/B INDIA

of Dr. K.Solymar, Expert in alumina process engineering to India between 20th September and 19th December, 1995

for the
Jawaharlal Nehru Aluminium Research
Development and Design Centre, Nagpur

about

- Follow-up actions concerning the pre-investment studies prepared for BALCO, HINDALCO and NALCO in 1993-94 and co-operation with MALCO
- Co-operation / guidance in laboratory simulation and preparation of a working paper on selection of optimum process technology for Indian bauxites based on mineralogy
- Guidance / preparation of training materials. Organisation of the technical programme and delivery of papers to a workshop on "Emerging trends and novelties in alumina production" held at JNARDDC.

Backstopping officer : Dr. T. Grof, Substantial officer, UNIDO, Vienna

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ABSTRACT

The second return mission was organised by UNIDO Vienna in the framework of the project to assist the Government of India in setting up a functioning Aluminium Research Development and Design Centre (Project no. DP/IND/88/015/11-08). The second return mission is the continuation of the former two missions. During the fist mission of the expert during the period 13th September and 24th November 1993 preinvestment studies for the modernisation/expansion of alumina plants of BALCO, HINDALCO and NALCO were prepared by the staff of JNARDDC with guidance of the consultant. During the first return mission between 7th November 1994 and 21st January 1995 the main duties of the consultant were: guidance in preparation and fulfilment of follow-up activities covering above stdies, laboratory simulation and guidance and preparation of training materials. During the present second return mission the following main activities have been fulfilled by the consultant :

- Guidance in the preparation of further follow-up activities concerning the preinvestment studies prepared for BALCO, HINDALCO and NALCO in 1993-94 and related to co-operation with NALCO.
- Co-operation/guidance in laboratory simulation and preparation of a working paper on "Optimum process technology for Indian bauxites based on mineralogy"
- Guidance/preparation of training materials. Organisation of the technical programme and delivery of papers to a workshop on "Emerging trends and novelties in alumina production" held on 30th November and 1st December 1995 at JNARDDC.

Altogether four papers have been prepared and delivered by the consultant dealing with the status of primary aluminium industries, competitiveness of the Indian alumina refineries, pressure decantation and hyperbaric filtration of red mud slurries.

In order to achieve further progress in laboratory process simulation the implementation of an up-to-date digestion testing equipment, larger volume precipitators and a traditional red mud settling equipment are recommended. The organisation of simultaneous digestion and precipitation tests and systematic simulation and mathematical modelling of precipitation for all alumina plants are advised.

Closer cooperation and regular contacts are required with the companies in order to reach faster progress in implementation of process technologies recommended by JNARDDC.

Further development of the good level of mathematical modelling is recommended which can be one of the strongest areas of the Centre in the future besides bauxite reserve evaluation and energy auditing

Cooperation with engineering company (e.g. Engineers India Limited) in preparation of preinvestment studies is highly recommended, with regard to instrumentation and process control the Tata Research Development and Design Centre would be an adequate counterpart of the JNARDDC.

Nagpur, 18th December, 1995

Dr. K. Solymar
UNIDO Consultant

INTRODUCTION

The second return mission was also organised by UNIDO, Vienna and by the Jawaharlal Nehru Aluminium Research Development and Design Centre (JNARDDC), Nagpur in the framework of UNIDO Project "Assistance to the Government of India in setting up a functioning Aluminium Research Development and Design Centre" (Project No. DP/IND/88/015/11-08). The second return mission was the continuation of the former ones fulfilled between 13th September and 24th November 1993 and between 7th November 1994 and 21st January 1995. The mission was planned originally for 2 months duration but it has been extended on the site to 3 months on the request of national Director and CTA.

The recommendations of the preinvestment studies are valid now-a-days yet and the expected intensification of the alumina plants need further laboratory simulation, computer modelling and techno-economic evaluation to be carried out by JNARDDC.

In the meantime HINDALCO decided to realise the plant expansion independently in cooperation with foreign aluminium company, while at BALCO urgent actions were necessary to stabilise the plant operation because of the shortage in caustic soda and alumina in the cycle. The intensification of both BALCO and NALCO plants are very actual. Furthermore, recently JNARDDC started the cooperation with MALCO where the capacity increase is also required. The report has been written by Dr. K. Solymar as a result of his second return mission. The related job sescription is enclosed as **Annexure-I**.

The activity at JNARDDC in Nagpur was started on 23rd September and terminated on 18th December 1995.

ACTIVITIES

The actualised tasks of the consultant have been determined by Dr. T.R. Ramachandran, Director and Dr. J. Zambo, Chief Technical Adviser in agreement with the above job description, requests of the companies and the workplan of JNARDDC for 1995. The work prgoramme of the consultant is enclosed as **Annexure-II**.

According to this work programme the activity of the consultant covers three main fields :

- Follow-up actions concerning preinvestment studies prepared for BALCO and NALCO in 1993-94 and preparation of the cooperation with MALCO.
- Co-operation /guidance in laboratory simulation of digestion and precipitation.
- Guidance/preparation of training materials, organisation of a workshop on alumina production and deliver papers.

The companies related activity was focussed on the problem shutting of the BALCO Korba Alumina Plant caused by the critical shortage in caustic soda and alumina in the cycle.

In connection with laboratory simulation tests and development of the Indian alumina production a working paper was prepared on "**Optimum process technology for Indian bauxites based on mineralogy**".

The draft of the study on "Main development trends, laboratory simulation and modelling of precipitation prepared by the consultant during his first return mission has been finalised by the experts of JNARDDC in the main time.

The following papers have been prepared and delivered by the consultant at the **Workshop on "Emerging trends and novelties in alumina production**" which was held at JNARDDC on 30th November and 1st December 1995 :

- The status of primary aluminium industries
- Compatitiveness of the Indian alumina refineries
- Pressure decanter; a revolution for red section
- Hyerbaric filtration as means of significant improvement in red mud disposal.

The same experts of the Centre who have participated in the preparation of the preinvestment studies in 1993-94, were mostly involved in the follow-up actions, discussions, consultations and laboratory test work, too. The list of the cooperating experts (senior counterpart staff) is enclosed as **Annexure-III**.

The close and good cooperation with Dr. C. Misra, UNIDO consultant in all laboratory and alumina plant related topics is also to be emphasized beside the valuable kind guidance of the Director and CTA.

The detailed programme of the above mentioned workshop and the list of delegates are enclosed as **Annexure-IV**.

The schedule of the second return mission is given below :

Departure from Budapest to Delhi	Sept. 20
Visit UNDP Office	Sept. 21-22
Arrival to Nagpur from Delhi	Sept. 22
Evaluation and discussion of the alumina production related activity of Centre carried out in 1995. Guidance of lab tests	
Fact finding mission to Korba alumina plant of BALCO (Departure on 8th Oct, arrival back on 14th Oct)	Oct. 8-14
Preparation of technical papers for the workshop and for BALCO	Oct. 15-Nov. 29
Workshop	Nov. 30 - Dec. 1
Meeting with NALCO experts at JNARDDC	Dec. 2
Meeting with BALCO delegates in Nagpur	Dec. 3
Finalisation of the working paper on optimum processing of Indian bauxites	Dec. 4-11
Departure from Nagpur to Bombay, meeting at MALCO Office	Dec. 12
Departure from Bombay to Mettur Alumina Plant of MALCO visit of via Bangalore	Dec. 13
Departure from Mettur to Nagpur via Bangalore-Hyderabad	Dec. 14
Preparation of the report on second return mission	Dec. 15-18
Departure from Nagpur to Delhi	Dec. 18
Departure from Delhi to Budapest	Dec. 19

A/ Follow-up actions concerning the preinvestment studies prepared for BALCO, NALCO and HINDALCO in 1993-94 and cooperation with MALCO

Extended and successfull activity is going on in the Centre in the field of the evaluation of the bauxite reserves and future bauxite supply for BALCO and HINDALCO including detailed studies on quantitative mineralogical composition and lab simulation of the grindability and digestibility of the selected bauxite samples.

Encouraging results have been achieved relating to the optimal beneficiation of the Panchpatmali (NALCO) bauxite by means of the high intensity wet magnetic separation.This ore dressing seems to be viable if the long distance transportation of this bauxite is required, e.g. to BALCO plant or to abroad.

The energy auditing of BALCO Korba alumina plant has been carried out with great success and similar measurements are expected soon at NALCO Damanjodi alumina plant, too.

Unfortunately, no significant progress was achieved relating to the intensification and alumina plant expansion at the companies.

1. Fact finding mission and evaluation of the status of the BALCO Korba Alumina plant

We visited the Korba alumina plant during the period October 9-13, 1995 together with Dr. A.K. Nandi, Mr. M.J. Chaddha and Mr. V.Vishwanathan. Dr. T.R. Ramachandran Director and Dr. J. Zambo CTA also were with our team for a couple of days. The evaluation and recommendations can be found in **Annexure-IV**.

The detailed study of the actual situation and that of the expected improved status which can be achieved after the stabilisation of the plant operation by means of the refillment of the caustic soda and alumina shows that the target 185 kt/a production can be achieved. In order to reach 200 and 225 kt/a capacity MR control, hydrate slurry cooling, digestion lime charge, thereafter process intensification by parallel stream or sweetening are required.

Based on the further discussion on 3rd December with Mr. K.P. Paul JNARDDC analysed the level of Na_2O loss in function of the amount of the return water from the red mud pond. It was found that 2m3/t recycling is required to avoid extra loss which increases very rapidly at 1.5 m^3/t already (about +5 kg Na_2O/t) and at 1 m^3/t reaches a value of + 9 kg Na_2O/t.

Furthermore, the laboratory modelling of the BALCO precipitation combined with computer simulation justified that at an aluminate liquor concentration of 145-150 g/l as Na_2O caustic with an MR of 1.62 and with 350 g/l seed 73-74 kg/m^3 liquor productivity can be achieved if 12 precipitator tanks are in operation (temperature profile: 60°C -50°C or 65°C-54°C).

2. Further cooperation with NALCO

A meeting was held in connection with the Workshop at JNARDDC in order to discuss the potential topics for cooperation between NALCO and the Centre. The minutes of meeting is enclosed as **Annexure-V**. Although the only feasible intensification is the low pressure digestion, no decision has been made yet. The Centre should make further efforts in this direction. The regular contact and the projects mentioned with NALCO interest can strengthen the cooperation very significantly.

3. MALCO Cooperation

JNARDDC has already been involved in MALCO related activity in the field of laboratory simulation of digestion.

The meeting held in Bombay at MALCO headquarter on 12th December was the first top level discussion between NALCO and JNARDDC. Dr. T.R. Ramachandran's presentation indicated the capability of the Centre and the potential fields of cooperation. MALCO expressed his willingness to use the assistance of JNARDDC. The UNIDO consultant discussed the opportunities of the intensification and capacity expansion of the alumina plant and emphasized the capability of the Centre to prepare related techno-economic study. It has been agreed that the next technical discussion will be held in Nagpur at

JNARDDC on 22nd December. In order to prepare this meeting accordingly the Agenda of the meeting with explanatory notes was prepared by JNARDDC based on the plant visit taken by JNARDDC team (Dr. J. Zambo, Dr. K. Solymar, Dr. A.K. Nandi., Mr. H.K. Chandwani). The Agenda is enclosed as **Annexure-VI**. The recommended intensification is based upon the increase of the caustic soda concentration of precipitation and digestion with about 20 g/l Na_2O caustic.

B. Co-operation/guidance in laboratory simulation and preparation of a working material

Between February and September 1995 the laboratory technological tests were focussed on the digestion and evaluation of different bauxite samples from technological point of view.

The precipitation equipment was investigated only related to the temperature profiles and no precipitation tests were carried out.

The consultant made actions to prepare the laboratory modelling of precipitation until the arrival of Dr. C. Misra. These tests have been guided by him.

In order to promote the further development work and laboratory simulation a working material has been prepared by the consultant on "**Optimum process technology for Indian bauxites based on mineralogy**".

This study emphasizes the role of the mineral individualism and heterotypism in the bauxites with special regard to the high crystallinity of gibbsite, boehmite and anatase in Indian bauxites. This fact should be considered at the selection of the optimum process technology. It is evident that the gibbsitic bauxites should be processed at low-pressure digestion (145-160°C) and the monohydrate bauxites at high temperature digestion (optimally with lime charge) along with gibbsitic ore either in a parallel stream or applying sweetening in order to reach adequate saturation of the digestion effluent and pregnant liquor by alumina which is the most important precondition of the high liquor productivity, that is the competitiveness of the alumina refinery in long term.

This working paper can be used successfully at the elaboration of R&D project proposals as a basic information.

C. Guidance/preparation of training materials, Organisation of Workshop on alumina process technology

According to the workplan of JNARDDC for 1995 the activity of the consultnat was also focussed on the elaboration of the training material and organisation at the technical programme of the related Workshop.

The training material on the "**Main tendencies in the development of the world aluminium industries with special reference to alumina production**" has been prepared by the consultant during his first return missions and was completed early 1995 by the staff of the Centre.

