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20755

REPORT ON THE MISSION
DP/IND/88/015/11-09
INDIA

of Dr. J. Zoldi, expert in alumina production to
India between 28.12.1993 and 10.02.1994

for the

Jawaharlal Nehru Aluminium Research
Development and Design Centre, Nagpur

about

The transfer of knowledge in field of the organic
impurities in the Bayer - technology.

Backstopping officer : Dr. T. Grof, Subsistance
officer

UNIDO, Vienna

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Abstract

The mission was organized by UNIDO Vienna in the framework of the project to assist in setting of an Aluminium Research Development and Design Centre in India. (Project No. DP/IND/SS/015/11-09).

The objective of the mission was to transfer the knowledge in the field of organic impurities in the Bayer technology and provide training for the counter part staff of the centre on the influences of organic impurities for the Bayer process.

Based on the laboratory tests carried out togather with the staff of centre and the analysis data of BALCO and NALCO plant samples the following measures were proposed:

- Laboratory determination of extrctable organic content of Mainpat bauxite deposits which is to be processed (based on bore hole samples).
- Change of use of starch (settling aid) to the use of synthetic flocuulants at BALCO Alumina plant.
- Plant trial with crystal growth modifier at BALCO Alumina plant (CGM is used at HINDALCO sucessfully).

The organic problems were discussed with representatives of alumina plants in framework of a workshop which was held in Nagpur on 1st February 1994.

Dr. J.Zoldi
UNIDO expert

Nagpur 9th Feb 94
Date: 9th Feb.1994

Time Schedule

Arrival to Delhi (from Budapest)	----	28.12.1993
Visit UNDP, Delhi Office (Meeting with Dr. T.R. Ramachandran and Mr. Ramamurti)	----	29.12.1993
Visit UNDP, Delhi Office (Meeting with Mr. Ramamurti)	----	30.12.1993
Arrival to Nagpur (from Delhi) (Meeting with Dr. J. Zambo and Dr. T.R. Ramachandran) Discussion on the work programme in JNARDDC.	----	31.12.1993
Working in JNARDDC according to the detailed work programme (Annexure 2)	----	02.01.1994 - 09.02.1994
Travel from Nagpur to Budapest	----	09.02.1994
Arrival to Budapest	----	10.02.1994

Activities

The mission was organised by UNIDO Vienna and by Jawaharlal Nehru Aluminium Research Development and Design Centre, Nagpur in the framework of UNIDO Project "Assistance to the Government of India in setting up a Functioning Aluminium Research Development and Design Centre".

The aim of the mission was to transfer knowledge in field of the organic impurities in the Bayer technology, parallelly with transfer of up-to-date analytical methods and procedures used for determination of total organic content and diferent organic compounds in the raw material and intermediate materials of Bayer-process.

Activities during the mission were fulfilled according to the job descriptin (Annexure - 1) and the detailed work programe agreed with Dr. J.Zambo and Dr. T.R. Ramachandran (Annexure - 2). The activities were as follows :

1. Providing training for the counterpart staff on the following topics :

   Impacts of inorganic and organic impurities in the Bayer process.

Organics contents of different types of bauxites.

Distribution of organics in the bauxite deposits.

Extraction and formation rates of organics in the digestion process.

Comparison of organic levels of Indian alumina plants to these of alumina refineries in abroad.

Accumulation of the organic impurities in the Bayer process.

Organic balances of Bayer alumina plants.

Adverse effects of different organic compounds in the Bayer process especially in precipitation.

Methods for control and removal of organics impurities.

Organization and carrying out laboratory digestion tests for determination of organic dissolution rate for BALCO and NALCO plant feed bauxite, (Annexure - 3).

3) Organization of collection average plant samples from BALCO and NALCO Alumina Plants for determination of organic balances.

4) Copies of articles dealing with organics, salt removal and precipitation were handed over to the counterpart (Annexure - 4).

5) Presentation of lecture at the workshop held in Nagpur, Ist February 1994 on the **"Impact of organics on the Bayer cycle and their control". (Annexure - 5).**

6) Discussion with the management of BALCO Alumina Plant on the actual plant problems **(Annexure - 7)**

7) In order to determine C-org. Content and EOC in Indian Bauxites and cross check the result of JNARDDC, it is agreed to analyse some of the samples in Hungary. In this connection, 12 bauxite samples are jointly selected. Out of these, 10 samples will be analysed for Corg content and in 2 samples EOC (extractable organic carbon) will be determined. Among 10 samples, first 5 belong to Panchpatmali deposit drawn from various depth of lateritic bauxite profile. A list of samples and detail enclosed here. Analytical results of these samples will be communicated to JNARDDC **(Annexure 8).**

PROPOSALS

1. Determination of distribution of extractable organics in the Mainpat bauxite deposit which is to be processed at BALCO Alumina Plant based on bore hole samples by the JNARDDC.

2) Finalization of the total organic balances for the BALCO and NALCO Alumina Plants. Determination of Na-oxalate balance for BALCO precipitation process by gas chromatography based on plant samples (pregnant liquor, spent liquor, hydrate wash water, seed hydrate and product hydrate).

3) Change of tne use of the starch with use of synchetic flocculant at BALCO Alumina Plant to decrease the total organic and oxalate inputs.

4) Organized plan of the trial at the BALCO Alumina Plant (1.5 - 2 months) using Crystal Groth Modifier to decrease adverse effects of the Na-oxalate and to increase the liquor productivity in precipitation phase.

7. Increase the temperature of the strong liquor before settling of the salt to avoid the gel-formation.

Annexure-1

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION*

DP/IND/88/015/11-09

Post Title: Expert in Testing of Organic Impurities

Duration: 1.5 months on site and 0.5 months homebase

Date required: 28 December 1993

Duty Station: Nagpur, India

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 co-operation 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 transfer knowledge in field of the organic impurities for the Bayer-technology in form of in-house training.

His main duties will be to:

1. Provide training for the counterpart staff of the Centre on the organic content of different type bauxites, on the dissolution,

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*Applications and communications regarding this Job Description should be sent to:
Project Personnel Recruitment Section, Industrial Operations Division
UNIDO, Vienna International Centre, P.O. Box 300, Vienna/Austria

accumulation and discharging organics from the Bayer circuit;

2. Provide training on the determination of organics dissolution rate under laboratory conditions;

3. Provide training on the influences of organics in precipitation step of the Bayer technology;

4. Organize the determination of the total organic balance for the two Indian (e.g. BALCO and NALCO) refinery together with the staff of Centre. (Plant samples will be provided by the Centre);

5. Provide lectures on the technological possibilities of decreasing of organics level in the Bayer-circuit.

The expert is expected to submit a Final Report after completion of the mission in 3 copies to UNIDO and 4 copies for the Government of India and the counterpart.

Qualifications:

University degree (preferably Ph.D.) in analytical chemistry with extensive practical and research experience in gas chromatography and its use in the aluminium industry.

Language requirements:

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 in operation and six aluminium smelters with an overall capacity of 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 t 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-2

WORK PROGRAMME OF DR. J.ZOLDI, UNIDO EXPERT

WEEK -1

-Preparation of materials and required chemicals for organic dissolution tests.

-Preparation of Laboratory equipments to make them operative for laboratory tests for digestion with synthetic liquor.

-In house training on the organic contents of different Bauxites with JNARDDC scientists of Alumina and Bauxite with special reference to Indian Bauxites.

-Disscussion on use of high gibbsitic bauxites at medium temperature digestion considered in pre-investment studies prepared for Balco and Nalco and effect of organics in Bayer'circuit while processing.

WEEK -2

-Laboratory determination of organic dissolution rate on Laboratory scale at high and medium temperature .

-Different composition of organics in different alumina refineries plant liquor processing different type of Bauxites.

-Organic dissolution test using Balco and Nalco bauxite feed.

WEEK- 3

- Collection of samples from Balco and Nalco refineries.

-Investigation planning for the determination of Organic balances for each refinery.

-In house training on 'Influences of organics in Bayer's circuit of alumina extraction'.

-Discussions on influences of different groups of organics in precipitation and whole Bayer's circuit.

WEEK -4

-Organising the determination of total organic balance for two Indian alumina refineries (e. g. Balco and Nalco) together with the staff of the center.

-Evaluation of organic determination and balances calculated for Balco and Nalco Plants.

WEEK - 5

-Workshop on the "Effects of organic impurities in bauxites on Bayer's Process of alumina extraction with possible measures to control/reduce for higher productivity and better quality".

Annexure-3

ORGANIC DISSOLUTION TEST WITH BALCO PROCESS BAUXITE

DIGESTION PARAMETERS ;

- Temperature : 240°C
- Preheating time : 1 hour 15 minutes.
- Holding time : 30 minutes.
- Caustic liquor concentration : 171 g/l Na^2O
- Target Molar ratio : 1.5
- Bauxite charge : 46.47 gm/120 ml.

CHEMICAL ANALYSIS DATE OF BAUXITE:

Al_2O_3 : 49.43%
SiO_2 : 3.05%
Fe_2O_3 : 16.72%
TiO_2 : 7.65%
LOI : 23.4%

NUMBER OF BOMB : 899

MESURED DATA (C- ORGANIC CONTENT)

- Bauxite : 0.901%
- Digestion liquor (blank) : 0.004 g/l
- Blow off slurry (Liquid Phase) : 0.255 g/l
- Wash water : 0.096 g/l
- Red mud : 0.052%

ORGANIC BALANCE

INPUTS	Volume (mls.)	C (org) g/l	Mass gms.	Corg %age	Corg (gms.)
Bauxite	-	-	46.47	0.0901	0.0418
Dig.Liq (blank)	120	0.04	-	-	0.0048
TOTAL					0.0466
OUTPUTS					
Blow off Liquor	115	0.255	-	-	0/0293
Wash wat.	570	0.096	-	-	0.00545
Red mud	-	-	15.6	0.052	0.00809
TOTAL					0.0428

- Dissoution rate $$= \frac{0.0293 + 0.00545 - 0.0048}{0.0418} * 100$$

$$= 71.5\ \%$$

Number of Bomb : 901

MESURED DATA

C organic content

- Bauxite : 0.0901 %
- Digestion liquor (Blank) : 0.004 g/l
- Blow off liquor : 0.0263 g/l
- Wash Water : 0.096 g/l
- Red mud : 0.052%

ORGANIC BALANCE

INPUTS	VOLUME (mls)	Corg g/l	Mass gms.	Corg. %age	Corg gms.
Bauxite	-	-	46.47	0.0901	0.0418
Digestion Liq. (blank)	120	0.04	-	-	0.0048
TOTAL					0.0466
OUTPUTS					
Blow off Liq.	115	0.263	-	-	0.0315
Wash water	570	0.096	-	-	0.00545
Red mud	-	-	-	0.0518	0.00824
TOTAL					0.0452

Dissolution rate : $$\frac{0.0315+0.00545-0.0048}{0.0418} * 100$$

$$= 76.9\ \%$$

Annexture 4

List of papers handed over to JNARDDC Specialists

1. J. Zoldi and G. Malor : Separation of vanadium salt from the Bayer Cycle containing CaO additive
   Edited by ALUTERV-FKI 1979

2. F.W. Perry and A.S. Russel : Advances and Prospects in Alumina Technology.

   Journal of Metals Oct. 1982 p.p. 48 - 53

3. T.R Muller and T.L. Johnson : Simulation of Mass, Heat and Particulate Balances in the Bayer precipitation.

4. Terry L. Owerbey and Chasles E. Scott : Characterisation of Bayer Plant Liquors and Seeds utilizing a mathematical Model for precipitation.