The present activity was aimed to organise a workshop on "**Emerging trends and novelties in alumina production**". The technical programme of the Workshop has been recommended and finalised by the consultant with close cooperation with Director, CTA, Dr. C. Misra and Dr. P.M. Prasad. The programme covered the fields of the precipitation and chemical grade alumina hydrates and alumina and that of the red mud disposal and utilisation beside of the analysis of the status of the aluminium industry at the end of 1995 and discussions of the status and future prospects of Indian bauxites and the main tendencies in process and equipment development as pressure decantation and hyperbaric filtration of red mud. The mathematical modelling of the Bayer process and especially that of the precipitation were also key topics of the workshop. Naturally all the papers paid special attention to the Indian conditions. It was a great success that the scientists of the Centre delivered excellent papers in different topics demonstrating the progress achieved also in this aspect during the past few years. the required contribution of the Consultant to this activity was limited mostly to the selection of the scope of the papers and to advice of the presentation. Dr. A.K. Nandi, Mr. M.J. Chaddha, Mr. H.K. Chandwani and H. Mahadevan justified their high technical level and capability to teach their colleagues in India. The programme of the workshop and the list of Delegates are enclosed as **Annexure-VII.**

The consultant should express his high appreciation related to the actual preparation of altogether 8 papers on behalf of the scientists of JNARDDC to be presented at **BAUXAL Conference** next year.

The consultant has prepared and delivered the following papers :

- The status of primary aluminium industries
- Competitiveness of the Indian alumina refineries
- Pressure decanter : a revolution for red section
- Hyperbaric filtration as a means of significant improvement in red mud disposal.

The status of primary aluminium industries at the end of 1995 is healthy and encouraging. It is expected that most probably 2.7 m tpy brownfield and 1.0 m tpy greenfield alumina capacity will be erected by the end of this decade. Based on the good competitiveness of the Indian alumina refineries, first of all NALCO and Orissa bauxite related projects, the expectations for the Indian alumina industry in the near future are very promising. Intensification of Damanjodi Alumina Plant to increase the capacity by 0.5 m tpy and the 1.0 m tpy UTKAL greenfield projects are prime candidates.

The competitiveness of the Indian alumina refineries can be evaluated on the basis of the detailed analysis of the alumina production costs. Although the NALCO Damanjod alumina refinery can be found among the most competitive alumina plants on the world, it is to be considered that this advantage is the consequence of the availability of the high grade and very cheap bauxite. (40 US $ saving per ton of alumina in comparison with the world average bauxite cost) and the low cost of the manpower and overhead (further 20 US $/t advantage).

The sum of these cost elements, that is 60 US $/t is the difference in the production costs of Damanjod plant and world average. It should be drawn the conclusion that all the efforts are to be made to increase the competitiveness of the Indian alumina refineries, including NALCO operation, mostly by means of the intensification in order to reach stable position on the world alumina and aluminium market for long term. Export oriented alumina plants can be viable only on the basis of a state of the art process technology, therefore the use of the low pressure digestion, parallel stream operation and sweetening are the only solutions as they have been recommended in the pre-investment studies prepared by JNARDDC in 1993-94.

<u>The pressure decanter : a revolution of red section</u> because this process technology and equipment enables the maximum supersaturation of the pregnant liquor by alumina without any danger of autoprecipitation. This is a key equipment to reach high liquor productivity up to 90 kg/m^3 and beyond in any existing plant. Further advantage is that the amounts of stored NaOH and alumina in the liquor circuit (inventory), can significantly be reduced. The equipment is 50 times more effective relating to the surface area than the traditional thickener. Finally, but not less important is the fact that the pressure decanter enables to develop and accomplish new processes where the pressure decantation is a key unit operation, e.g. Counter-current double digestion, fast separation of the slurry after sweetening etc.

The first tests for pressure decantation have been carried out in Ewarton (Jamaica) and Vaudreuil (Canada) then at Simizu (Japan). It is planned that the transformation of the Ewarton plant to pressure decantation will be accomplished by the end of 1996. So ALCAN have experiences for processing Jamaican, Guinean (Sangaredi, Boke) and blended Weipa/Bintan bauxites. The temperature limit of 150°C can be assumed, imposed by flocculant degradation.

The underflow mud of the Jamaican bauxite contained 25-30 % solids and the solid content in the overflow of the pressure decanter amounted to 30-80 mg/l at a flocculant dosage of 100 g/t red mud. The pressure decanter should be considered as a qualitative break-through in the separation of blow-off slurry.

<u>Hyperbaric filtration as a means of significant improvement in red mud disposal.</u>

The hyperbaric filter combines the continuous operating principle with an increase in filtration pressure of up to 6 bar simply by placing the entire disc or drum filter inside a pressure vessel. The hyperbaric pressure filters, mostly disc filters are in operation world-wide in coal and mineral dressing industry. The filters are built by Andritz A.G. (Graz, Austria) in sizes from 6 m^2 up to 120 m^2 for the disc model and from 1.6 m^2 up to 25 m^2 for the drum model.

The laboratory simulation tests and the pilot plant tests carried out by the Andritz mobile hyperbaric filter plant justified the great prospect of this new operation and equipment for the filtration of red mud slurries, first of all in red mud disposal. The hyperbaric filter enables the red mud to be filtered and dried to a moisture content of less than 30 % (typically to about 25%, in some cases even as low as 20 %), it has comparatively high productivity (300 to 6000 kg/m^{2}h) and its operation is practically continuous. The hyperbaric pressure filtration produces a non-thixotropic, dry cake of 75 % solids. This red mud can be transported by truck or conveyor belt to the disposal area. Its caustic soda content can not be drained off or reclaimed by rain water which does not penetrate a mud deposit of this density after proper disposal and compaction.

The application of hyperbaric pressure filtration is fully justified for the alumina plants which are under critical conditions due to the huge amount of rain water accumulating continuously in red mud pond, e.g. at Interalumina Venezuela or NALCO at Damanjodi. One of the most promising further field of application may be the direct filtration of blow-off slurry. The consultant contacted Andritz A.G. in order to supply the Centre and the Workshop's participants with relevant information and basic literature. This request was fulfilled and the informative leaflets have been distributed.

It can be forecasted that the pressure decanter and hyperbaric pressure filter will find wide application in the future alumina plants.

The related work plan of JNARDDC for 1995 has also contained the task of "Preparation of training material for the freshly recruited staff of the primary alumina and aluminium producers".

Based on the availability of the adequate training materials and Workshop proceedings in the Centre, the preparation of further training kit has not been required. The guideline of the recommended training programme and the selected material to be studied by the freshly recruited alumina experts is enclosed as **Annexure-VIII**. It can be seen that at least one month training (Group training) is to be organised at JNARDDC which contains the most important laboratory simulation tests of the main unit operations of the Bayer process, too.

D. Providing the Centre with copies of relevant literature

The list of the copies of the relevant literature submitted to the Centre is enclosed as **Annexure-IX**.

CONCLUSIONS

1. Extended and successful activity is going on in the Centre in the filed of the evaluation of the bauxite reserves and future bauxite supply for BALCO and HINDALCO. Such kind of activity has been recommended for NALCO, too. The recent negotiations seem to be successful.
2. Encouraging results have been achieved relating to the optional beneficiation of the Panchpatmali bauxite (NALCO) by means of the high intensity wet magnetic separation.
3. Energy auditing of BALCO Korba Alumina Plant has been carried out with great success. Similar activity is expected in the near future at NALCO, too.
4. Unfortunately, no significant progress was achieved relating to the intensification and alumina plant expansions at the companies, although the recommended process technologies elaborated in the pre-investment studies are feasible and justified by world-wide practice.
5. Significant efforts were made to stabilize the BALCO Korba Alumina Plant operation to solve the problems caused mostly by the shortage in caustic soda and alumina in the cycle. Proper evaluation and recommendations have been elaborated by JNARDDC based on a fact finding mission and measures made already by BALCO suddenly resulted in some improvement.
6. The laboratory simulation and mathematical modelling of the precipitation processes of BALCO and NALCO is in good progress, which was prepared by the consultant during his first return mission and now in cooperation with Dr. C. Misra, then the activity was performed by the staff under the guidance of Dr. C. Misra.

Similar activity is to be started relating to MALCO and HINDALCO precipitation, too.

The first results have been validated and applied for different variants of BALCO precipitation.

7. Cooperation with NALCO is expected to be restarted as a result of a meeting held in Nagpur on 2nd of December.

8. As a new alumina producer, MALCO was contacted in 1995 and further extended activity relating to the intensification of the Mettur plant is expected based on the discussions made in Bombay on 12th December and plant visit taken in Mettur on 13th December.

9. A working material prepared by the consultant on "Optimum process technology for Indian bauxites based on mineralogy" justifies the recommended process technologies in the preinvestment techno-economic studies for BALCO, HINDALCO and NALCO. They are : low pressure digestion at NALCO, parallel stream operation and/or sweetening at BALCO and HINDALCO.

10. The workshop on "Emerging trends and novelties in alumina production" concentrated on the most actual tasks of the technical development on the one hand as future bauxite supply, physical and mathematical modelling of precipitation in order to increase liquor productivity, mathematical modelling and advanced control of Bayer process, competitiveness of the Indian alumina refineries, basic development options (keynote address), production of chemical grade alumina hydrates and alumina, red mud disposal and utilisation on the one hand and on the most important novelties as pressure decantation and hyperbaric filtration on the other hand.

    The significant contribution of the JNARDDC Scientists (especially Dr. A.K. Nandi, Mr. M.J. Chaddha, Mr. V. Vishwanathan, Mr. H.K. Chandwani and Mr. H. Mahadevan as excellent authors and lectur, furthermore the highest level organisation made by Mr. R.N. Goyal) to the great success of the Workshop justified further significant progress achieved since the former workshop.

11. The Centre has well trained personnel (at a world standard level) in bauxite geology and evaluation (directed by Dr. A.K. Nandi), furthermore in laboratory simulation, material testing and mathematical modelling.

RECOMMENDATIONS

1. Although some progress was achieved in the implementation of few more adequate laboratory equipment for the simulation of the Bayer process, further actions are required to implement proper digestion testing equipment, larger volume precipitators and red mud settling equipment (more small size tubes, with temperature control in water bath).

2. The performance of simultaneous digestion tests and precipitation tests is required where detailed studies should be carried out to determine the characteristic digestion curves (alumina yield in function of MR or A/C) at different caustic soda concentrations, salt levels and retention times, at different temperatures. The effect of digestion lime charge is also to be studied related to amount, preparation of the slurry and feeding points. These laboratory simulation tests should be performed for each alumina plant in order to select the optimum process parameters for intensification.

3. The systematic simulation and mathematical modelling of the precipitation processes for each plant is required under the varying parameters of starting caustic soda and MR, temperature (temperature profile), seed amount and salt level. These data are also required for the studies on intensification.

4. It is recommended to collect representative bauxite samples form the most significant and characteristic bauxite deposits of the world (e.g. Weipa, Gove, Western-Australia, Trombetas, Jamaica, Boke, Sangaredi, Venezuela, etc.) in order to carry out comparative tests and studies with special regard to the crystallinity and reactivity of the bauxite minerals related to the typical Indian bauxites.

5. Further efforts are needed on behalf of JNARDDC and companies to introduce the recommended technical development measures and to intensity the alumina plant operations at NALCO, BALCO and MALCO focused on the digestion and precipitation.

6. Closer cooperation is required with the companies. At least twice in a year, once at JNARDDC, once at the alumina plant detailed technical discussions is recommended beside the every day contacts.

7. Further development of the good level of mathematical modelling is recommended which can be one of the strongest areas of the Centre in the future along with the energy auditing and bauxite reserve evaluation.

8. The cooperation with an engineering company (e.g. Engineers India Limited) in preparation of preinvestment studies is highly recommended. Relating to the instrumentation and process control the Tata Research Development and Design Centre is recommended as counterpart of the JNARDDC.

Annexure - I.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION

DP/IND/88/015/11-08

Post Title: Expert in alumina process engineering

Duration: 2 m/m

Date required: August 1995

Duty Station: Nagpur, India with travel in the country

Purpose of project: The immediate objective of the project is to assist the Government of India in setting up a functioning Aluminium Research, Development and Design Centre consisting of:

(a) Alumina Production Research Department
(b) Aluminium electrolysis Department
(c) Analytical Research Department
(d) General Services, instrumentation and Control Department (incl. Workshop and Maintenance)
(e) General Administration and Finance Department

The Centre will develop capability of carrying out the following main functions on behalf of and in cooperation with the bauxite processing/alumina production and aluminium smelter industries in the country:

(a) Assimilation and adaptation of available technologies
(b) Providing recommendations and ad hoc or applied and analytical research to local industries in process improvement, transfer of technology, etc.

(c) Setting up and operating a data bank

(d) Providing training of Indian engineers.

Duties: The expert will be required to advise on the improvement of alumina production technology and on basic engineering of alumina plants. He will assist in the setting up of the alumina production research department of the Centre and in mathematical modelling and preparation/application of energy and material balances of alumina refineries.

His main duties will be:

1. To assist in starting up activities in alumina process engineering, provide training to scientists of the centre in the techno-economic justification of R & D projects, calculation of benefits of recommendations of changes in technology, modification of processes, development of equipment, process control etc.

2. To deliver a series of lectures on preparation of feasibility reports, conceptual design and basic engineering packages for modernization of existing alumina plant and establishment of new ones.

3. To guide in the preparation of a case study for the modernization of one of the existing alumina plants and another on the expansion of an alumina plant with new production line.

4. Provide the centre with information related to the economics and international competitiveness of alumina production.

Qualification:

University degree (preferably Ph.D.) in chemical or metallurgical engineering. Well conversant and experienced with the operation of all alumina production units/phases and process parameters as well as with mathematical modelling and basic engineering of alumina production plants.

Language: English

Background Information:

The Indian aluminium industry looks back to a history of 44 years. The first aluminium smelter (in Alumpars, Kerala) was put into operation in 1943. At present there are five alumina plants about 587,000 and 580,000 tonnes per year, respectively. These facilities belong to five aluminium companies, namely Bharat Aluminium Company Ltd. (Balco), Hindustan Aluminium Corporation Ltd. (HINDALCO), the Indian Aluminium Company Ltd. (INDAL), the Madras Aluminium Company Ltd. (MALCO) and the National Aluminium Company Ltd. (NALCO).

With the commissioning of NALCO the share of the public sector in aluminium smelting is more than half of the total installed capacity of India. This indicates the decisive influence of the public sector on the future of the industry. The sustained growth and development of the aluminium industry in India, apart from requiring the adoption of suitable long term policies in relation to production management, output, pricing, and fiscal levies, is also in need for technology and market development, which will gradually be handled by the proposed Centre.

During the past years, India became one of the leading countries in the world having substantial bauxite resources, after the discovery of large deposits in the Eastern Coast in the nearly 1970s. The total bauxite reserves of India are estimated to be of the order of 2,650 million tonnes, which places India on the fifth place in the world list.

With the vast reserves of bauxite and coal in India, the aluminium industry has ambitious plans for a faster growth rate keeping in view the future demand in the foundry and export potentials.

The existing alumina/aluminium plants in India are based almost entirely on technology imported from various sources. Both in the areas of production of alumina and aluminium, a number of technological improvements have taken place in advanced aluminium producing countries. Import of improved technology is not always possible, also its introduction is not feasible in the existing plants. Import of technology necessitates proper assessments to determine its suitability under Indian conditions, the available raw materials, product demands, state of engineering developments, etc. Though research and development work is being carried out by the major aluminium producers in the country, these are mainly directed towards solving their day to day process problems in the plants. No work is done for the development of process know-how and basic engineering. The technologies followed in the existing plants are from various countries/suppliers - KAISER, ALUTERV-FKI, VAMI, ALCAN, MONTECATINI and ALUMINIUM PECHINEY. Apart from the strategic importance of having an indigenous Research, Development and Design Centre for Aluminium, the Centre is expected to save substantial hard currency payments to the foreign partners.

For meeting the estimated demand of aluminium by the turn of the century, substantial additional capacities for alumina and aluminium will have to be set up in the 1990s. Additional demand for aluminium by the turn of the century, which is in excess of the currently available capacity would be of the order of 440,000 tonnes per annum. Considering the payment for know-how, basic engineering and royalties for this additional follow-up stage this would mean an expenditure of at least US$ 95 million.

It is to be pointed out that the cost for Establishment of the Aluminium Centre in Nagpur (both Indian Government and UNDP contribution) is of the order of US$ 12.5 million. The financing of operations and further development of the Centre is envisaged by the Government to be secured through a collection of Rs. 100 per ton of aluminium for aluminium research and development, added to the price of aluminium (established now by the State in India). The funds so generated would serve as financial basis for operation and further extension of the Centre.

When the new aluminium capacity will be established the Centre will be fully functioning and if it contributes to savings of only ten per cent of the expected expenditure for project engineering and royalties, apart from rendering other useful services, its establishment would be fully justified.

It is to be noted that all the leading aluminium producing countries have their own R and D centres. Close interactions among these Centres' Research and educational institutions and industry has enabled numerous technological advances - this example is needed to be followed in India.

In the light of the above, a coordinated effort in R and D will be essential for the development of know-how and basic engineering to self-reliance in alumina and aluminium technology needed for the establishment of future plants without need to go for foreign consultancy. Future development of aluminium industry in the country based on indigenous expertise demands the immediate establishment of a self-reliance full-fledged and independent research, development and design centre for aluminium at the national level.

The development objective of the project is to aim at self-reliance in alumina and aluminium production technology and to achieve faster growth of the Indian aluminium industry to meet the domestic demand for aluminium products. This goal will be achieved by setting up of an Aluminium Research, Development and Design Centre at the national level which will be in a position to carry out research and development in the field of bauxite processing, alumina and aluminium production leading to improvement in the existing plants and creating new production facilities. Thus, the output of the project will be physical facilities of an Aluminium Research Development and Design Centre, adequately equipped with specialized research and testing equipment and trained professional staff to render research and development technology in the existing plants and for setting up of new alumina/aluminium production facilities based on indigenous raw materials and natural resources.

In addition, the Centre will handle related projects such as dealing with the use of by-products, design improvements for saving of energy and materials, development of new products and alloys. Another particular problem that the Centre is expected to address is emanating from the lack of adequate and uninterrupted power supplies which has led to poor utilization of capacities in the recent past. Investigations into energy saving technologies of alumina and aluminium production will be one of the important tasks that the Centre will have to tackle.

It is expected that once the Centre is established it will meet the fast growing technological service needs of the aluminium industry in India. The Centre will consist of the following departments:

- Alumina production research department with four laboratories and one pilot plant;
- Aluminium electrolysis research department with four laboratories;
- Analytical research department with three laboratories;
- General services, instrumentations and control department with four sections;
- General administration and finance department with three units.

The civil construction works for the Centre started in Nagpur in 1990 and will be finished by 1992-1993. The centre is planned to fully operate/function by 1994-1995.

The assignment of the national staff and procurement of equipment started in 1989-1990. The first R/D works have started in 1991-1992. Training of the staff is being carried out in India and abroad.

For a more detailed information reference could be made to the Project Document and the Detailed Centre Design.

Annexure - II

WORK PROGRAMME

For Dr. K. Solymar UNIDO Expert
22nd September 1995 -18th December 1995 at JNARDDC at Nagpur.

The following main fields of activity are planned in connection with the related job description :

1. Follow-up actions concerning the preinvestment studies prepared for BALCO, HINDALCO and NALCO in 1993-94 and cooperation with MALCO

1.1 Fact finding mission and evaluation of the status of BALCO Korba Alumina Plant.

1.2. Elaboration of recommendations relating to the further co-operation with NALCO.

1.3 Determination of the main fields of the cooperation with MALCO based on discussions and plant visit.

2. Cooperation/guidance in laboratory simulation of digestion, red mud settling and precipitation. Preparation of a working material concerning the selection of optimum process technology for Indian bauxites based on mineralogy.

3. Guidance/preparation of training materials. Organisation of the technical programme of a workshop on "Emerging Trends and Novelties in Alumina Production" at JNARDDC.

Annexure III

List of the Co-operating Experts (Senior Counterpart Staff)

Name of Participants	Designation	Field
Dr. T.R.Ramachandran	Director	Overall Supervision
Dr. J. Zambo	Chief Technical advisor	Co-ordination & Guidance
Dr. C. Mishra	Consultant (UNIDO)	Alumina Technology
Dr. P.M.Prasad	Professor, Consultant	Red Mud Disposal and Utilisation
Mr. R.N.Goyal	HOD (Alumina)	Alumina Technology
Mr. H Mahadevan	Scientist	Alumina Technology and Lab. Simulation
Mr. H.K.Chandwani	Scientist	Alumina Technology and Lab. Simulation
Mr. V.Vishwanathan	Scientist	Mass & Heat Balance
Mr.M.J.Chaddha	Scientist	Alumina Technology & Mass and Heat Balance
Mr.K.V.Krishnan	Scientist	XRD Analysis
Mr.Ramana Murthy	Scientist	Alumina Technology and Lab. Simulation
Mr.K.J.Kulkarni	Scientific Assistant	Lab. Simulation
Mr. R.K.Meshram	Steno-cum-Assistant	Preparation of Reports

421/JNARDDC/DIR/95

October 24, '95

Mr. Divakar Dev
Chairman-Managing Director
Bharat Aluminium Company Limited
Scope Complex, Lodi Road
New Delhi 110 003

Sub: Visit of the JNARDDC team to Korba to evaluate the alumina plant and smelter performance

Dear Mr. Dev:

A team of experts from our Centre (consisting of Drs. Solymar, Horvath and Nandi and Messrs Agarwal, Basu, Viswanathan and Chadda) visited the Korba alumina plant and smelter during the period October 9 -13, '95 and discussed with the plant personnel about the performance of the plants. Dr. Zambo, our Chief Technical Adviser and I were with the team for a couple of days. We had collected extensive data on plant parameters and analysed them. Based on these inputs, we have prepared a report, a copy of which is enclosed herewith for your kind information.

It may be noted that some steps are to be taken urgently at both Delhi and Korba to normalise the operations at the alumina plant and the smelter. We have already faxed this information to you. In addition, we have indicated the areas where further work is to be taken up by our Centre. We would submit detailed proposals for carrying out these tasks in a phased manner in the next three to four weeks. Once we obtain the approval of the BALCO management, we could initiate investigations in these areas immediately.

I would be pleased to make a presentation at Delhi on the problem areas as we foresee them.

Looking forward to the pleasure of hearing from you and with best regards,

Yours sincerely,

(T.R. Ramachandran)

ALUMINA PLANT

Findings

1. The total alumina production in 1994 - 95 was 168,660 tonnes which is 16,340 tonnes less than the target of 185,000 tonnes

2. From April '95 the caustic consumption has increased and the production of alumina decreased - details are given in Table 1. The soda losses were not properly replaced by input of fresh caustic, therefore the volume of the process liquor has shrunk significantly. This has resulted in the use of only 9 precipitators in stead of the normal 13 units. In addition a large quantity of seed hydrate was taken out of the system.
   The total reduction of caustic in the production liquor is 1831 tonnes of NaOH (100%). The shortage of alumina trihydrate (ATH) in the production cycle is 4,767 tonnes expressed in terms of Al2O3. This includes 3,000 tonnes of ATH stock (2,000 in terms of alumina) which was consumed totally. The caustic and alumina requirements to fill up the plant and achieve the normal operating conditions are detailed in Table 2. The reason for higher caustic consumption is analysed in Annexure I.

3. Due to the significant reduction of caustic and alumina in the production cycle the alumina plant is unable to operate to the rated production capacity (185,000 tonnes per year)

4. The alumina quality is poor, the Na2O content is close to 0.6 % and the - 45 µm fraction is about 65 %. The reason is that in order to achieve higher production figures and thereby meet the target, the end temperature of precipitation is set about 52°C, which may result in higher liquor productivity, but the product is very fine and the agglomerates contain considerable amount of occluded caustic.

5. The normal stock of 3000 tons of ATH has to be restored. For this immediate purchase of 2000 tons of alumina is to be made.

6. Presently only 1000 tons of alumina are avilable as inventory. This implies that the rest of earlier existing stock (about 8,000 tonnes) was also consumed.

Immediate Measures :

To achieve the normal capacity of the alumina plant (185,000 tpy) the following immediate actions are required:

BALCO Headquarters

1. Procure as a one time action an additional 1,831 tons of caustic (100% NaOH) to fill up all the 13 precipitators and increase the overall process concentration of caustic.
2. Purchase of 2767 tons of alumina in order to replenish the seed level in precipitators (in all the 13) to the earlier level of 350 gpl.
3. Purchase of 2000 alumina to fill up the ATH stock (in the alumina plant for calcination) upto the earlier level of 3000 tonnes of ATH
4. Purchase of another 6800 tons of alumina for building up the alumina stock to the desired level of 15 days requirements {(15*520) -(1000)} i.e. 6800 tonnes.

Calculations of the immediately required (a one time action) caustic and alumina are given in Table 2. IT MAY BE NOTED THAT 1831 TONNES OF CAUSTIC (100%) AND 11,567 TONNES OF ALUMIN ARE TO BE PROCURED IMMEDIATELY.

Plant Management

1. Increase the digestion yield in order to reduce the specific consumption of bauxite and all other utilities, including caustic soda by means of increase caustic soda concentration of the digestion liquor upto 171 gpl as Na2O, by keeping six autoclaves in operation in both lines
2. With the present manual control system the target MR is to be increased to 1.55.
3. By maintaining the Mainpat bauxite content to no more than 33% (1/3) of feed, the caustic consumption level can be kept below 90 kg NaOH/ton of alumina. The justified level of soda consumption in case of of Mainpat bauxite will be determined on the basis of study to be conducted by JNARDDC.
4. To decrease Na2O content and coarsening the product, it is necessary to increase the end temperature of the precipitation process above 55 °C
5. To discuss the quality of lime with the suppliers and elaborate / agree with them a new price scale offering more than the linear component for each percent of CaO content above 70 % and more penalty if the CaO content less than 70 %.