5. A. Halpon and S.Kaliquine : Alumina Tri-hydrate Crystallization.

   The Canadian Joural of Chemical Engineering

Vol. 34. June 1976

6. K.B. Kellogy and C.H. Holley : The Measurement of Particle Size and Its Effect on Alumina Tri-hydrate Precipitation Control.

7. M. Kanehara : Formulation of Alumina Hydrat Precipitation Rate in Bayer Process for Plant Design and Operation, TMS copy.

8. Yamada, T.Hashimoto and K.Nakano : Behavior of Organic Substances in the Bayer Process.

9. K. Sacamoto, N. Kanehara, K. Matsushite : Agglomeration of Crystalline Particles of Gibbsite during the Precipitation in Sodium Aluminate Solution.

10. N.Brown : The Heat of Crystallyzation of Aluminium Trihydroxide Derived from Equilibrium Solubility Data.

11. J. Scott : Effect of Seed and Temperature on the Particle Size of Bayer Hydrate.

12. R.P. Mahoney and Lawrence J.Connelly : Bayer Liquor Plishing

TMS Annual Meeting, Deuver, Feb. 21 - 25, 1993.

13. A.E. Gross and D.O. Owen : Development of a Bauxite Dust Control and Ore Handling Agent.

TMS Annual Meeting, Deuver Feb. 21 - 26, 1993.

14. Nalco Chemical Company : Surface Active Deliquoring Agents for Alumina Tri-hydrate.

15. W.J. Roe and D.O. Owen : Crystal Growth Modification : Practical and Theoretical Considerations for the Bayer Process.

16. Evaluation of Downstream Effects fo Specially Chemicals in the Bayer Process. TMS annual meeting February 18-20,1991

17. Gordon Lever : Some Aspects of the Chemistry of Bauxite Organic Matter on the Bayer Process : The sodium oxalate - Humate Interaction.

JAWAHARLAL NEHRU ALUMINIUM RESEARCH DEVELOPMENT AND DESIGN CENTRE, NAGPUR

IMPACT OF ORGANICS ON THE BAYER CYCLE AND THEIR CONTROL

DR J ZOLDI
UNIDO EXPERT

WORKSHOP
FEBRUARY 1, 1994

IMPACT OF ORGANICS
ON
THE BAYER CYCLE AND THEIR CONTROL

IMPACT OF ORGANICS ON THE BAYER CYCLE AND THEIR CONTROL

Dr. J.Zoldi, UNIDO EXPERT

ABSTRACT

Deterimental effects of different impurities enriched in the Bayer process are discussed with special reference to organics. The following aspects would be emphasised :

- Organic contents of diasporic, boehmitic and lateritic, gibbsitic bauxites.
- Distribution of organic impurities in bauxite deposits depending on depth .
- Extraction and formation rates of organic impurities in Bayer's digestion depending on the nature of processed bauxites and digestion conditions.
- The level of organic impurities in Indian alumina plants in comparison with those of some other alumina refineries. (Eurallumina , Italy; Pinjara, Australia; Kwinana, Australia; Almosfazito & Ajka, Hungary; Gramercy, USA)
- Composition of the organics identified in the process liquors of Indian alumina plants in comparison with that of other alumina plants abroad.
- Organic balance of the HINDALCO and BALCO alumina refineries prepared in ALUTERV-FKI and JNARDDC in comparison with that of the Almosfazito refinery.
- Adverse effects of the organics in the Bayer process specially in precipitation stage:
- Effect of oxalate and other low molecular weight organics.
- Effects of Humates.
- Methods of reduction and control of organic impurities level

- Barium aluminate method for oxalate and carbonate removal (Aluminium Pechiney).
- Giullini method for the removal of humates by magnesium compounds (Alcoa Chemie)
- Seperate evaporation of the hydrate wash water (Hungarian Patent).
- Wet oxidation processes

  a) With oxygen.
  b) With compressed air.

- Liquor buning methods.
- Decreasing the level of humates by addition of anionic synthetic polymers.
- Use of CGM in precipitation stage.

OUTLINE OF THE PRESENTATION

- IMPACTS OF INORGANIC AND ORGANIC IMPURITIES IN THE BAYER PROCESS.
- ORGANIC CONTENTS OF DIFFERENT TYPES OF BAUXITE.
- DISTRIBUTION OF ORGANICS IN THE ORE BODIES.
- EXTRACTION AND FORMATION RATES OF ORGANICS IN THE BAYER 'S PROCESS DIGESTION.
- ORGANICS LEVEL AT DIFFERENT ALULMINA REFINERIES.
- COMPOSITIONS OF ORGANICS IN DIFFERENT ALUMINA PLANTS.
- ACCUMLATION OF THE ORGANIC IMPURITIES IN THE BAYER PROCESS.
- ORGANIC BALANCES OF BAYER ALUMINA PLANTS.
- ADVERSE EFFECTS OF DIFFERENT ORGANIC COMPOUNDS IN THE BAYER PROCESS ESPECIALLY IN PRECIPITATION.
- METHODS FOR CONTROLL OF ORGANIC IMPURITIES .
- CONCLUSIONS.
- PROPOSALS.

IMPACT OF ORGANIC CONSTITUENTS AND METHODS OF CONTROL

INTRODUCTION

More than ninety percent of the world alumina production is produced by Bayer Technology. The Bayer process in a first approach seems to be quite simple hydrometallurgical enrichment of alumina in caustic solution, than the crystallisation of alumina hydrate from the supersaturated aluminate liquor.

It is well known, that in the practice this process is much more difficult because some other bauxite constituents are dissolving in the process too. A quite large amount of the dissolved impurities is accumulated in the closed Bayer circuit causing a lot of technical and technological difficulties.

A very short review is given in the Table -1 on the dissolving inorganic impurities, their adverse effects and processes or methods improved for the control of impurity level in the circuit.

It seems from this short review that proved methods are applied for the removal and control of inorganic contaminants . There is a common task for all alumina plants to control the organic impurities, accumulated in Bayer process too. Organic materials and their degradation products cause a lot of difficulties in the alumina

TABLE- 1

INORGANIC IMPUIRITIES IN THE BAYER PROCESS LIQUOR

IMPURITIES	ADVERSE EFFECTS	IMPROVED TECHNOLOGIES FOR CONTROL
REACIVE SiO_2	-Na_2O,Al_2O_3 LOSSES -Scale formation. -Alumina contamination	-predesilication -post desilication -Liquor desilication
-Carbonates (Calcite, Dolomite, Siderite)	-decausticization of NaOH -Increase solubility of Al_2O_3. -Scale formation	-Salt Removal and Causticization -Inside causticization.
-TiO_2 (at High Temp.)	-Na_2O losses. -Scaling	-Lime addition.
-P_2O_5	-Alumina contamination -Scale formation	-Salt removal -Lime addition
-V_2O_5	-Alumina contamination	-Salt removal (By product)
-SO_4	-Scale formation	-lime addition
-F	-Scale formation	-crystallisation
-ZnO	-alumina contamination	-removal by Na_2S addition
-Ga_2O_3		-Ga metal production (by product)

production technology. The different groups of organics and their adverse effects are summarized in .Table-2

ORGANIC CONTENTS OF DIFFERENT TYPES OF BAUXITE

The main source of organics entering into the Bayer process is the processed bauxite. According to our opinion different types of bauxite contain different quantity of organic impurities.

Less organic contaminants have been found in diasporic type bauxite. We have determined the organic content of Iranian, Turkish and Greek diasporic bauxite ores and total organic contents of these bauxites were found less than 0.05%. A little bit higher 0.05 - 0.1% total organic contents were determined in boehmitic type karstic bauxites (Hungarian, Yugoslavian , Serdanian etc.)

Lateritic gibbsitic type, young bauxite deposits, which are close to the surface, close to the soil and vegetation contain the higher quantity of organic impurities which are in the range of 0.10 - 0.30 % . Extremely high organic content can be found for instance in the western Australian bauxite deposits. This type of the ore is processed in Wagerup , Kwinana and Pinjara alumina refineries, where the level of the organics is extremely high (Over 30 g/l).

DISTRIBUTION OF THE ORGANICS IN THE BAUXITE DEPOSITS

The organic contents of different bauxite deposits depend upon the natural history of the region. Determining

Table 2

Organic impurities accumulated in the Bayer process liquors

Groups of organics	Adverse effects of theOrganics
Humic acids	- decreasing of the activity of seed hydrate.
Aromatic acids	
ftalic hemimellitic triimellitic trimesinic piromellitic	- decreasing of the liquor productivity by increasing solubility of Al2O3 - changing in physical properties of the process liquor:
Dicarbonic acids succinic glutaric adipinic	- boiling point rise. - specific gravitv - viscosity - specific heat
Monocarbonic acids formic acetic propionic butiric valeric	- ion activity co-efficients - foaming - increasing of solubility of inorganic salts (e.g. Na_2CO_3)
Oxalic acid	- formation of fine particles - alumina contamination (Na_2O) - disintegration of particles during calcination
Unidentified components	- Unknown

factors are the following e.g. geology, rainfall , temperature, vegetation and soil microbiology. The distribution of extractable organic carbon in the orebody is not homogeneous. Both the amount and the types of organics compounds found near to the top of orebody are different from these of near to the bottom. The high molecular weight, colouring compounds occur closest to the surface or the orebody. Darling Range bauxite deposit was investigated in details by Grocott (1). Extractable organic distribution is shown of Figure-1 for a Darling Range mine site. The typical organic distribution in bore hole samples taken out from different depth is shown on Figure-2. It can be seen, that the extractable organic carbon, oxalate and carbonate components are different in different depths.