SPECIFIC CONSUMPTION 1995-96

Month	Production, Tons		Bauxite (t/t)		Soda Loss Distribution				Recoveries		Net Soda Loss	Lime as 70 % CaO	F.Oil, l/t	Steam t/t	Power		Bauxite Quality %	
	Hydrate	Calcined	(As is)	(Dry)	Bound	Sol.	With Prod.	Salt + Phys.	Caustn.	R.W.	kg/t	kg/t			Hyd.	Cal.	Al2O3	SiO2
Apr'95	15000	14300	2.59	2.55	87.6	13.8	5.4	15.1	26.8	-	95.1	230	103.0	3.33	361	57	47.93	3.70
May	16000	16020	2.62	2.58	90.2	14.0	5.4	15.1	28.0	-	96.7	238	102.5	3.35	370	59	48.30	3.52
June	14050	12200	2.65	2.60	83.8	16.0	6.0	19.2	26.0	-	99.0	238	107.0	3.35	387	77	48.60	3.47
July	15355	15410	2.71	2.58	84.8	15.6	6.1	16.6	28.0	-	95.1	252	102.5	3.37	369	52	48.70	3.39
Aug	16100	17000	2.69	2.56	87.9	15.5	6.1	16.6	27.0	-	99.1	255	118.0	3.35	-	-	49.16	3.54

Short term actions (1-2 years)

After successful completion of the first phase of modernisation of the smelter the annual aluminium production is expected to be about 100,000 tons per annum. In order to increase the production capacity of alumina plant to the level of 200,000 tons/year, following actions are required:

1. Increase of liquor productivity by increasing Na_2O concentration upto 175 gpl and seed concentration upto 400 gpl in the aluminate liquor
2. Introduction of instrumental MR control system at blow-off stage and setting up the blow off MR as 1.50
3. Alumina quality improvement and intensification of precipitation process by changing temperature profile through introduction of more heat exchangers interstage coolers - the start and end temperatures have to be over 70°C and 55°C respectively)
4. Lime addition to the digestor.

JNARDDC will elaborate and prepare proposals on a contract basis for the above mentioned tasks. The proposal will be submitted by JNARDDC within 2 to 3 weeks.

Medium Term Actions (3-5 years)

110,000 - 115,000 tons of aluminium per annum production capacity is expected to be achieved after the second phase of modernisation of the smelter. Annual production of 220,000 - 230,000 tons of alumina can be achieved by intensification of production processes through intensive uses of gibbsitic bauxite such as Panchpatmali and/or other bauxite resources. Pre-feasibility study analysisng the optimum bauxite supply, introduction of medium temperature (~150 °C) digestion temperature in one of the existing digestion line or implementation of the so called sweetening technology could be prepared by JNARDDC on a contract basis.

SPECIFIC CONSUMPTION 1994-95

Month	Production, tons		Bauxite (t/t)		Soda Loss Distribution				Recoveries		Net Soda Loss	Lime as 70 % CaO	F.Oil, l/t	Steam t/t	Power		Bauxite Quality %	
	Hydrate	Calcined	(As is)	(Dry)	Bound	Sol.	With Prod.	Salt + Phys.	Caustn.	R.W.	kg/t	kg/t			Hyd.	Cal.	Al2O3	SiO2
Apr'94	13600	10700	2.58	2.50	85	13.2	5.4	15.1	38.2	6.5	74.0	298	105.5	3.42	402.2	70.7	48.9	3.3
May	16010	14000	2.59	2.53	78	11.3	5.6	14.6	29.4	6.1	74.0	270	103.0	3.35	381.4	56.9	48.5	3.35
June	12500	14500	2.60	2.51	79.5	11.5	5.6	15.1	31.7	5.0	75.0	270	107.0	3.45	413.4	54.6	49.3	3.47
July	14500	13500	2.65	2.52	77.0	11.0	5.6	14.0	25.0	5.6	77.0	200	105.0	3.44	410.1	64.7	49.8	3.35
Aug	14200	14300	2.69	2.53	79.0	15.2	5.6	15.1	22.7	2.2	90.9	180	110.0	3.35	404.6	63.9	49.6	3.26
Sept	13500	14600	2.75	2.58	84.3	17.5	5.5	17.6	12.6	2.3	110.0	130	110.0	3.30	414.6	60.8	48.6	3.70
Oct	14500	13400	2.63	2.54	83.0	12.1	6.0	16.6	26.5	6.0	85.1	220	103.0	3.30	400.2	62.5	48.83	3.77
Nov	15000	14600	2.60	2.54	76.9	12.6	5.7	14.6	25.7	6.0	78.1	237	103.0	3.30	377.5	63.4	49.03	3.61
Dec	13100	15300	2.60	2.54	74.1	16.5	5.6	14.6	20.8	5.0	85.0	212.6	102.5	3.32	414.4	59.4	49.10	3.71
Jan'95	13300	13200	2.60	2.53	80.8	16.3	5.6	15.6	29.3	5.0	84.0	255.0	104.0	3.32	422.1	67.0	48.81	3.53
Feb	12750	12800	2.60	2.53	80.6	16.0	5.6	16.6	33.0	2.0	83.8	260.0	103.5	3.33	422.1	70.7	47.5	3.80
Mar	15700	14300	2.51	2.53	86.2	12.0	5.6	14.6	28.8	4.0	85.6	218.8	102.5	3.33	348.5	63.1	48.3	3.50
	168560	165200	2.63	2.53	80.4	13.7	5.6	15.3	26.9	4.6	83.5	229	104.8	3.35	400.9	63.1	48.86	3.53

SPECIFIC CONSUMPTION 1993-94

Month	Production	Tons	Bauxite (t/t)		Soda Loss Distribution				Recovery			Lime as 70% CaO	F. Oil l/t	Steam, t/t	Power		Bauxite Quality %	
	Hydrate	Calcined	(As is)	(Dry)	Bound	Sol	With prod.	Salt Physic.	Caust.	R.W.	Net Loss				Hyd.	Cal	Al2O3	SiO2
April '93	15000	14500	2.61	2.53	81.2	10.9	4.0	14.6	29.7	6.0	75.	220	102	3.35	380	58	49.22	3.72
May	15500	17300	2.61	2.53	80.1	10.6	4.5	14.6	29.8	6.0	74.0	220	101	3.28	374	48	48.18	3.62
June	15130	12020	2.73	2.57	86.2	10.7	4.8	14.1	30.3	6.5	79.0	190	102	3.30	386	63	48.20	3.96
July	15300	16200	2.77	2.57	86.2	10.7	5.0	14.1	31.5	6.5	78.0	203	102	3.35	407	48	48.20	3.70
Aug	14820	10500	2.75	2.57	93.0	12.1	5.0	15.1	36.2	7.0	82.0	235	102	3.35	399	66	48.50	4.20
Sept	14800	18775	2.70	2.55	82.0	13.5	5.0	15.6	32.4	4.7	79.0	230	101	3.34	408	46	47.80	3.40
Oct	15520	14100	2.57	2.49	80.0	11.5	5.2	14.6	28.3	6.0	77.0	220	101	3.32	405	57	48.2	3.55
Nov	15400	14200	2.54	2.46	79.8	12.0	6.0	14.6	28.7	6.7	77.0	215	101	3.40	380	57	47.9	3.90
Dec	15310	14880	2.54	2.46	79.2	13.0	6 0	15.6	29.3	6.5	78.0	215	101	3.40	424	58	48.5	3.70
Jan'94	15700	15200	2.60	2.52	88.0	1.0	5.6	14.6	33.2	7.0	84.0	215	103	3.35	365	60	46.9	3.80
Feb	14510	16030	2.58	2.50	86.0	13.7	5.5	14.6	35.3	6.5	78.0	295	100	3.35	359	49	49.2	3.30
Mar	15050	18235	2.58	2.50	85.1	13.1	5.3	14.6	3.6	6.5	75.0	297	101	3.35	365	46	48.9	3.30
	182040	181940	2.63	2.52	83.9	12.3	5.2	14.7	31.8	6.3	78.0	229	101.4	3.34	388	54	48.31	3.68

Table 1 (Contd.)

BAUXITE RECEIPT AT BALCO PLANT (QTY IN LAKH TONNES)

YEAR	CAPTIVE MINES OF BALCO				PURCHASE	GRAND TOTAL	PECENTAGE	
	Amarkantak	Phutkapahar	Mainpat	Total			Captive Mines	Purchase
1984-85	3.31	1.24	--	4.55	0.33	4.88	93.3	6.7
1985-86	3.03	1.56	--	4.59	0.18	4.77	96.2	3.8
1986-87	3.00	2.12	--	5.12	0.36	5.48	93.4	6.6
1987-88	2.12	1.43	--	3.55	0.43	4.00	89.2	10.8
1988-89	2.10	1.53	--	3.63	1.64	5.27	68.9	31.1
1989-90	1.86	0.70	--	2.56	2.22	4.78	53.6	46.4
1990-91	1.52	1.05	--	2.57	2.75	5.32	48.3	51.7
1991-92	1.12	0.72	--	1.84	3.72	5.59	33.5	66.5
1992-93	1.09	0.83	--	1.92	2.97	4.89	39.3	60.7
1993-94	12.5	0.75	0.64	2.64	1.71	3.35	60.7	39.3
1994-95	1.32	0.68	1.00	3.00	1.76	4.76	63.0	37.0

Immediate measures

Requirement of additional caustic soda and alumina to normalise the Balco alumina plant

1. Caustic Soda Requirement

Existing conditions during precipitation :

No of precipitators in line	=	9 (Volume 2151 m3 each)
Caustic concentration	=	138 gpl (as Na_2O)
Alumina concentration	=	80 gpl
Solids content	=	300 gpl

(a) Additional caustic soda requirement to increase the caustic concentration to 142 gpl.

19359 x 0.004 x 1.29 = 100 tons

(b) To take into line 4 additional precipitators

8604 x 0.142 x 1.29 = 1576 tons

(c) For entire plant process liquor (To reach 171 gpl caustic Na_2O in digestion liquor from 168 gpl).

40000 x 0.003 x 1.29 = 155 tons

Total Caustic Soda Requirement :

(a) + (b) + (c) = 1831 tons as NaOH (100%)

2. <u>Requirement of additional alumina hydrate</u>

(a) To fill the existing line of precipitators from a solids content of 300 to 350 gpl.

2151 x 9 x 0.050 = 968 tons hydrate

(b) For filling 4 additional precipitators

2151 x 4 x 0.350 = 3011 tons hydrate

Total for precipitators (a) + (b) = 3979 tons hydrate

= 2602 tons as Al2O3

(c) To increase the Al2O3 concentration by 3 gpl for the entire process

55000 x 0.003 = 165 tons Al2O3

(d) Additional 3000 t hydrate (around 2000 t as Al2O3) are required to replenish the stock.

<u>Total Alumina Requirement</u> = 4767 tons as Al2O3
(a) + (b) + (c) + (d)

3. Alumina requiremnts for filling up the plant stock

Desired level is to meet requirements of 15 days alumina consumption. Considering that the present stock is 1000 tonnes, the total requirment is (15x520) - (1000) = 6800 tonnes to be purchased immediately.

TOTAL ALUMINA TO BE PURCHASED IS 11,567 TONNES.

Short term measures

Requirement of additional caustic soda and alumina in Balco Plant to reach caustic concentration of 175 gpl as Na2O in digestion liquor and solids content in precipitators as 400 gpl

1. Caustic Soda Requirement

For entire plant process liquor (To reach 175 gpl caustic Na2O in digestion liquor from 171 gpl)

40000 x 0.004 x 1.29 = 206 tons as NaOH (100 %)

2. Alumina Requirement

To fill all the 13 precipitators from a solids content of 350 to 400 gpl (Seed)

2151 x 13 x 0.050 = 1398 tons hydrate (914 tons as Al2O3)

Evaluation of increased caustic soda loss

The distribution of caustic soda losess, the caustic soda recovery and net loss in the time period April 93 to September 95 can be seen in Table 1 along with the alumina production. The yearly average caustic soda loss in 1993-94 amounted to 78kg/ton and in 1994-95 it went upto 83.5kg/ton, while in the last 6 months between 95-99 kg/ton.
Based on analysis of blow-off-mud, the average Na2O content increased from 5.2% (1994-95) to 6.0 % (April to September'95), while silica content remain almost unchanged (7.75-7.87%) respectively. It means that Na2O/SiO2 ratio increased from 0.67 to 0.76 probably due to higher reactivity and conversion yield of titanium minerals present in the process bauxite. The same difference i.e. 0.8% as Na2O was maintained in the related average values of the causticized red muds. This increase in the bound soda content in the causticized mud has caused 12.5kg/ton additional NaOH loss in the given period. The reason for same is required to be investigated by JNARDDC.
Due to the increased undigested alumina losess (boehmite and diaspore) the specific bauxite consumption has also increased from about 2.60 ton/ton to 2.70 ton/ton. The soluble NaOH losess increased from 13.2 kg/ton to 15 kg/ton during this period. Slight increase (2 kg/ton) was measured with product alumina and salt removal. Altogether the increase of these losses reached about 16.3 kgs NaOH per ton.

Furthermore no return water was recycled during the past half year, which resulted in a decrease of about 6 kg/t in caustic soda recovery.
Finally the red mud causticisation should be mentioned. While the recovered NaOH by causticisation reached about 35 kg/t under optimum conditions and the average in 1993-94 was also 31.8 kg NaOH/t alumina, this value decreased to a level of 26-27 kg/t in the last half year due to changed chemical and mineralogical composition of red mud to be causticised. The level of efficiency of causticisation reduced on account of increase in quantum of bound soda. In addition the quality of lime used is always below the accepted international practice.
It can be stated that two main reasons for the increase in soda consumption are:

1. The low level of caustic soda in the circuit
2. Intensive use (1/3rd of feed bauxite) of Mainpat bauxite - although the detailed effects need to be investigated

SOME COMMENTS ON RESPONSES OF MR. K. CHATTOPADHYAY, GM KORBA ON STABILISATION SUGGESTIONS OF JNARDDC

Alumina

The present problems in the alumina plant are associated with the reduction of production liquor and hydrate in the process. The plant can not operate on the rated capacity of 185,000 t/a with a depleted system. Concentration of the process liquor, the duration of precipitation and the seed ratio are still significantly lower then normal. The effect of these factors were analysed by mathematical modelling of the Balco's precipitation process and the results are summarised in the enclosed table. If the plant operates according to the designed parameters (case No 1) the liquor productivity is 67.69 g/l and production capacity of 195,000 t/a can be easily achieved by the normal flow rate of 360 m^3/h aluminate liquor (8,000x3600x67.67 = 194,890). The effect of decline in any main parameter was also shown in the table and it can be summarised as follows:

1. The Na_2O concentration in the digestion and aluminate liquor is about 4-5 g/l lower then the normal. Due to this the liquor productivity and the production capacity of the whole plant is lower by about 2 g/l.
2. Due to the empty precipitator tanks the retention time is shorter, therefore the precipitation yield and consequently the liquor productivity is also lower. Normally 12/13 tanks could be operational out of the total 14. Presently 11 is in line, i.e. the precipitation time is about 15 % shorter than possible (earlier 9 tanks were operational only). If the number of operational tanks is reduced from 12 to 11 the liquor productivity is decreasing from 67.69 g/l to 64.26g/l, and there is another 3 g/l additional reduction in production capacity when the operational tanks are 9 only.
3. The seed ratio in the precipitation were also reduced from 350 g/l to 300 (in the last precipitation tank). The model indicates, that the effect of this action on the liquor productivity is also another 3 - 3.5 g/l provided that all other parameters are unchanged.
4. Increase in the end temperature of digestion up to 55 °C was suggested because of the very poor quality of the alumina produced. It is true, that the liquor productivity may be decreased by about 6 g/l compered to 50 °C, but on the other hand, according to the smelter people the fine was over 60 % and the Na_2O concentration was above 0.5%. If our information is not correct (the mentioned in the letter data are not enclosed), the practice of low end temperature can be continued, until the required quality allows it. However, it is worthy to note that the annual production of 185,000 can be achieved by the suggested parameters as well as it can be see in case of 11 in the table (8000x3600x64.66=186,221)
5. One more factor, mentioned in the letter of Mr. Chattopadhyay concerns the production capacity namely the target MR. It is true that increase of MR in blow off liquor from 1.52 to 1.55 will reduce the liquor productivity by about 2g/l (case 6 in the table), but our earlier study has shown, that by manual control the wide fluctuation in

the blow off MR can not be eliminated, and in many cases - especially when the production is forced by charging more bauxite - the actual MR is much bellow the target and considerable part of the available alumina left undigested. That is one of the main reason of the higher bauxite and caustic consumption.

6. In addition, hydrate and alumina stock in the plant is not exist at all. Smooth operation can not be organised / maintained without buffer stock before the calciner (hydrate) and between the alumina plant and the smelter.
7. The effect of lime quality on the causticisation efficiency is crucial. It is felt, that effort in this direction is worthwhile action.

Aluminium

The aim of the ongoing programme is to achieve the stable pot operation
Action programme prepared by the plant management is in the right direction, however, it is felt, that the goal will not be achieved till the target date due to:
Time requirement for repairing of the studs is much longer than anticipated (20 studs per day is the present capacity of repairing).
The effect of the actions for improvement of the anode repairing procedure is not controlled due to the lack of proper facilities.
Alumina feeding system can not be normalised unless the wheel crust breakers and short side breakers are not procured. It is true, that the wheel crust breakers are not required after the second phase of modernisation is completed, however without the procurement of wheel breakers the goals of the first phase - which are the precondition of the second phase - can not be achieved.
Lack of crane weighting system the aluminium tapping is not controlled.
More effort and longer time period is required for maintaining the standard operation practice i.e.:

- uniform metal and bath height
- uniform alumina thickness on the crust
- uniform anode and cathode current distribution

In the material it is mentioned that the results of addition of little bit of anthracene oil in the binder were not encouraging, but the test results are not given and not known by us.

COMPARISON OF LIQUOR PRODUCTIVITY OF BALCO ALUMINA PLANT WITH VARYING PARAMETERS

S.No	Aluminate Liquor, Na_2Oc	Aluminate Liquor, MR	No. of precipitators in line	Blow-Off Liquor MR	First Precipitator Temp. °C	Last Precipitator Temp. °C	Precipitator Solids, gpl	Spent Liquor Na2Oc	Liquor Productivity	Remarks
1	141.0	1.67	12	1.55	64	50	350	3.258	67.69	In normal operation
2	**135.7**	1.67	12	1.55	64	50	330	3.270	65.51	
3	141.0	1.57	**11**	1.55	64	50	336	3.108	64.26	
4	141.0	1.67	**9**	1.55	64	50	332	2.951	60.26	
5	141.0	1.67	12	1.55	**70**	**55**	334	3.011	61.87	
6	141.0	**1.63**	12	1.55	64	50	346	3.194	69.69	
7	141.0	1.67	12	**1.52**	64	50	337	3.170	65.73	
8	141.0	1.67	12	1.55	64	50	**300**	3.137	64.94	
9	135.7	1.63	9	1.52	62	50	300	3.036	63.42	Incorporating all changes at a time
10	135.7	1.63	11	1.52	62	50	299	3.217	67.57	As per present conditions
11	141.0	1.67	13	1.55	70	55	350	3.125	64.66	As suggested

PRESENTS FINDINGS

The critical situation of the caustic soda shortage has been investigated in detail in the period of 29 November-3 December at JNARDDC with the participation of Mr. K.P. Paul and Mr. A.K. Roy from BALCO.

It was found that that the traditional method used to make monthly balances by BALCO is not adequate because the change in liquor and stock is not in agreement with the amount of NaOH procured and used for production. The reason is the unaccounted losses caused by the heavy rainfalls in the monsoon period which resulted in extra losses due to the common system (The rain water can not be separated!) on the one hand and the blocked amount of the caustic soda in red mud lake on the other hand.

It is clear that new method should be developed and used to determine the real inventory.

It has been calculated that The caustic soda consumption would be **95 kg NaOH/t** in average now, considering the extra consumption caused by the limited amount of return water from the lake, the lower efficiency of the cycle and the liquor losses caused by increasing supply of Mainpat Bauxite. Normal conditions can justify **90 kg NaOH/t** consumption.

In the last year however, the caustic soda losses can be estimated as high as **110 kg/t.** The difference in comparison with the accounted value exceeded **2000 t/a NaOH** which should be found in red mud lake. This amount is missing from the cycle and should be fed into the plant circuit along with the related alumina in order to normalise the operation. The adjustment of the pregnant liquor concentration to 141 gpl (from 136) as Na_2O and the digestion liquor concentration to 174 gpl Na_2O (from 167) will result in a production capacity of 185 kt/a.

The actions taken by the alumina plant management are in the right direction, so recently the 12th precipitator tank has been taken into operation and the filling of caustic soda and alumina (seed) is in good progress.

A further rise of caustic soda concentration of pregnant liquor up to 145, then 150 gpl Na_2O caustic and the seed amount to 350 gpl hydrate (dry basis) is highly recommended.

These actions should be completed by the following measures, **to be started immediately** in order to reach 200 kt/a production rate :

- MR Control System installation (to run at 1.50 target molar ratio)
- Further interstage cooling units in precipitation to optimize the temperature profile (liquor productivity and alumina quality)
- Side stream causticization to control the Na_2CO_3 level in the liquor.

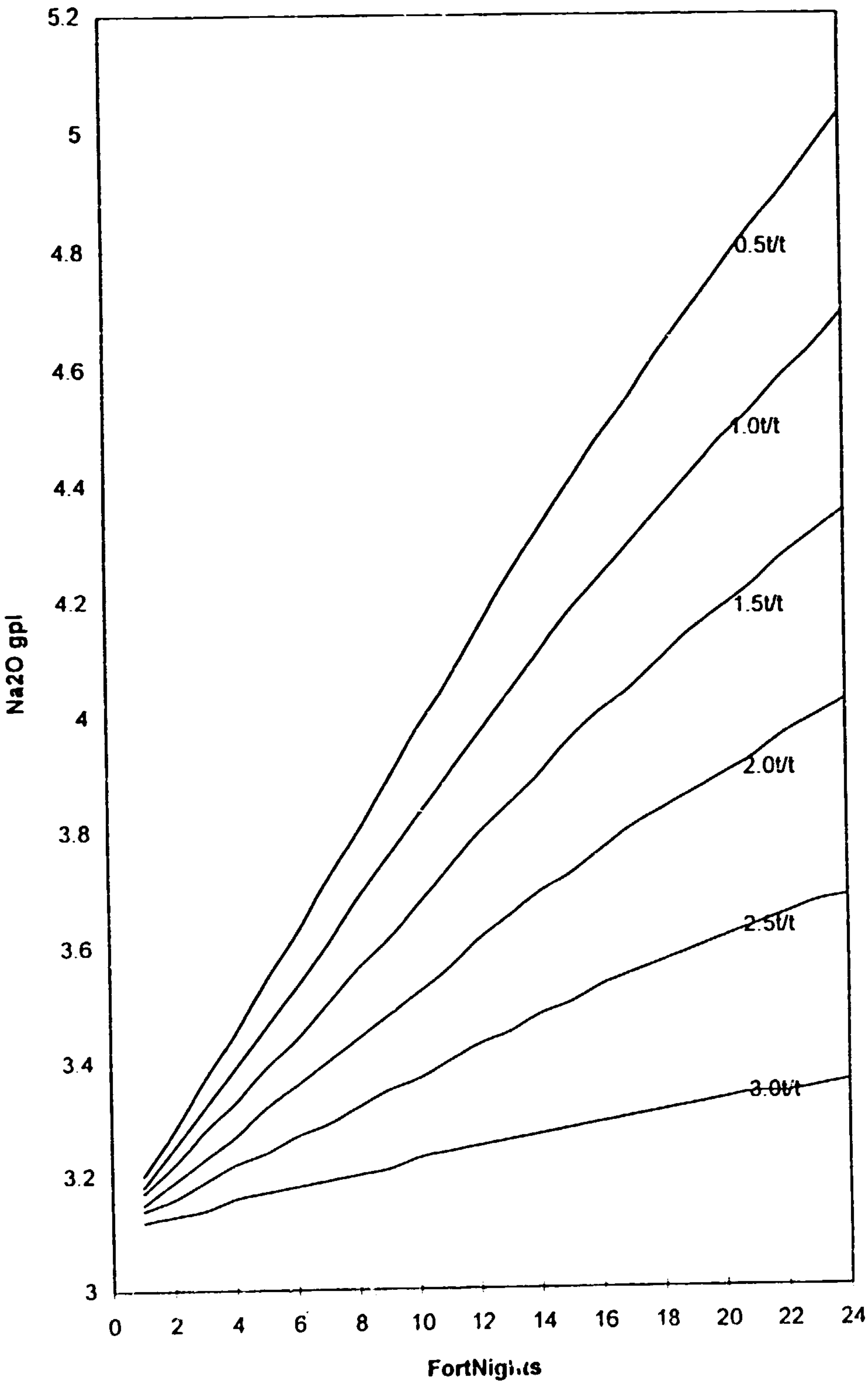
The results of BALCO precipitator simulation (based on computer simulation and validation by laboratory modelling and plant data) are the following :