Figure 1

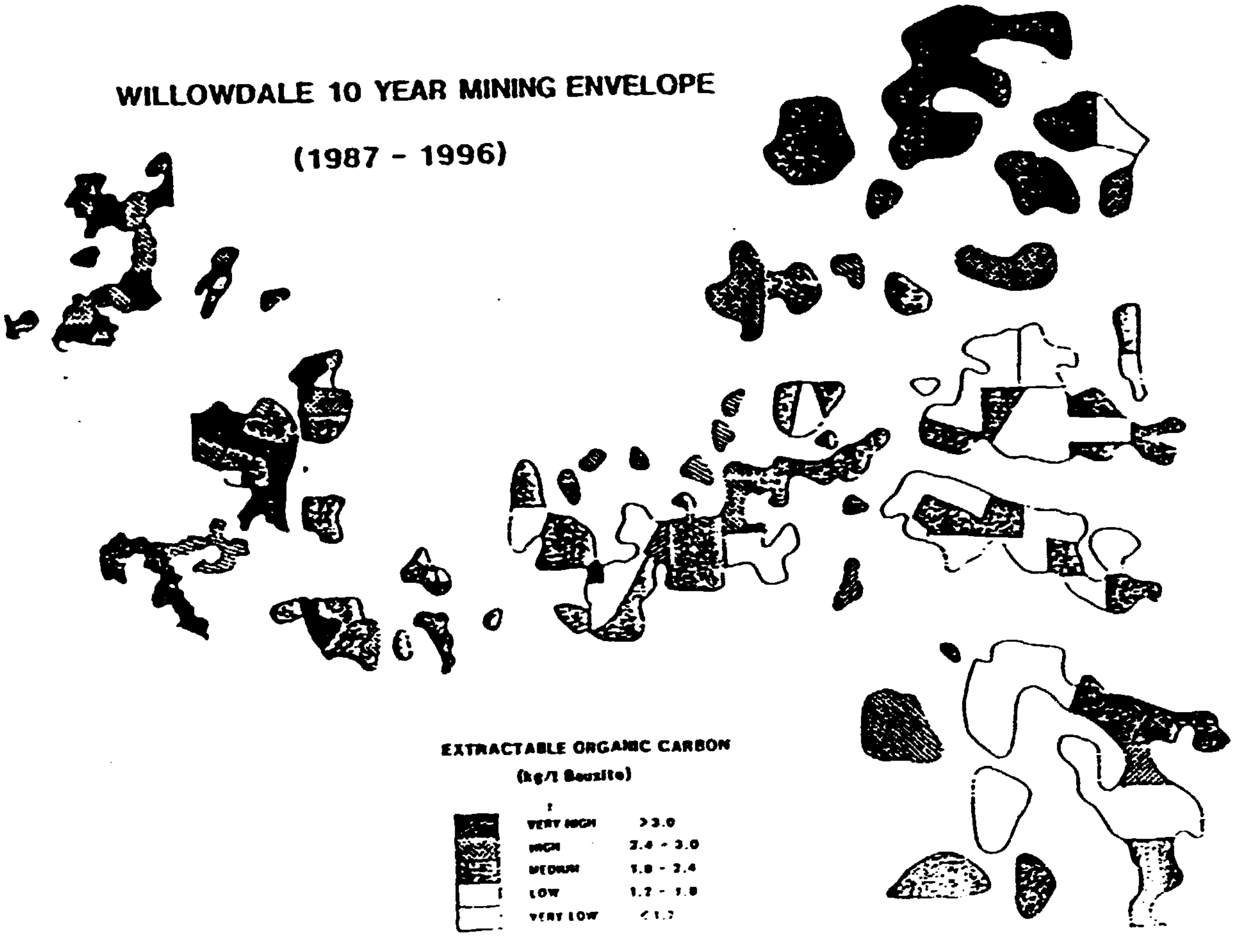
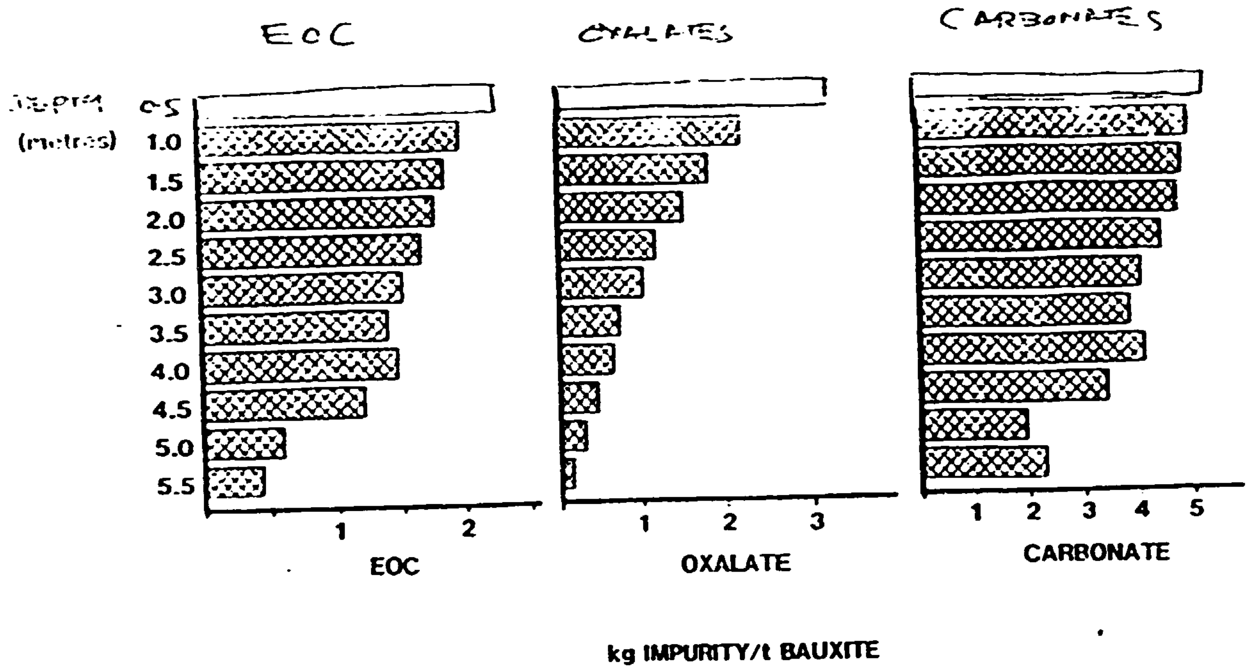

WILLOWDALE 10 YEAR MINING ENVELOPE
(1987 - 1996)
EXTRACTABLE ORGANIC CARBON
(kg/t Bauxite)
VERY HIGH >3.0
HIGH 2.4 - 3.0
MEDIUM 1.8 - 2.4
LOW 1.2 - 1.8
VERY LOW <1.2

Figure 2



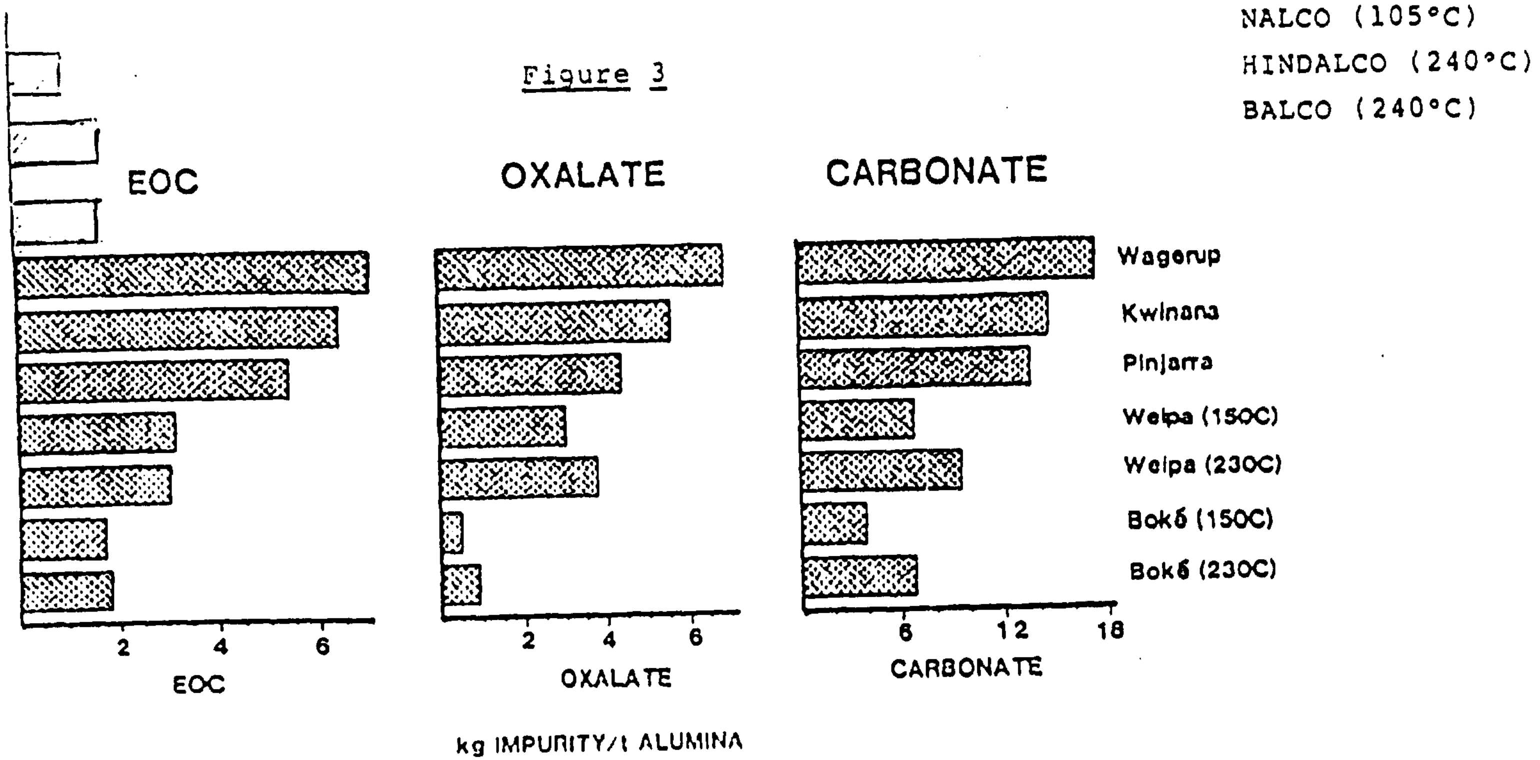
Average impurity extraction/formation rates as a function of depth of bauxite (average of 13 drill hole samples from four minesites in the Darling Range).

EXTRACTION AND FORMATION RATES OF ORGANIC IMPURITIES DEPENDING ON THE PROCESSED BAUXITES AND THE DIGESTION CONDITIONS.

The results of the model digestion tests, made by Australian researcher Grocott are plotted in Figure -3. The organic impurity extraction and formation rate of the western Austrlian, Weipa and Boke bauxite were compared at 150° C and 230°C digestion temperature. Quantities of extractable organic carbon, oxalate and carbonate were determined and plotted for one ton of alumina. It can be seen that quantities of the investigated impurities are different depending on the bauxite and on the digestion temperature.

Data of organic extraction tests made by JNARDDC AND ALUTERV-FKI for BALCO , NALCO AND HINDALCO plant feed bauxites are compared to these of most important and very large bauxite deposits. It can be seen from the comparison that Indian alumina refineries are in medium position even extractable organic content of NALCO plant feed bauxite is extremely low.

Figure 3



Bauxite impurity extraction and formation rates.