Result of BALCO Precipitator Simulation

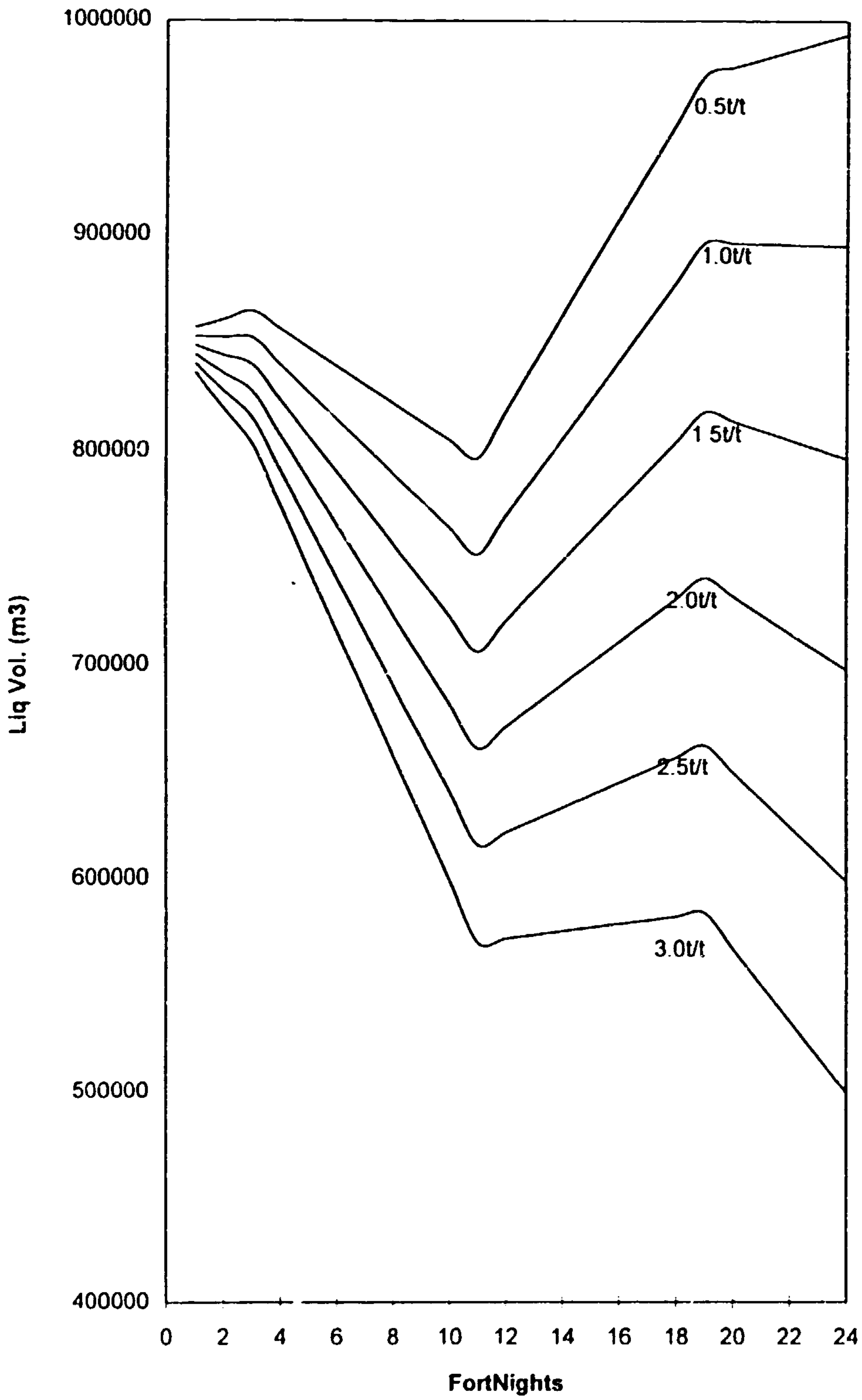
Based on laboratory modelling and computer simulation conducted by Dr. C. Misra at JNARDDC.

Sl.No.	Aluminate Liquor		No. of Precipitators in Line	Seed g/l	Temperature°C of Precipitators		Spent Liquor		Liquor Productivity Al_2O_3 Kg/M^3
	Na_2Oc	MR			First	Last	Na_2Oc	MR	
1.	145	1.62	12	350	60	50	146.52	3.23	147.25 -73.85 74.40
2.	145	1.62	12	350	65	54	146.45	3.21	147.25 -74.21 73.04
3.	150	1.62	12	350	60	50	150.00	3.18	152.33 -77.60 74.73
4.	150	1.62	12	350	65	54	150.00	3.11	152.33 -79.34 72.98

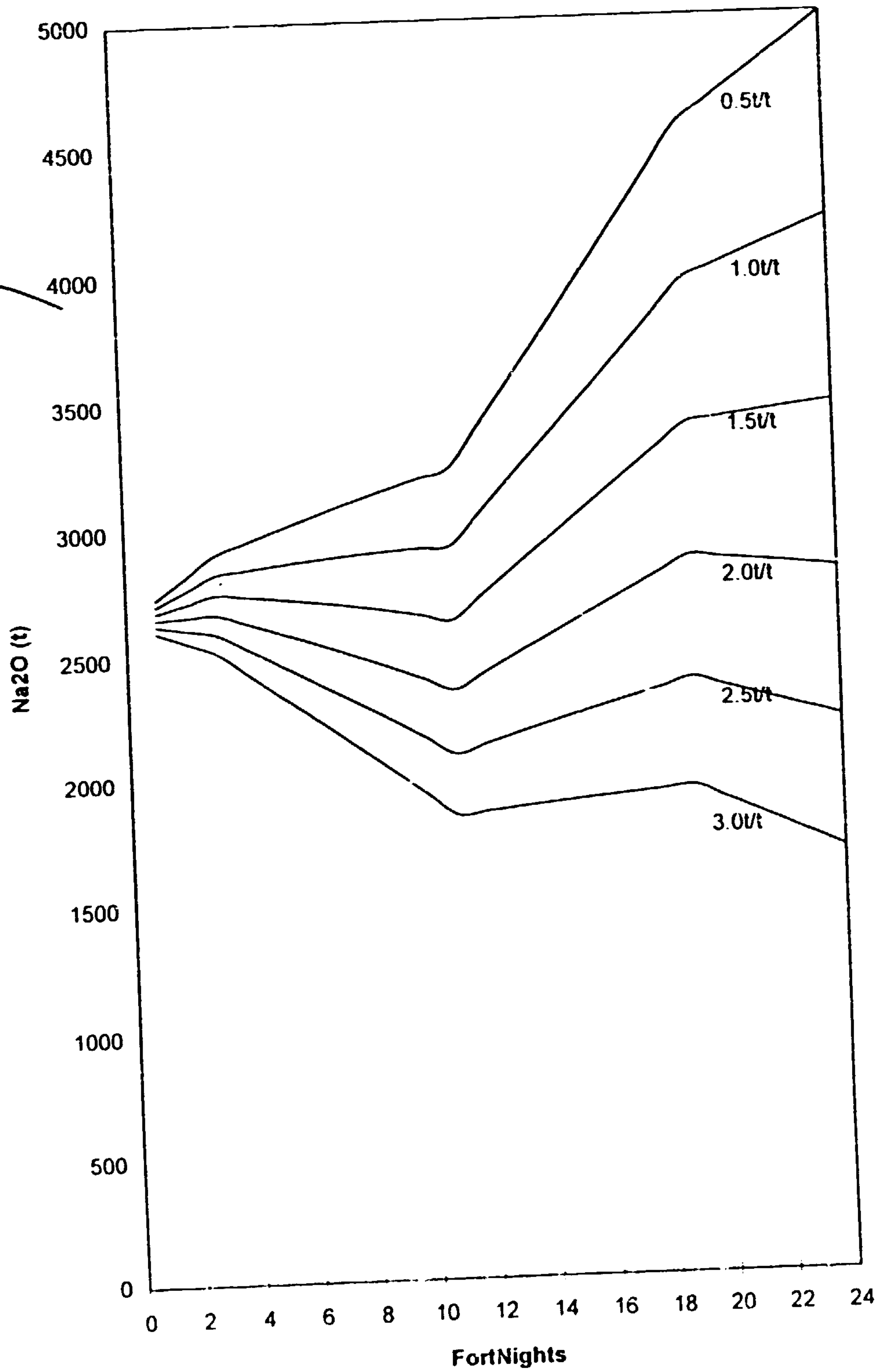
Pond Na2O Conc (gpl) as a function of return water from pond

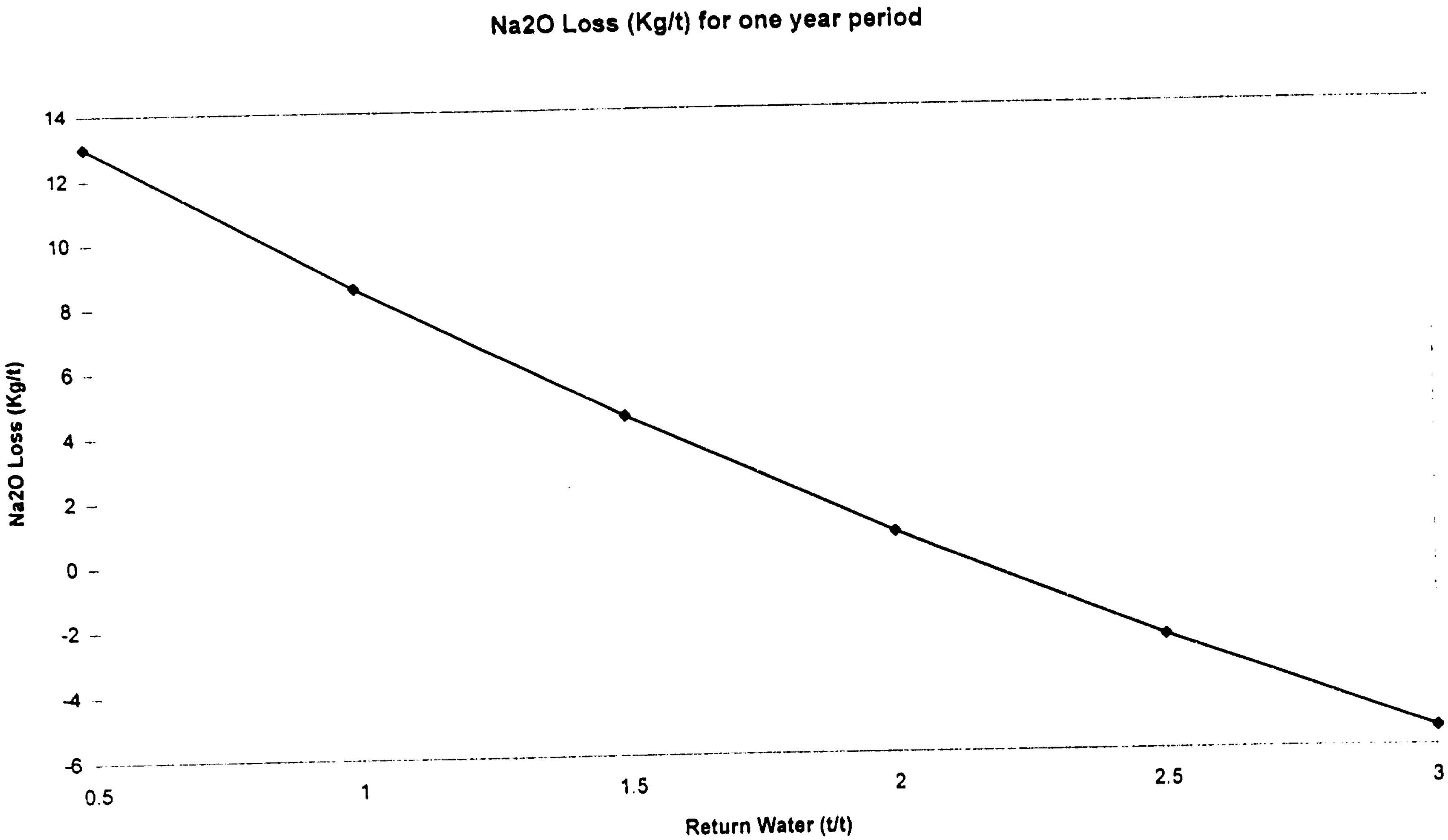


Pond Liquor volume (m3) as a function of return water from pond



Pond Na2O Quantity (t) as a function of return water from pond




Na2O Loss (Kg/t) for one year period
Na2O Loss (Kg/t)
14
12
10
8
6
4
2
0
-2
-4
-6
0.5
1
1.5
2
2.5
3
Return Water (t/t)

FortNights	Pond Vol (m3)	Pond Soda Conc (gpl)	Pond Soda Qty (t)	Return Soda Qty (Kg/hr)
1	857351.63	3.2	2740.67	35.96
2	861123.26	3.28	2826.66	36.93
3	864894.89	3.37	2912.63	37.89
4	856329.32	3.45	2955.98	38.83
5	847763.75	3.54	2998.25	39.79
6	839198.18	3.62	3039.45	40.75
7	830632.61	3.71	3079.56	41.71
8	822067.04	3.79	3118.58	42.68
9	813501.47	3.88	3156.5	43.65
10	804935.9	3.97	3193.32	44.63
11	796370.33	4.05	3229.04	45.62
12	818647.76	4.14	3391.41	46.61
13	840925.19	4.23	3555.32	47.56
14	863202.62	4.31	3720.72	48.49
15	885480.05	4.39	3887.56	49.39
16	907757.48	4.47	4055.79	50.26
17	930034.91	4.54	4225.39	51.11
18	952312.34	4.62	4396.31	51.94
19	974589.77	4.69	4568.51	52.74
20	978361.4	4.76	4653.93	53.51
21	982133.03	4.83	4739.32	54.29
22	985904.66	4.89	4824.69	55.05
23	989676.29	4.96	4910.03	55.81
24	993447.92	5.03	4995.35	56.57
Return Water = 1.0 t/t				
1	853234.13	3.18	2714.7	71.59
2	852888.26	3.25	2774.16	73.18
3	852542.39	3.32	2833	74.77
4	839859.32	3.39	2849.39	76.34
5	827176.25	3.46	2864.31	77.91
6	814493.18	3.53	2877.76	79.5
7	801810.11	3.6	2889.74	81.09
8	789127.04	3.68	2900.23	82.69
9	776443.97	3.75	2909.22	84.3
10	763760.9	3.82	2916.71	85.92
11	751077.83	3.89	2922.69	87.55
12	769237.76	3.96	3049.41	89.19
13	787397.69	4.03	3176.82	90.78
14	805557.62	4.1	3304.87	92.31
15	823717.55	4.17	3433.57	93.79
16	841877.48	4.23	3562.88	95.22
17	860037.41	4.29	3692.78	96.61
18	878197.34	4.35	3823.26	97.95
19	896357.27	4.41	3954.3	99.26
20	896011.4	4.47	4003.21	100.53
21	895665.53	4.52	4051.63	101.78
22	895319.66	4.58	4099.58	103.03
23	894973.79	4.63	4147.05	104.26
24	894627.92	4.69	4194.05	105.48

Return Water = 1.5 t/t FortNights	Pond Vol (m3)	Pond Soda Conc (gpl)	Pond Soda Qty (t)	Return Soda Qty (Kg/hr)
1	849116.63	3.17	2688.86	106.87
2	844653.26	3.22	2722.14	108.77
3	840189.89	3.28	2754.48	110.65
4	823389.32	3.33	2744.76	112.51
5	806588.75	3.39	2733.43	114.37
6	789788.18	3.44	2720.48	116.25
7	772987.61	3.5	2705.9	118.14
8	756187.04	3.56	2689.68	120.05
9	739386.47	3.61	2671.81	121.96
10	722585.9	3.67	2652.29	123.88
11	705785.33	3.73	2631.1	125.82
12	719827.76	3.79	2724.99	127.76
13	733870.19	3.84	2818.95	129.64
14	747912.62	3.89	2912.97	131.45
15	761955.05	3.95	3007.06	133.19
16	775997.48	4	3101.21	134.88
17	790039.91	4.04	3195.42	136.51
18	804082.34	4.09	3289.69	138.08
19	818124.77	4.14	3384.02	139.6
20	813661.4	4.18	3401.05	141.07
21	809198.03	4.22	3417.35	142.53
22	804734.66	4.27	3432.92	143.97
23	800271.29	4.31	3447.78	145.4
24	795807.92	4.35	3461.93	146.82
Return Water = 2.0 t/t				
1	844999.13	3.15	2663.15	141.82
2	836418.26	3.19	2670.62	143.68
3	827837.39	3.23	2677.07	145.52
4	806919.32	3.27	2642.09	147.34
5	786001.25	3.32	2605.6	149.18
6	765083.18	3.36	2567.59	151.02
7	744165.11	3.4	2528.03	152.87
8	723247.04	3.44	2486.93	154.74
9	702328.97	3.48	2444.28	156.61
10	681410.9	3.52	2400.06	158.5
11	660492.83	3.56	2354.27	160.4
12	670417.76	3.61	2418.15	162.31
13	680342.69	3.65	2481.72	164.15
14	690267.62	3.69	2545.02	165.92
15	700192.55	3.72	2608.04	167.61
16	710117.48	3.76	2670.8	169.25
17	720042.41	3.8	2733.32	170.82
18	729967.34	3.83	2795.58	172.34
19	739892.27	3.86	2857.62	173.8
20	731311.4	3.89	2847.38	175.21
21	722730.53	3.92	2836.36	176.6
22	714149.66	3.96	2824.57	177.98
23	705568.79	3.99	2812.01	179.35
24	696987.92	4.02	2798.69	180.69

Return Water = 2.5 t/t				
FortNights	Pond Vol (m3)	Pond Soda Conc (gpl)	Pond Soda Qty (t)	Return Soda Qty (Kg/hr)
1	840881.63	3.14	2637.56	176.44
2	828183.26	3.16	2619.6	177.92
3	815484.89	3.19	2600.76	179.39
4	790449.32	3.22	2541.39	180.85
5	765413.75	3.24	2480.83	182.32
6	740378.18	3.27	2419.09	183.79
7	715342.61	3.29	2356.14	185.27
8	690307.04	3.32	2291.99	186.76
9	665271.47	3.35	2226.62	188.26
10	640235.9	3.37	2160.03	189.78
11	615200.33	3.4	2092.21	191.3
12	621007.76	3.43	2128.88	192.83
13	626815.19	3.45	2165.15	194.3
14	632622.62	3.48	2201.02	195.7
15	638430.05	3.5	2236.52	197.05
16	644237.48	3.53	2271.65	198.34
17	650044.91	3.55	2306.45	199.58
18	655852.34	3.57	2340.91	200.77
19	661659.77	3.59	2375.05	201.91
20	648961.4	3.61	2342.1	203.01
21	636263.03	3.63	2308.51	204.09
22	623564.66	3.65	2274.28	205.16
23	610866.29	3.67	2239.42	206.21
24	598167.92	3.68	2203.94	207.25
Return Water = 3.0 t/t				
1	836764.13	3.12	2612.09	210.71
2	819948.26	3.13	2569.06	211.49
3	803132.39	3.14	2525.56	212.26
4	773979.32	3.16	2442.64	213.03
5	744826.25	3.17	2359.12	213.8
6	715673.18	3.18	2274.98	214.57
7	686520.11	3.19	2190.22	215.35
8	657367.04	3.2	2104.84	216.13
9	628213.97	3.21	2018.83	216.92
10	599060.9	3.23	1932.19	217.71
11	569907.83	3.24	1844.91	218.51
12	571597.76	3.25	1857.21	219.32
13	573287.69	3.26	1869.23	220.09
14	574977.62	3.27	1880.98	220.82
15	576667.55	3.28	1892.49	221.52
16	578357.48	3.29	1903.76	222.19
17	580047.41	3.3	1914.8	222.82
18	581737.34	3.31	1925.62	223.43
19	583427.27	3.32	1936.23	224.01
20	566611.4	3.33	1885.07	224.57
21	549795.53	3.34	1833.58	225.11
22	532979.66	3.34	1781.76	225.65
23	516163.79	3.35	1729.6	226.18
24	499347.92	3.36	1677.12	226.71

JAWAHARLAL NEHRU ALUMINIUM RESEARCH DEVELOPMENT & DESIGN CENTRE

BALCO ALUMINA PLANT PERFORMANCE MONITORING

(REGULAR WORK)

A] MATERIAL BALANCE : JNARDDC can conduct monthly material balance of alumina plant by special computer software. JNARDDC will provide basic document/format for required data/information from plant and based on analysis suggest measures for improvement.

B] LABORATORY WORK: JNARDDC may undertake detailed laboratory work on following lines:

- Chemical and mineralogical composition of monthly bauxite of various sources supplied to Korba (cross-checking).
- Chemical - mineralogical composition and digestion test on monthly process bauxite (cross-checking).
- Analysis of red muds at various stages (Blow-off muds, settler, washer and causticised muds) and account loss of alumina along the Bayer line.
- Monthly complete liquor analysis including impurities and organics.

C] BI-ANNUAL PROCESS INVENTORY: JNARDDC in cooperation with plant can undertake/estimate process inventory of causitc soda and alumina based on volumes of various process tanks/pond, caustic and alumina concentrations at various places and stocks/receipts. JNARDDC can develop a computer model for monitoring process inventory and provide future forecast.

D] JNARDDC will prepare monthly report on overall performance of alumina plant and submit the same to the management.

JNARRDC will submit detailed project proposal on above aspects. Apart from above specific plant problems can be studied by JNARDDC time to time in cooperation with Korba.

RND between NALCO and JNARDDC on 2/11/95 at Nagpur.

PARTICIPANTS

NALCO	JNARDDC
Mr. M.M. Seth, DGM (R&D), Bhubaneshwar Mr. P. Vidyasagar, DGM (R&D), Damanjodi Dr. B.K. Satpathy, Manager (R&D), Bhubaneshwar	Dr. J. Zambo, CTA, UNIDO Dr. K. Solymar, UNIDO Expert Dr. C. Mishra, UNIDO Expert M/s. H. Mahadevan, Coordinator (GS) Dr. A.K. Nandi, Scientist Mr. H.K. Chandwani, Scientist Dr. G. Balasubramanian, Scientist

At the outset CTA welcomed the guests. The JNARDDC team wished to know the views and status of the following projects and proposals submitted to Nalco management during the past two years.

1. Capacity improvement of Nalco Alumina Plant by process intensification.

2. Red mud pond problem and technological options available for solving the same.

3. Correlation of plant data on CGM addition and precipitation modeling.

4. Pre-Desilication studies of Panchpatmali bauxite with LP digestion and Desilication modeling.

5. Energy audi of Alumina and steam plant at Damanjodi.

6. Energy audit of Foundry shop and Anode Baking Furnace at Nalco.

7. Characterisation and utilisation of spent pot lining.

8. Co-operations in the field of development of special aluminas.

Nalco Team informed that an official reply to JNARDDC intimating the status of the first two projects would be conveyed by Mr. P. Vidyasagar after discussions with his colleagues. Regarding third to fifth projects, Mr. P.Vidyasagar expressed his willingness to co-operate, however he wished that a copy of the proposals be sent to him immediately so that he would get the necessary approval etc.. Regarding sixth and seventh projects Mr. M.M. Seth had agreed to get the necessary approval from his management. A copy of the proposal on SPL sent earlier was handed over to him. Regarding the eighth project Dr. Satpathy agreed to write to JNARDDC immediately requesting to develop standard practice for the first four products mentioned in their proposal to S & T on this subject.

Both JNARDDC and NALCO agreed that the general communication requires improvement. In this connection the following was agreed to.

- Technical Conference between JNARDDC and NALCO team is to take place once in every six months, the venue being once at Nagpur and once at Bhubaneshwar. The first such conference is proposed for January 1996 at Bhubaneshwar. The meeting would discuss problems and prospects with Nalco.

- JNARDDC after submitting a proposal must follow up the same and make a presentation to the Nalco team, as and when required, so that the proposal can be finalised immediately.

- JNARDDC would send its proposals separately with covering letter to the concerned Executive Director at Damanjodi or Angul and mark a copy of the letter to Mr. M.M. Seth, DGM (R & D) at Bhubaneshwar, for necessary follow up.

JNARDDC Team also discussed about the proposals under making on Geological evaluation of Panchpatmali Bauxite, Beneficiation studies on Panchpatmali bauxite, fluorine balance in Nalco's cell house and periodical performance evaluation of alumina-aluminium plants etc..Nalco's team showed keen interest and wished that a detail proposal may be made and sent to them for their further necessary action.

It has been agreed that selected bauxite samples will be analyzed by JNARDDC by means of both XRD and XRF which can be considered as reference samples for NALCO which most of the bauxite samples will be investigated by means of the cheaper traditional wet chemical analysis at other institution(s)

Nalco team insisted that all jobs being undertaken by JNARDDC be only analytical or projects must be completed in the specific time frame and certain cases as quickly as possible so that the job would be highly useful to the plant.

The meeting was concluded with an agreement to persue the projects with more understanding for the mutual benefit of both the institutions. CTA thanked the participants for their free and frank discussions.

M.M. Seth DGM (R & D) Nalco, Bhubaneshwar	P. Vidyasagar, DGM (R&D), Nalco, Damanjodi	H. Mahadevan 5/12/95 Co-ordinator (General Services) JNARDDC, Nagpur.

Annexure VI.

JAWAHARLAL NEHRU ALUMINIUM RESEARCH DEVELOPMENT AND DESIGN CENTRE

REF. NO. : 1333/JNARDDC/TECH/95
DATE : DECEMBER 18, 1995.

Opp. Wadi Police Station.
Near Wena Water Works.
Amravati Road. Wadi.
NAGPUR - 440 023. (INDIA)

FAX MESSAGE

FM : R.N. GOYAL HOD (ALUMINA) JNARDDC, NAGPUR	TO : MR.. ANIL AGARWAL MANAGING DIRECTOR STERILITE INDUSTRIES LTD., BOMBAY.
FAX NO. : 07104-36862	FAX NO. : 022-2836474
PHONE NO : 07104-36865	PHONE NO : 022-2855560
NO OF PAGES :	

DEAR SIR,

IN CONTINUATION TO MEETING HELD WITH YOU AS WELL AS AT METTURDAM, I AM ENCLOSING HEREWITH AN AGENDA FOR DISCUSSION TO BE HELD AT JNARDDC, NAGPUR ON DEC. 22, 1995 FOR YOUR PERUSAL.