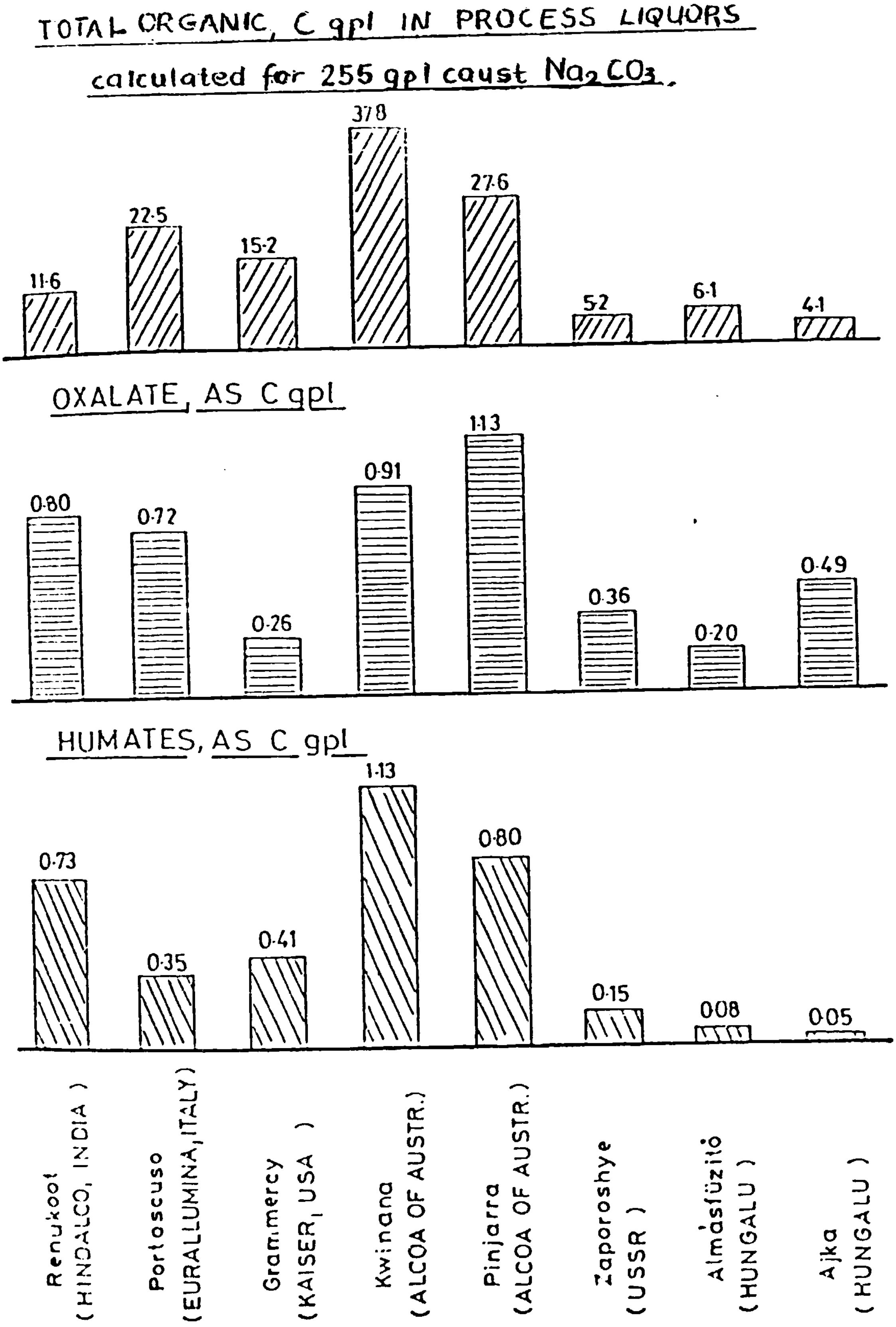
THE LEVEL OF THE ORGANIC IMPURITIES IN DIFFERENT ALUMINA REFINERIES

The extraction and degradation rate of organics are depending on the bauxite processed and the digestion technology applied. The problems arising by the organic content of the process liquors are also different and specific for each alumina refinery. Organic compounds determined by ALUTERV-FKI in process liquors of different refineries are shown on Figure-4 (2). The results were calculated at the same caustic soda concentration (256 g/l caustic soda as Na_2CO_3) for better comparison.

The extremely high total organic oxalate and humate contents of the Western Australian process liquor can be explained by the high total extractable organic contents of plant feed bauxites and by the high specific bauxite consumption. The organic level of the refineries processing European, Boehmitic type karstic bauxites are relatively low, however the level of oxalate can reach the saturation point in case of these plants too.

Total organic levels of Indian alumina plants are in the medium position (excluding the extremely low level in NALCO plant) but concentration of oxalate are at the supersaturation points in HINDALCO and BALCO process liquors.

Figure 4



The total organic carbon content in the process liquors of different alumina refineries

COMPOSITIONS OF ORGANICS IN DIFFERENT ALUMINA PLANTS

The distribution of the different organic components determined by gas chromatographic method in different process liquors are shown on Figure-5. The identified and determined components were ranged into six different groups as follows :

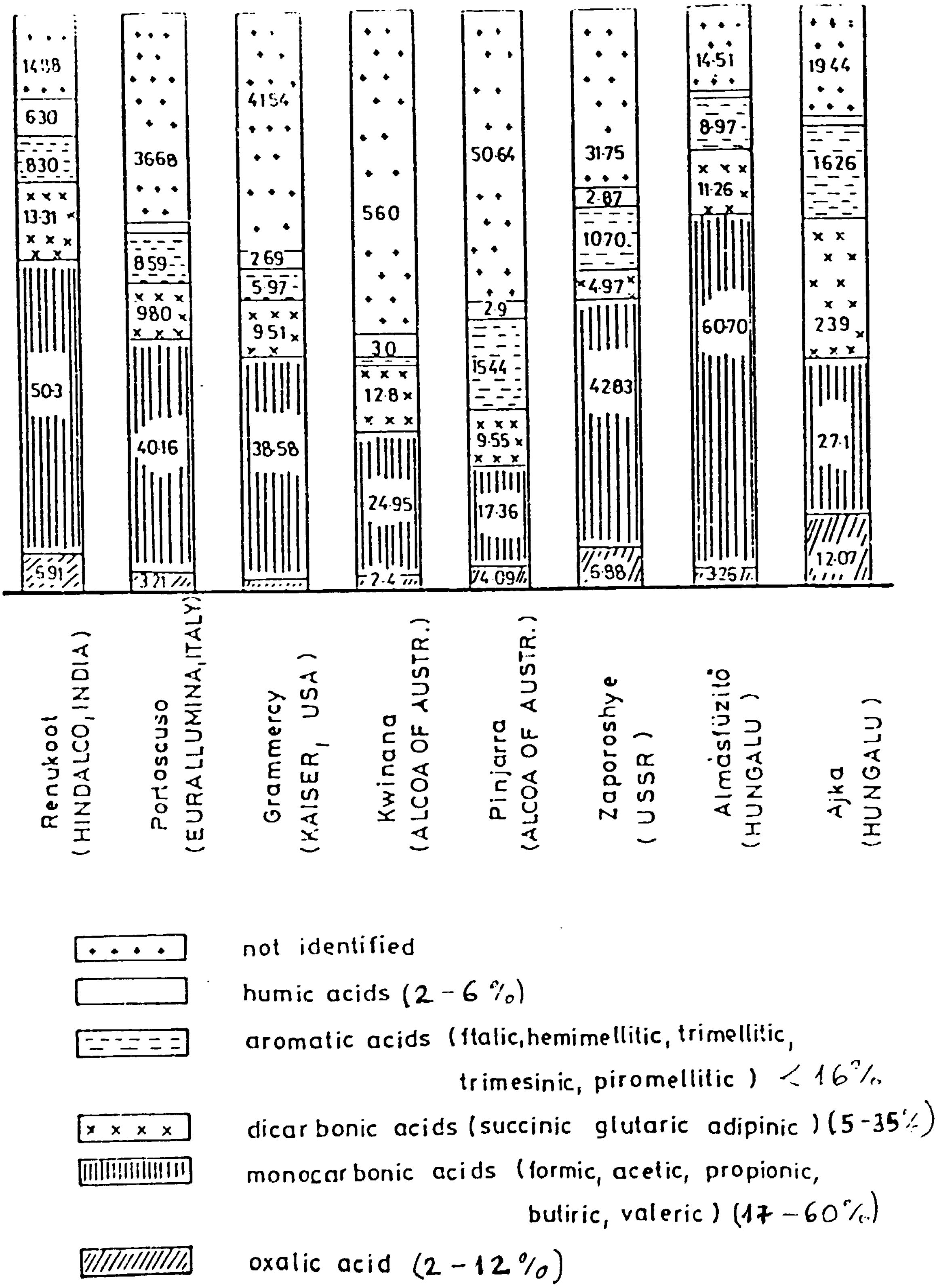
- Humic acids.
- Aromatic acids
- Dicarbonic acids
- Monocarbonic acids.
- Oxalic acids
- Unidentified components

The data show that each plant liquor contains a high amount of monocarbonic acids, their quantities are in the range of 17-60% in the different process liquors. The quantities of dicarbonic acids are much less, they are in the range of 5-25% . Aromatic acids were found to be less than 15-16% in the investigated process liquors. Characterstic humic contents are in the range of 2-6%. Oxalate contents, limited by the solubility of Na-Oxalate were found in the range of 2-12%.

It can be seen from the data of the HINDALCO process liquor that it can be characterised by relatively high humate and oxalate content.

Figure 5

DISTRIBUTION OF ORGANIC COMPOUNDS IN PERCENT EXPRESSED IN C ORG.



Distribution of organic compounds measured by gas-chromatography

ACCUMULATION OF THE ORGANIC IMPURITIES IN BAYER PROCESS. ORGANIC BALANCES OF DIFFERENT ALUMINA PLANTS.

The main source of organic input into the Bayer process is the processed bauxite. On the basis of laboratory dissolution tests can be stated, that usually 50 - 80 % of bauxite organics is dissolving during the digestion depending on the bauxite and the technological parameters. Other sources of the organic imput are summarized in Table-3

Taking into consideration, that Bayer plants are operating in closed circuit, the above inputs and outputs are the determining factors for the accumulation rate of organic impurities inside the Bayer cycle. Organic balance calculated on the basis of analysis of entering, intermediate and outgoing materials is the best means for the evaluation of the actual situation of a given plant and for the estimation of expected accumulation rate.

The balance of the total organic content in the Almasfuzito/Hungary/Refinery is demonstrated on Figure 6 and Table 4. It can be seen that the main source of organics is the bauxite, and the largest amount of organics leaves the cycle by red mud and product hydrate. In the investigated period about 10% (0.21 Kg organic C per ton of alumina) remained in the cycle increasing of the level of the organics. The enrichment of the organics on the surface of seed hydrate should be underlined considering its adverse effects in precipitation which will be discussed later.

Table 3

THE MAIN SOURCES OF ORGANIC IMPURITIES ENTERING INTO THE BAYER CYCLE

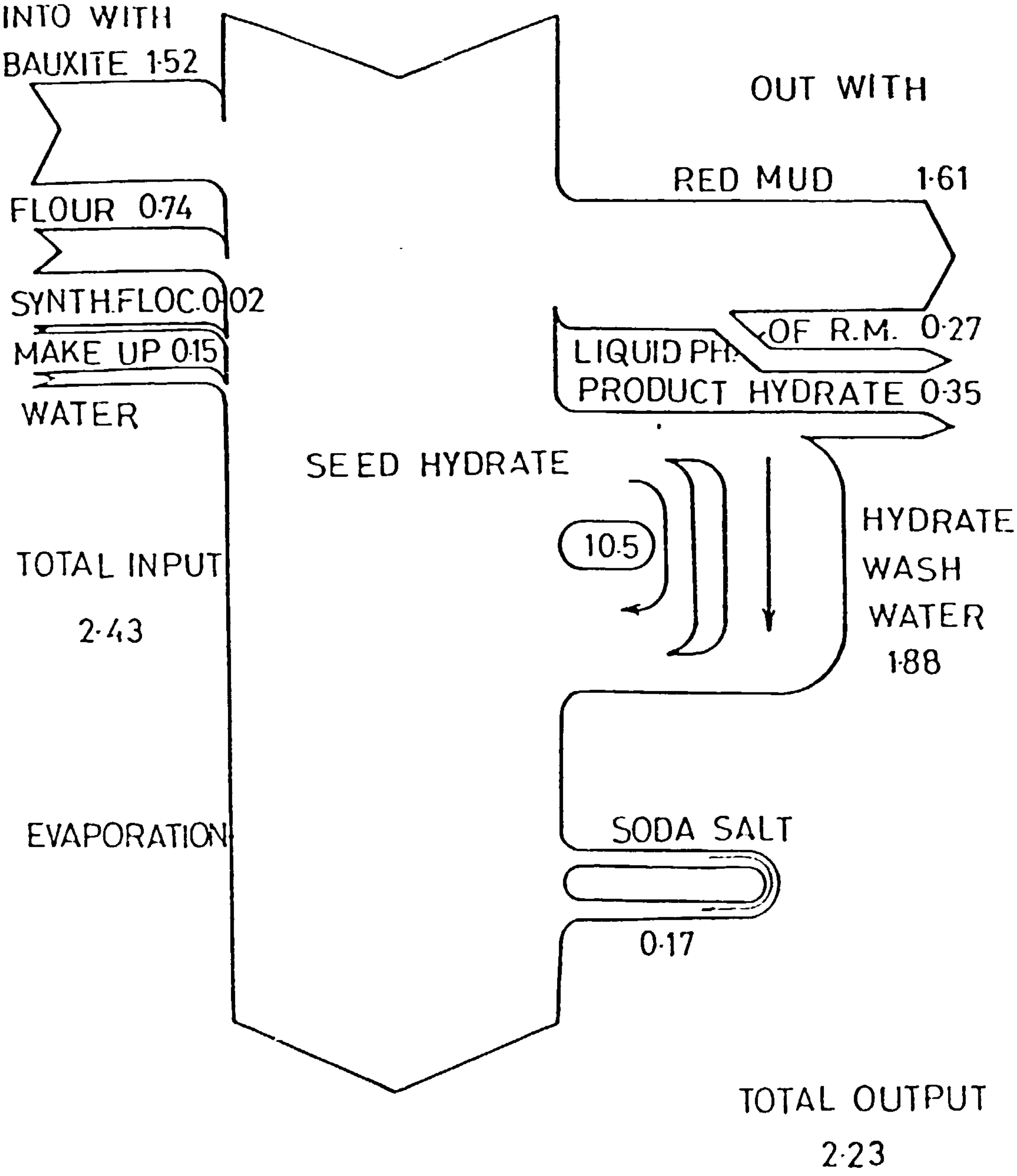
- BAUXITE PROCESSED.
- STARCH USED AS SETTLING AID.
- SYNTHETIC FLOCCULANTS.
- ANTIFOAM AGENTS.
- DEWATERING AIDS (AT THE PRODUCT FILTRATION).
- CRYSTAL GROWTH MODIFIERS.

ORGANIC OUTPUTS

- WITH RED MUD (UNDISSOLVED AND ADSORBED).
- LIQUID PHASE OF RED MUD TO THE LAKE /POND.
- PRODUCT HYDRATE.
- SEPARATED SALTS.

Figure 6

TOTAL ORGANIC CARBON BALANCE IN A BAYER PLANT. ($kgC_{org}/t\,Al_2O_3$)



The balance of the total organics in the Almásfüzitő Refinery in 1979.

TABLE-4

BALANCE OF THE TOTAL ORGANICS IN ALMASFUZITO REFINERY

INPUT WITH	Corg Kg/tAl_2O^3
Bauxite	1.52
Flour	0.74
Synthetic - Flocculant	0.02
Make up water	0.15
Total input	2.43
OUTPUT WITH	
Red mud	1.61
Liquid phase of red mud	0.27
Product hydrate	0.15
Total output	2.22
Remaining in cycle	0.21

Organic content in	
Soda salt	0.17
Hydrate wash water	1.90
Seed hydrate	10.50

Total organic balance determined for Indian HINDALCO plant in 1993 is demonstrated in Figure-7 and its characteristic data are summarized in Table -5 . The entering organic quantity is significantly more, than that of Almasfuzito" Refinery due to higher organic content of processed bauxite. The balance shows that there is 13% (0.406 Kg/ton) difference between the amount of organics entering and leaving the process. In this period the level of organics was increasing in the cycle.

Figure 7.

TOTAL ORGANIC BALANCES

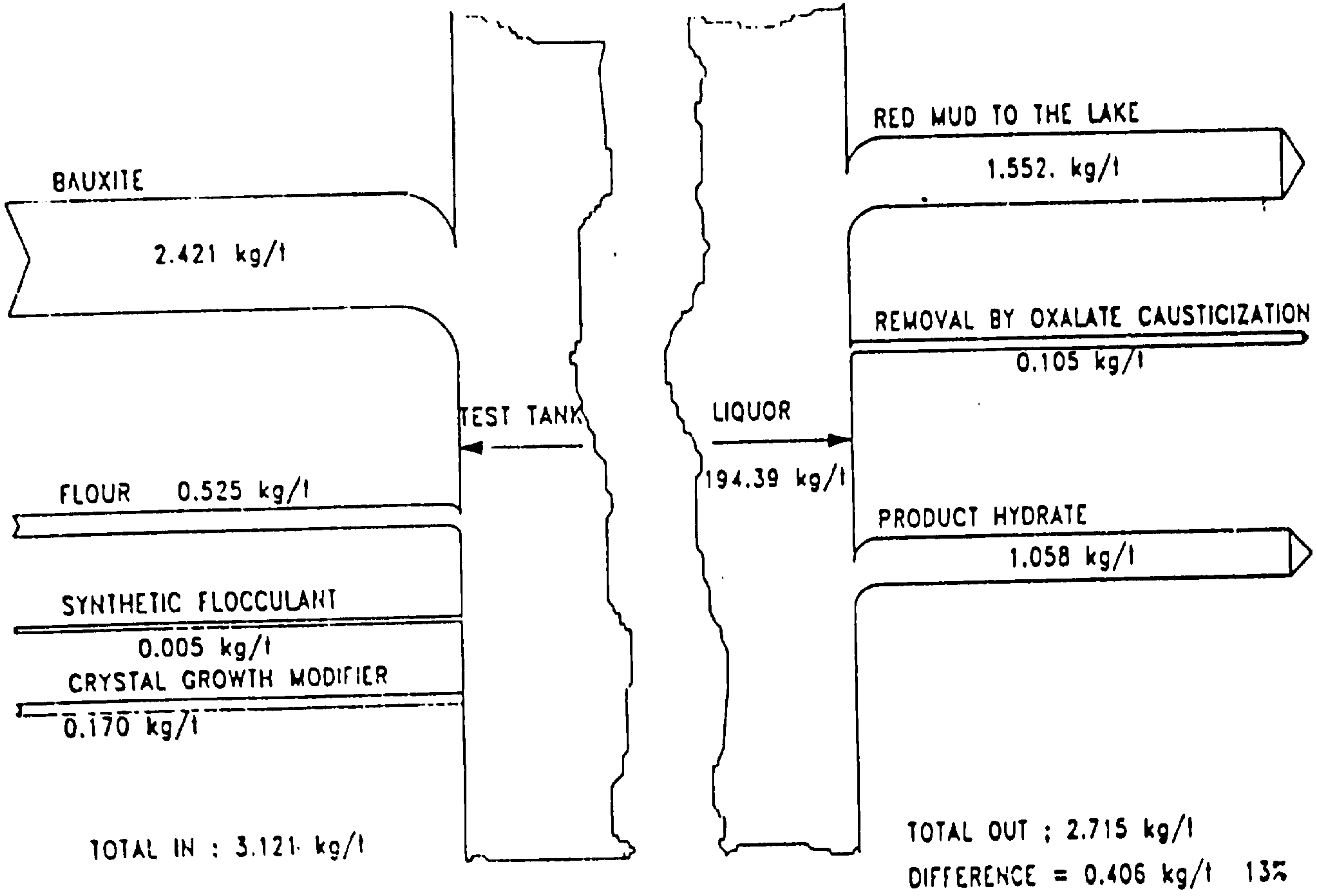


Table 5.

TOTAL BALANCE

	Mass	Volume	Na2CO3	Corg			Na-oxalate			C humin		Moisture	Remarks
	t/t	m3/t	gpl	gpl	%	kg/t	gpl	%	kg/t	gpl	kg/t	%	
In: Bauxite, solid	2.815		-	-	0.086	2.421	-	-	-	-	-	1.6	-
" , moisture	0.046												
Flour	0.002		-	-	35	0.525	-	-	-	-	-	-	-
Synthetic flocculant	1.3E-05		-	-	35	0.005	-	-	-	-	-	-	-
Crystal growth modifier	0.0005		-	-	35	0.170	-	-	-	-	-	-	-
Total in:						3.121							
Out: Red mud to the lake, solid	1.568		-	-	0.099	1.552	-	-	-	-	-	-	-
" , moisture	0.843		18.1	-	-	-	-	-	-	-	-	28.38	-
Removal by liquor causticizing	-	-	-	-	-	0.105	-	-	0.018	-	-	-	-
Product hydrate, solid	1.512	-	-	-	0.07	1.058	-	-	0	-	-	-	-
" , moisture	0.109	-	-	-	-	-	-	-	-	-	-	6.74	-
Total out:						2.715							
Difference:						0.406 13.0 %							

IMPACTS OF THE ORGANICS IN BAYER PROCESS ESPECIALLY IN PRECIPITATION.

Impacts of the organic impurities were summarized in Table-2 . The influence of the changing of physical properties of the liquor are measurable and commonly known.

The boiling point rise affects the flash heat recovery .Increasing of specific gravity and viscosity affect power consumption for pumping. For example 10 g/l of impurities changes density by 1% and increases power consumption by 1 percent.

Increasing of the viscosity of the liquor has a bad effect on the settling of red mud and fine alumina hydrate.

Foam formation is caused first of all by aliphatic carbonic acids (e.g. fatty acids) and foam can be stabilized by fine (hydrate or red mud particles.

It is very important from practical point of view, that organics are influencing, the solubility of other inorganic and organic salts. The influence of humic acids for solubility of Na_2CO_3 is shown on the **Figure 8/A**. This effect is very important relating to the salt removal. There is phenomena disturbing the soda salt separation from the high concentrated strong liquors, that is the so called gel-formation. The effect of humic acids on the coagulation of soda-containing strong liquor is shown on **Figure 8/B**.