BESIDES COOPERATION IN THE FIELD OF BAUXITE AND ALUMINA, WE WOULD ALSO LIKE TO DISCUSS POSSIBILITIES OF COOPERATION IN THE FIELD OF ALUMINIUM ELECTROLYSIS AND CARBON AND WITH INDIA ENGINEERS, BOMBAY REGARDING COOPERATION IN DESIGN AND EXECUTION. WE WOULD APPRECIATE IF EXPERTS IN BOTH THESE FIELDS ARE ALSO INVOLVED IN OUR DISCUSSIONS ON DEC. 22, 1995.

AS OUR DIRECTOR IS OUT OF STATION, I TAKE THIS OPPORTUNITY TO SEND YOU THE ENCLOSED DETAILS.

THANKS & REGARDS,

R Goyal

R.N. GOYAL
HOD (ALUMINA)

CC : MR. M.L. KAMPANI
CHIEF EXECUTIVE,
MALCO, METTURDAM.

FAX NO : 04298-22069

cc Dr. Solymar - for information please

MALCO / JNARDDC Meeting on Dec. 22 '95 at Nagpur.
<u>AGENDA FOR DISCUSSION</u>

1) General presentation on the capabilities of JNARDDC

2) Visit to the laboratories

3) Points for discussion

* <u>Capacity expansion to 60,000 mtpy by increasing liquor productivity</u>

i) <u>Equipment Requirement</u> :
- Crushing & Grinding Area. No additional facilities required
- Digestion & Desilication area. Additional heat exchangers may be required
- Settling & Washing area. No additional facilities required. Only synthetic settling aid is to be introduced
- Red mud filtration area. Performance improvement is to be attempted by way of optimising the operation. Additional filters may be required. Economics of introducing Vacuum or Pressure filter can be made.
- Control filtration. Additional filters may not be necessary.
- Precipitation area. Changeover to continous process. Improvement in the performance of the product classification operations. Introduction of inter stage cooling and seed washing may be required
- Calcination area. Retrofit the kilns with efficient heat recovery units

ii) <u>Process Requirement</u> :
- Caustic concentration of the digestion liquor is to be increased by about 20 gpl (170-175 gpl as Na_2O)
- Target molar ratio at digestion should be around 1.45
- Digestion temperature should be increased to the maximum (around 150°C)
- Desilication is to be modified
- Impurities control including causticity of the liquor is to be improved; one time removal of carbonate salts may be required
- Introduce calcium aluminate injection to kelly filters for reduction of colloidal iron content of the aluminate liquor, which in turn would reduce the iron contamination of the hydrate

iii) <u>Studies to be undertaken</u> :
- Simulation studies of digestion with increased soda concentration
- Simulation studies of desilication for reduction in liquor silica level
- Simulation studies of the precipitation process for optimising the parameters of the suggested process technology
- Mass and heat balance of the process before and after modifications
- Organic analysis of the bauxite, liquor etc..
- Settling studies with Gamma ray settler to evaluate and optimise the flocculant dosage
- Economic analysis of the scheme
- Economics of mud disposal
- Evaluation of bauxite supply - Present and future

* Further capacity expansion (Opportunities and Limitations)
    - Discussion on capacity improvement
    - Usage of extra capacity available at precipitation
    - Introduction of complete new line

* Discussion with India Engineers, Bombay regarding cooperation in design and execution

* Possibility in the field of aluminium electrolysis & Carbon

*Discussions of the content and scope of the contract

MALCO

QUESTIONNAIRE FOR BAUXITE

PRESENT BAUXITE MINES/SOURCES:

A] GEOLOGICAL DETAILS

- Status of prospecting and exploration
- Bauxite reserves - Proved, Probable and Possible with cut-off grades
- Bauxite grade
- Configuration of ore-body
- Lateral and vertical variation in chemical (including Corg.)and mineralogical composition
- Run-off-mine grade
- Details of bauxite sampling and quality control

B] MINING DETAILS

- Capacity of mines and annual production
- Type of mining
- Particle size of run-off-mine ore
- Details of bauxite beneficiation, if any
- Details of bauxite blending
- Mode of bauxite transport
- Mining, handling and transportation cost

C] PROCESSING DETAILS

- Process bauxite quality and day to day varations
- Bauxite blending at plant site, if any
- Bauxite bond work index
- Input and output size in crusher(s) and ballmills
- Available alumina and reactive silica at defined parameter
- Bauxite requirement per ton of alumina
- Moisture content and its variations

PLAN AND FUTURE BAUXITE SOURCES:

- Bauxite procurement plan for next five years and expected quality
- Future identified bauxite sources, their exploration status, reserves and quality
- Present landed cost of bauxite from various sources and future projections

DATA REQUIRED

1.	Bauxite source	Past, present and future
2.	Bauxite quality	-- DO --
3.	Bauxite mineralogy	-- DO --
4.	Process data for mass & heat balance	In the format enclosed
5.	Process control & Instrumentation	Prevailing status
6.	Samples	Bauxite, residue, red mud, hydrate and alumina (500 gms each)

Annexure VII.

WORKSHOP ON EMERGING TRENDS AND NOVELTIES IN ALUMINA PRODUCTION

(Nov 30 - Dec 1, '95)

Programme

Nov 30, '95

Technical Session I

9.30 - 9.40 hrs	T.R. Ramachandran	Introductory remarks
9.40 - 10.20 hrs	J. Zambo	Keynote address
10.20 - 11.00 hrs	K. Solymar	The status of primary aluminium industries
11.00 - 11.20 hrs		Tea break
11.20 - 12.00 hrs	A.K. Nandi	Present status and future prospects of Indian bauxites for alumina production with special reference to Eastern Ghats Deposits.
12.00 - 12.30 hrs	K. Solymar	Competitiveness of the Indian alumina refineries
12.30 - 13.00 hrs		Discussion
13.00 - 14.00 hrs		Lunch break

Technical Session II

14.00 - 14.40 hrs	M.J. Chaddha & V. Vishwanathan	Mathematical modelling of Bayer process
14.40 - 15.20 hrs	H.K. Chandwani & H.Mahadevan	Recent advances in Hydrate precipitation and scope for improvement in Indian Alumina Refineries.
15.20 - 15.40 hrs		Discussion
15.40 - 16.00 hrs		Tea break
16.00 - 17.00 hrs	C. Misra	Enhancement of liquor productivity by modelling and simulation of precipitation
17.00 - 17.30	Ravi Gopinath	Advanced Control and Optimisation in Alumina Refining (Presentation by participants).

December 1, '95

Technical Session III

9.30 - 10.30 hrs	C. Misra	Production and market of chemical grade alumina hydrates and alumina with special reference to Indian conditions
10.30 - 10.45 hrs		Discussion
10.45 - 11.00 hrs		Tea break
11.00 - 11.40 hrs	K. Solymar	Pressure decanter : a revolution for red section
11.40 - 12.20 hrs	H. Mahadevan, H.K.Chandwani & P.M. Prasad	Red mud disposal - An Overview
12.20 - 12.40 hrs		Discussion
12.40 - 14.00 hrs		Lunch break

Technical Session IV

14.00 - 14.45 hrs	K. Solymar	Hyperbaric filtration as a means of significant improvement in red mud disposal
14.45 - 15.45 hrs.	P.M. Prasad	Problems & prospects of red mud utilisation with special reference to Indian conditions.
14.45 - 16.00 hrs		Discussion
16.00-16.20 hrs		Teal break
16.20-17.30 hrs	R.N. Goyal, K.V. Krishnan, G. Balasubramanian	Visit to the facilities of the Centre Demonstration c characterisation facilities
17.30 - 18.00 hrs		Concluding session

List of Delegates

Sl. No.	Name	Company / Institutation
1.	Dr. Ravi Gopinath	TRDDC, Pune
2.	Mr. Y.P. Thareja	Mecon, Ranchi
3.	Mr. P. Ashwadhama	L&T, Bombay
4.	Mr. M. Kapadia	L&T, Bombay
5.	Mr. B.N. Shaha	L&T, Bombay
6.	Mr. K. Ramachandran	Malco, Metturdam
7.	Mr. S. Bhattacharya	EIL, New Delhi
8.	Mr. S. Haldar	EIL, New Delhi
9.	Mr. R.J. Singh	Hindalco, Renukoot
10.	Mr. N.N. Roy	Hindalco, Renukoot
11.	Mr. R.K.P. Verma	Hindalco, Renukoot
12.	Ms. Mohua Banerjee	Indal, Belgaum
13.	Dr. B.K. Satpathy	Nalco, Bhubaneswar
14.	Mr. K.P. Paul	Balco
15.	Mr. P. Vidyasagar	Nalco, Damanjodi
16.	Mr. M.M. Seth	Nalco, Bhubaneshwar

Annexure - VIII

Guidline for Training for the Freshly Recruited Staff of the Alumina Producers.

The following materials, proceedings available at JNARDDC are recommended as basic information to be studied :

1. UNIDO Group Training in Production of Alumina. Training kit prepared by ALUTERV-FKI, Budapest, July 1979 for UNIDO.

- Volume 2. Chemical background and technology of processing bauxite to alumina.
- Volume 6. Technological investigations of bauxites and red muds.
- Volume 7. Evaluation of bauxite investigations for the selection of alumina processing technology. Brief outline of feasibility studies.

2. Laboratory practice in alumina production. Theoretical Background and Laboratory Manual. Prepared by ALUTERV-FKI, Budapest 1983 for UNIDO Group Training.

3. Preinvestment studies prepared by JNARDDC in 1993-94 for BALCO, HINDALCO and NALCO for intensification, modernisation and expansion of Korba, Renukoot and Damanjodi alumina plants.

4. Workshop Materials :

- Proceedings of workshop on "Improvement of Alumina Production Technology" prepared by JNARDDC. (The Workshop was held in Nagpur on 12th and 13th January 1995.)
- Proceedings of workshop on "Emerging Trends and Novelties in Alumina Production" prepared by JNARDDC. The workshop was held in Nagpur on 30th November and 1st December 1995.)

The studying of the papers presented at TMS Annual Meetings in the last few years and the Proceedings of the Alumina Quality Workshop held in Australia is also highly recommended.

Further selection of the training materials/books should be made according to the special duties and interest of the trainees.

It is required a special short course relating to the mathematical modeling of the Bayer process (Preparation of material and heat balances.)

It is advised to organise at least one month programme consisting of lecture programme, laboratory practice, technological calculations and mathematical modeling. Laboratory Simulation tests on predesilication, digestion, red mud separation and precipitation should be carried out by the trainees along with the evaluation of the lab test results under guidance of the scientists of JNARDDC. It is recommended to involve high level experts from the companies in the lecturing programme and to discuss the status and development strategies of the Indian alumina refineries in detail.

As an example, the programme of the UNIDO Group Training held in China at **Zheng Zhou** Light Metals Research Institute can be considered. (The related final report is available in the library of JANRDDC.

Annexure - IX

List of the Copies of Publications

1. Techno-economic feasibility study for alumina production from Elburz bauxite by the Bayer tube digestion process.

   UNIDO Contract No. 89/59
   Project No. DP/IRA/85003
   Draft Final Repcrt Vil. I-II.
   ALUTERV-FKI, Budapest, February 1990.

2. Alminium,Bauxite and Alumina (by Patricia A. Plunkert and Errol D. Sehnke)
   Annual Report 1993
   U.S.Department of the Interior Bureau of Mines.

3. Report on the Plant Tests carried out between 03.02 and 10.02. 1984 in the Renukoot Alumina Plant of HINDALCO. ALUTERV-FKI, 1984.

4. The UNIDO Group Training in China on Alumina Production and Aluminium Electrolysis held in Zheng Zhou P.R. of China, from 29.10.1984 to 07.12.1984. Final Report. Contract No. 84/102. between UNIDO and ALUTERV-FKI UNIDO Project No. : UC/UD/CPR/84/138 Prepared by ALUTERV-FKI, Budapest, 1984.

5. Light Metals 1995 Proc. of the technical sessions of LMD of TMS at the 124th TMS Annual Meeting, Las Vegas, Fer. 12-16 1995. All papers of Bauxite/Alumina sessions.

6. Metal Bulletin's & Industrial Minerals' International Bauxite and Alumina Markets Conference (papers presented) Miami , Florida USA, 3-4 April 1995.

7. Pollution Prevention and Abatement Guidelines for the Aluminium Indusrty, Study prepared by ICF Kaiser Engineers International, USA, for UNIDO, in the Project US/GLO/91/202 January 1994.

8. Status of the World Aluminium Industry. Study prepared by Vincent Tortoriella Franqui Patines and Norberto Labracdor (Instituto de Inguinieria Caracas, Venezuela, for UNIDO IPCT. 178 (SPEC), 7 July 1992.

9. Literature and leaflets on Hyperbaric pressure filtration developed by Andritz A.G.

10. Double stage digestion and pressure decantation related patent applications.