Figure 8/A

The effect of humic acids on soda salt removal

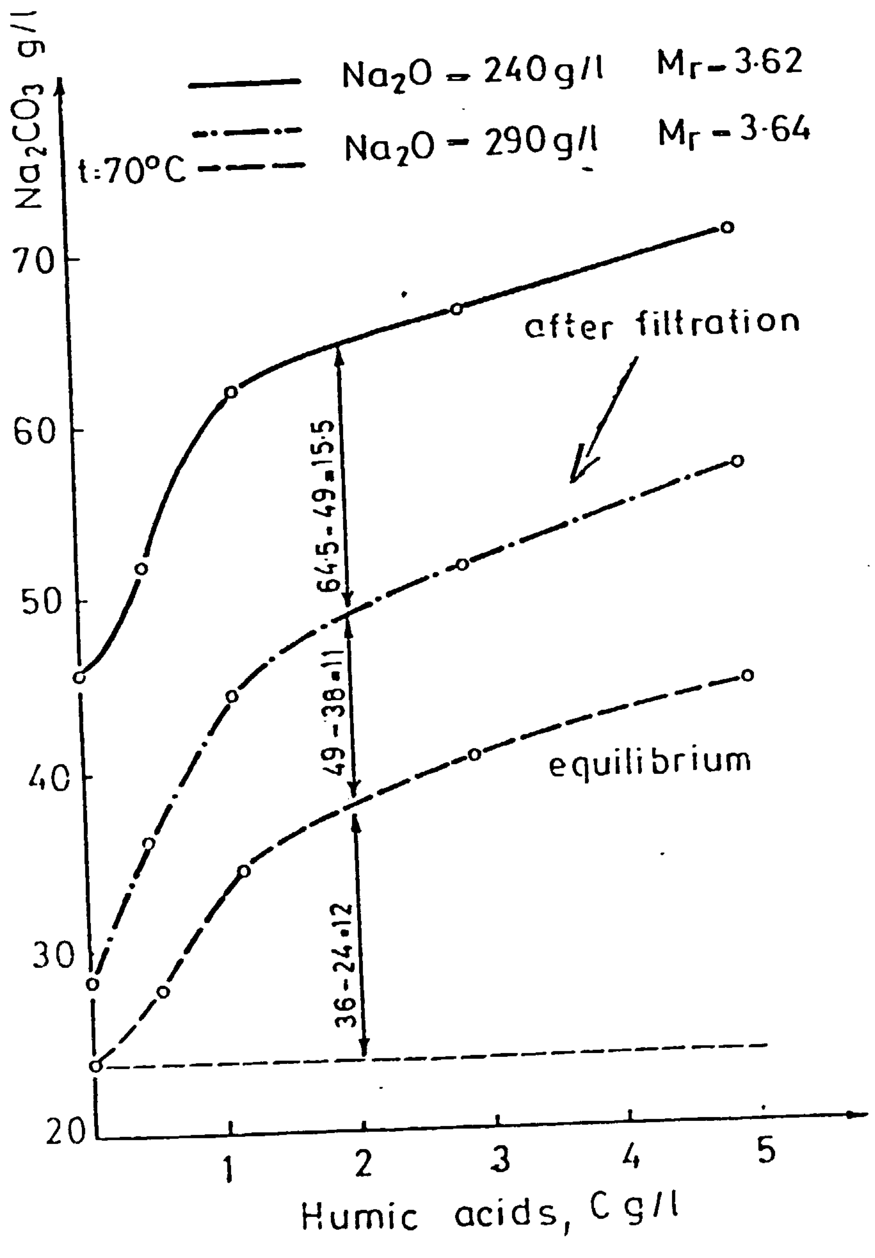
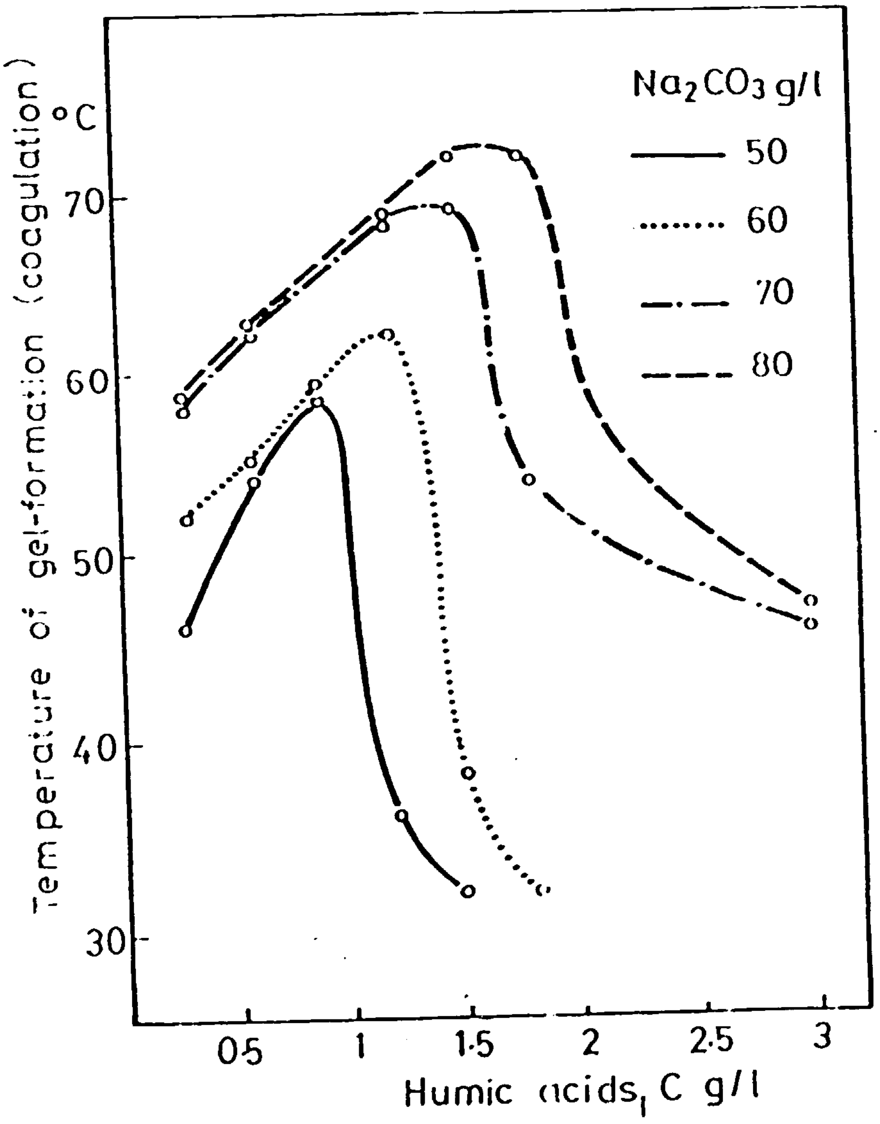


Figure 8/B

The effect of humic acids on the coagulation of soda-containing strong liquor. The temperature of gel-formation in the function of organic content and Na_2CO_3 content /Na_2O_{caust} 250 gpl, Al_2O_3 100 gpl/



The most difficult task to evaluate the influence of organics in precipitation. The well known adverse effects are summarized in **Table 6**. Many efforts were made for quantitative determination of the influences of different organic components. Yamada have investigated the influence of organics for the precipitation. Decreasing of the final molar ratio after the precipitation carried out at constant parameters with increasing organic content of the liquor is shown on the **Figure 9**. The data measured by Yamada and reproduced by ALUTERV-FKI Alumina Laboratory are showing the same tendency. The influence of humic acids for precipitation yield is shown on **Figure 10**. Decrease of precipitation yield was measured by ARCAN's Laboratory in presence of different low molecular weight organics too. The results measured at two different caustic soda concentration are summarized in Table 7. It should be underlined that different kinds of organics are influencing each other, that is why very difficult to determine influence of an organic compound separately.

Organics have an adverse effect on the gramulometry, and physical properties of product alumina hydrate too. Fine Na-oxalate crystals promote the crystallization of fine particles in precipitation, and oxalate containing agglomerated particles are less stable during calcination, significant adverse effect of humic acids can be observed essentially at higher concentration of these organics.

TABLE -6

- INCREASING OF THE SOLUBILITY OF ALUMINA.
- DECREASING OF THE ACTIVITY OF SEED SURFACE BY COVERING THE ACTIVE/ACIDIC POINTS ON THE SEED SURFACE.
- INCREASING OF THE FORMATION OF FINE PARTICLES, SEED EFFECTS OF THE SMALL Na OXALATE CRYSTALS
- DECREASING OF THE AGGLOMERATION RATE.
- INCREASING OF BREAK DOWN OF AGGLOMERATES DURING CALCINATION CAUSED BY INCLUDED Na OXALATE.
- HYDRATE FILTRATION PROBLEM CAUSED BY FINE Na OXALATE CRYSTALS..

Figure 9

FINAL MOLAR RATIO AFTER PRECIPITATION
vs. C_{org} CONTENT OF THE LIQUOR

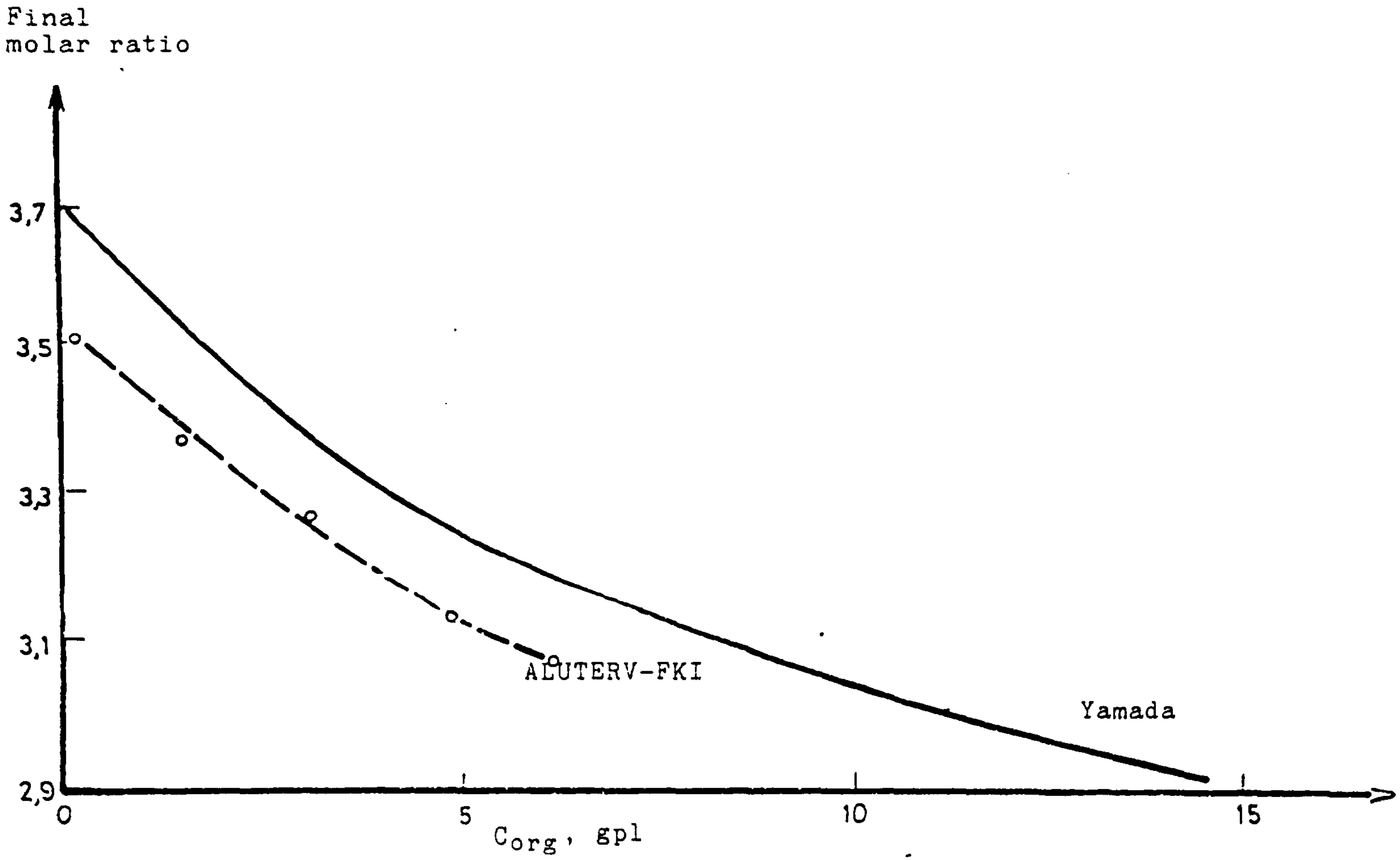


Figure 10

Precipitation yield vs. humic acids's concentration. /Na_2O_{caust} 135 gpl, initial molar ratio 1.75/

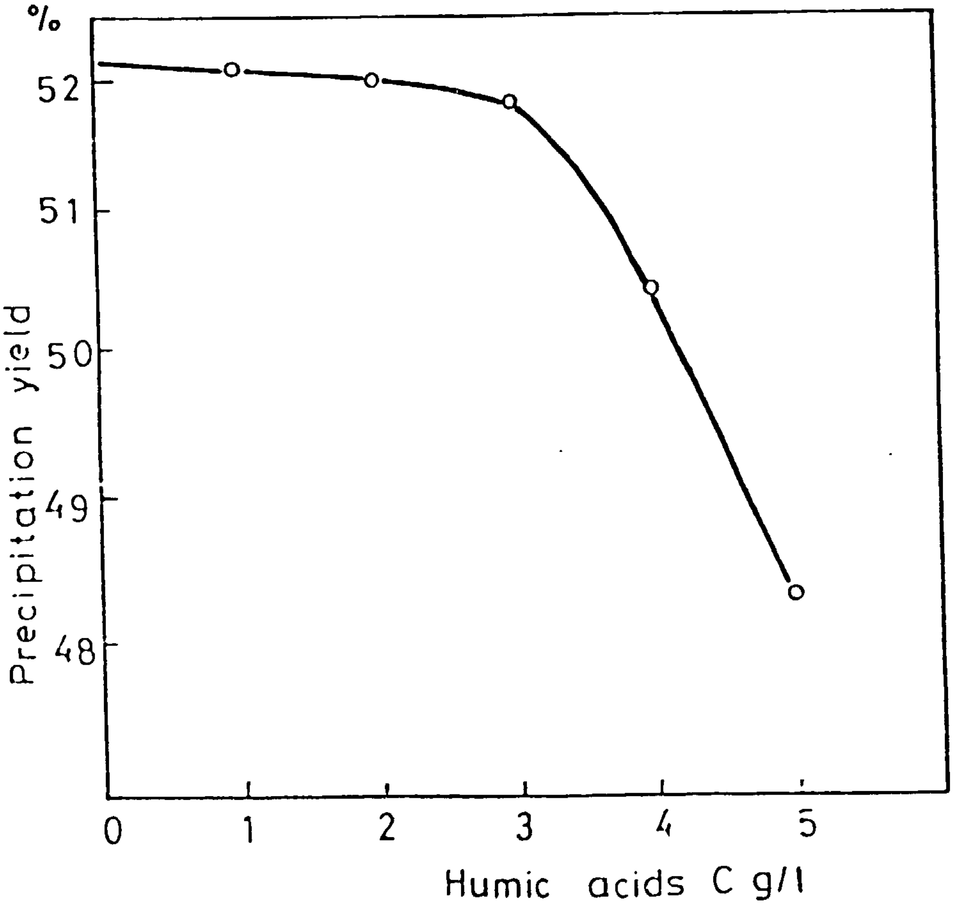


TABLE -7

DECREASE IN PRECIPITATION YIELD /gpl/per gpl ORGANIC COMPOUND EXPRESSED AS ORGANIC CARBON

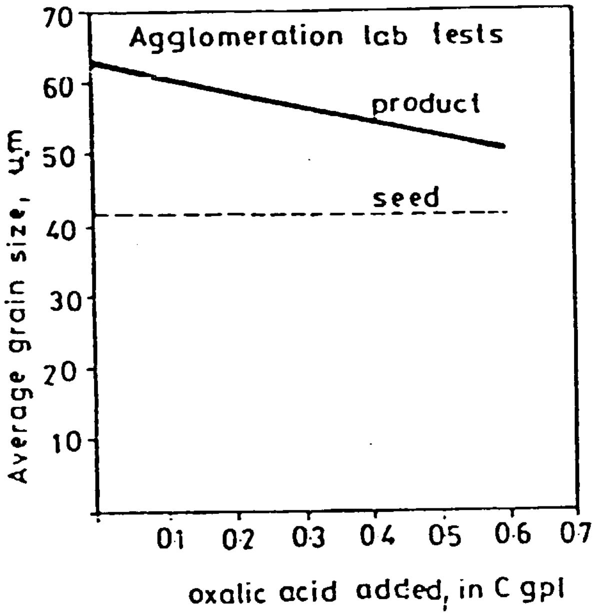
ORGANIC COMPOUND	CAUSTIC CONCENTRATION gpl Na_2CO_3	
	180	214
Sodium formate	0.65	0.72
Sodium acetate	0.33	0.46
Sodium succinate	0.20	0.33
Sodium lactate	1.21	1.35
3,5 dihydroxy benzoic acid	0.19	0.42
1,2,4, benzenetricarboxylic acid.	0.24	0.31
1,2,4,5 benzenetetracarbocyclic acid.	0.19	0.16
Benzenepentacarbocyclic acid	0.33	0.25
Initial ratio A/C	0.601	
Precipitation time	23 hrs.	
Temperature	70°C	55°C

The effects of oxalate and humate addition on the agglomeration are plotted on the Figure 11. It can be seen from the test results that average grain sizes of products were decreasing with increasing of organic addition in both cases. The attrition of the products obtained has been increased in both cases as well.

Sodium oxalate is the most detrimental component of the low molecular weight organics, which causes many problems because of its limited solubility. In many plant liquors sodium oxalate is present in a supersaturated state and after reaching a critical level it will be crystallized in form of very fine crystals. At a given caustic soda concentration and temperature the supersaturation concentration depend on the amount of stabilizing organic compounds (mainly humates). The supersaturation concentration of sodium oxalate versus total organic C content in various plant spent liquors are shown (by The and Bush) (5) in Figure 12. The behaviour of sodium oxalate at the Burntisland Alumina Plant is demonstrated on Figure 13 (6) for a one year period. It seems from the data, that there are 2-3 months periods of supersaturation, followed by sodium oxalate crystallization periods. The changing of the oxalate contents of the spent liquor, seed hydrate and product hydrate are shown on Figure 14.

Figure 11

Agglomeration laboratory tests with the process liquor of Almásfüzitő Refinery, at 70° C, with 0.3 seeding ratio and 8 hours retention time. Initial liquor: caustic soda: 222 gpl as Na_2CO_3, A/C ratio = 0.64



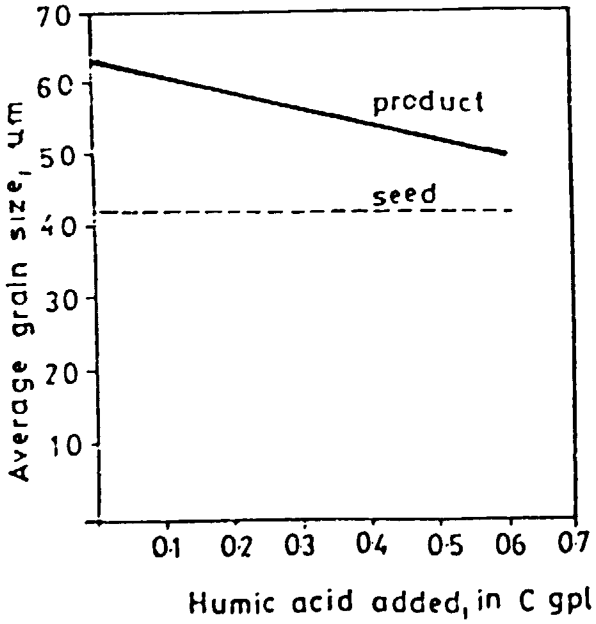
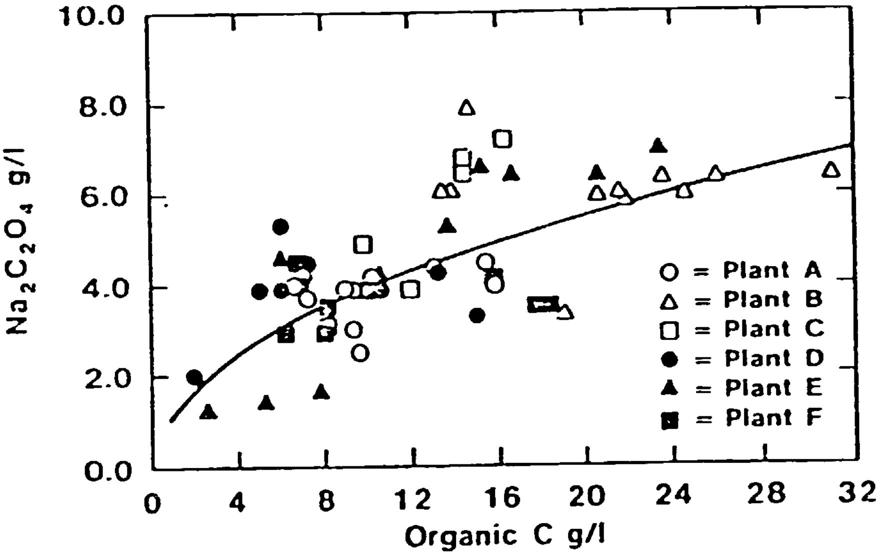
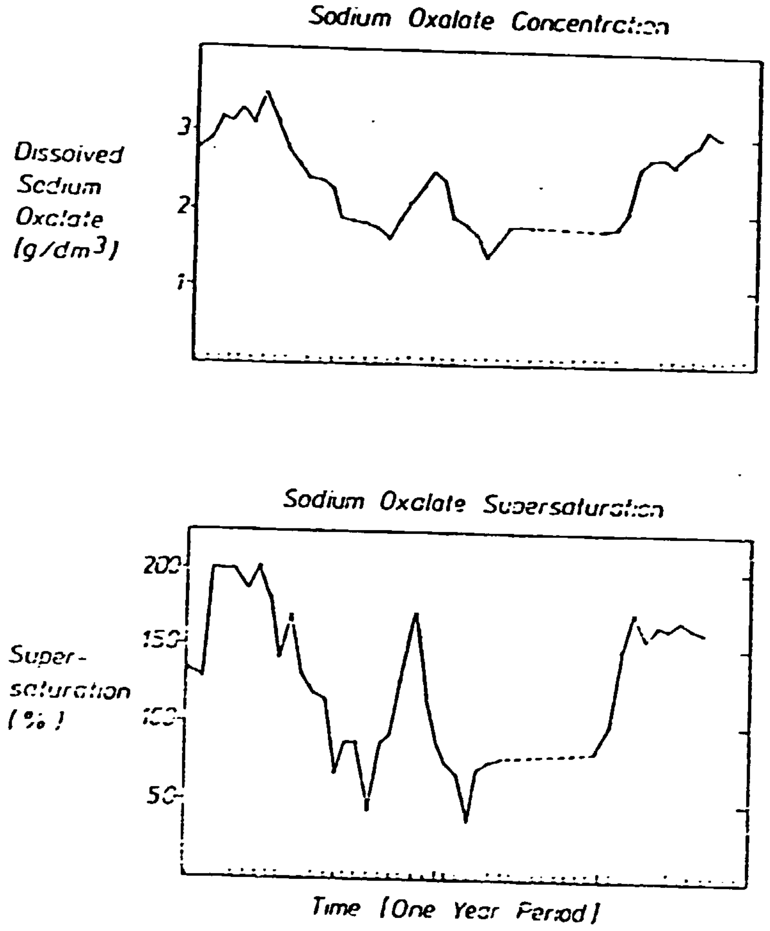


Figure 12



Steady state concentrations of $Na_2C_2O_4$ versus organic C in various plant spent liquors.

Figure 13

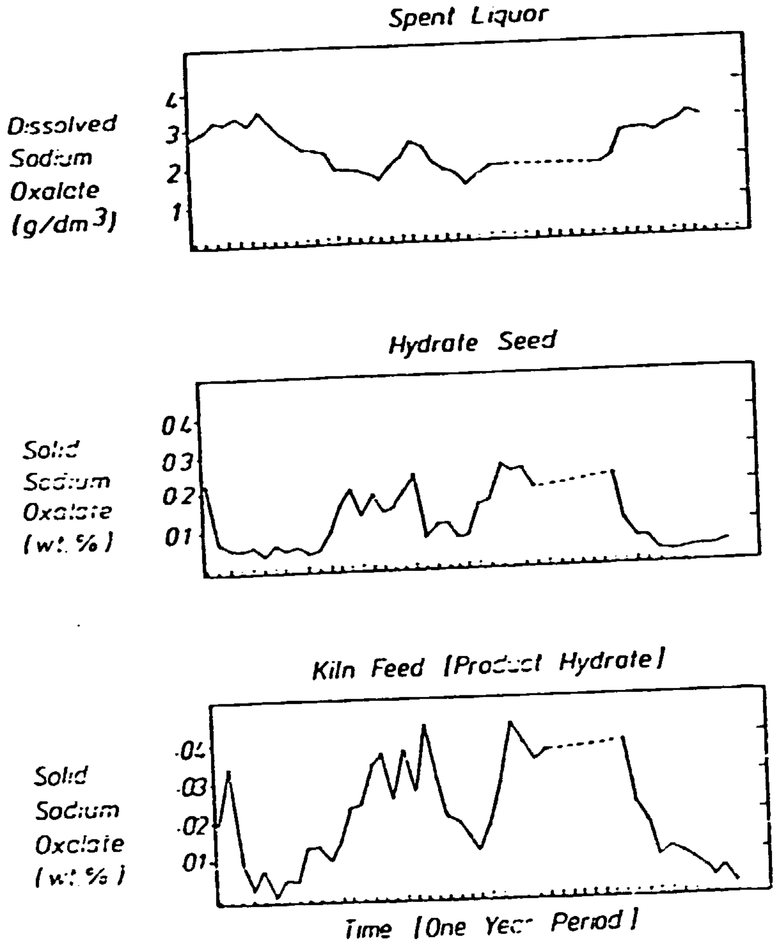


Sodium Oxalate Concentration

Sodium Oxalate Supersaturation

The Behaviour of Spent Liquor Sodium Oxalate Concentration Compared with the Calculated Sodium Oxalate Supersaturation

Figure 14


Spent Liquor

Hydrate Seed

Kiln Feed (Product Hydrate)

The Behaviour of Sodium Oxalate at the Burntisland Alumina Plant.

METHODS FOR ORGANIC REMOVAL

No method has been found until now applicable effectively and economically under plant conditions everywhere . Alumlina specialist could not develop a common method for the removal of the total quantity of organic impluritics.

Inspite of technical and economiccal difficuties of liquor purification, the research and development activity is focussed to this field.

The main aim of the liquor purification is to produce sandy type alumlina at the high liquor productivity. Several methods were developed for the organic control at laboratory or pilot plant scale, but only some of them is used in industrial scale. Most of the methods except liquor burning are specific only for a given part of organic present in the Bayer liquor.

<u>The barium aluminate process</u> was developed by Aluminium Pechiney (7) . The barium aluminate is dissolving in the caustic liquor. By addition barium aluminate to the Bayer hydrate wash water than to the spent liquor the barium carbonate and barium oxalate are precipitated. The precipitated salt after filtration is calcined together with alumina hydrate and barium aluminate can be recycled for the liquor purification..

Disadvantages of barium aluminate method are as follows :

It is specific for oxalate and carbonate, only very small part of other organics (e.g. humates) can be removed by this method and use of the barium alumlinate is dangerous from the point of view of labour safety. This method could not reach industrial use in abroad (except French Salindres refinery).

Alcoa chemie (former Giullini) developed a method for the removal of humates by magnesium compounds first of all by Kieserite ($MgSO^4 . H^2O$) (8).

According to the orginal procedure patented by Giullini , Kiserite is applied as digestion additive. The original procedure has been improved later and the Kiserite is added to the clear pregnant liquor to control filtration where better reductiobn can be achieved even at a much lower dosage rate . The layout of the process for a 600,000 ton /anum allumina plant is given on Figure-15 .

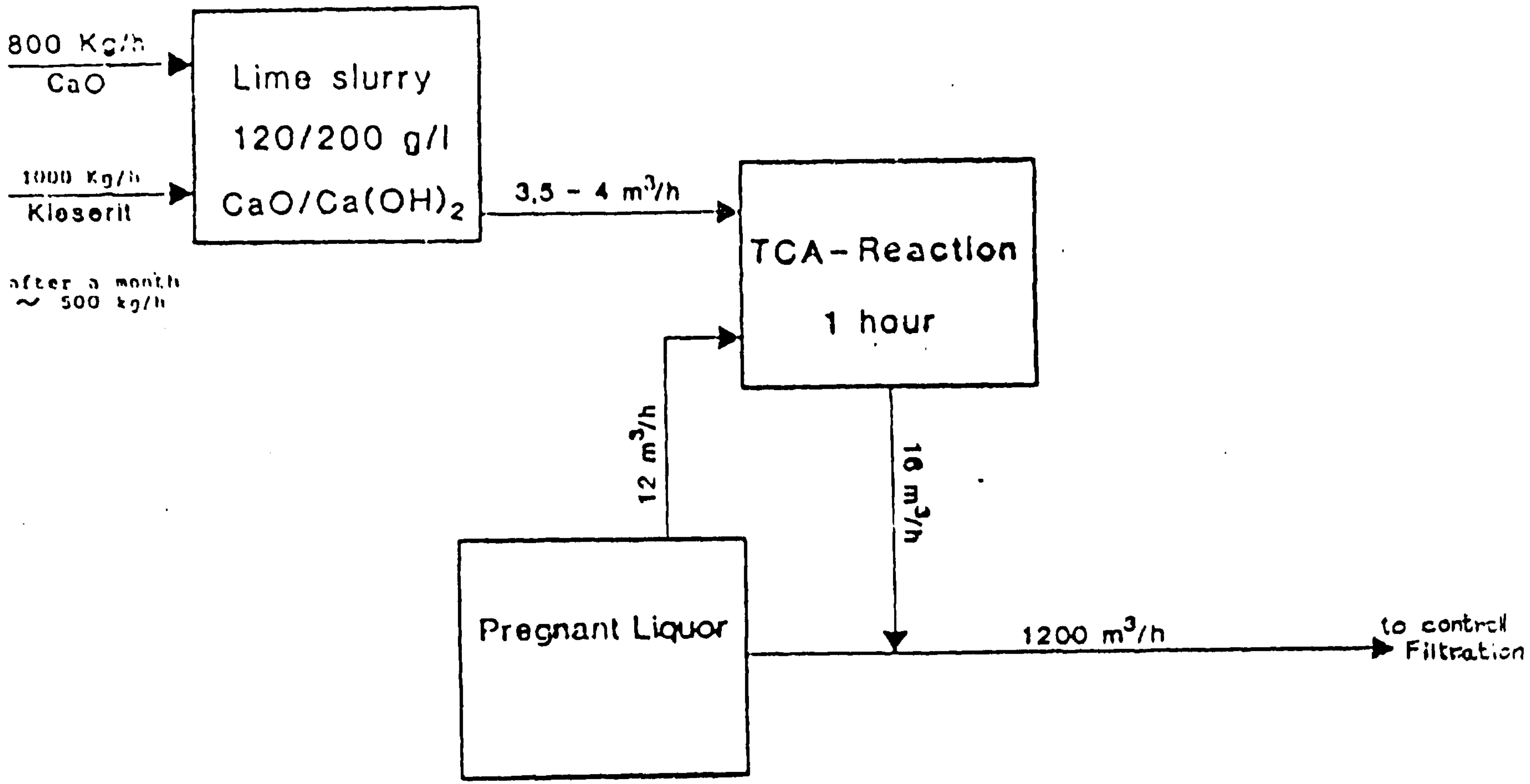
Using this new technological variant 24 ton/day Kiserite is required in the given case which can be reduced upto 12-16 ton /day.

The essence of the process can be summerized as follows:

- There is a co-precipitation of $Mg(OH)_2$ and $Al(OH)_3$. The $MgO : Al_2O_3$ ratio is varying in the range of 3:! to 15:1 depending on the quantity of the kiserite.

Figure 15

Pregnant Liquor 1200 m^3/h



The layout of the organics removal by kieserite addition for a 600 000 t/a alumina plant.

- Big flocs are build up with high specific surface area in the process of co-precipitation and these are able to adsorb organic impurities, mainly humates from the process liquor.

- Iron content of the pregnant liquor can be reduced also using this variant of the Kiserite addition.

The potential application of the kieserite at Alumafuzito Refiery (Hungary) has been studied in laboratory, Results of the laboratory investigation are summarized in the **Table-8**.

The process has been applied at Alcoa Chiemie, Ludwigshafen, at Kidricevo Alumina Plant in Yugoslavia and at Euroallumina Plant in Italy.

A new method has been developed in Hungary. The essence of the method is **Seperate Evaporation of Hydrate Wash Water** containing about 2 g/l organic carbon and 30-40 g/l caustic Na_2O (9-10).

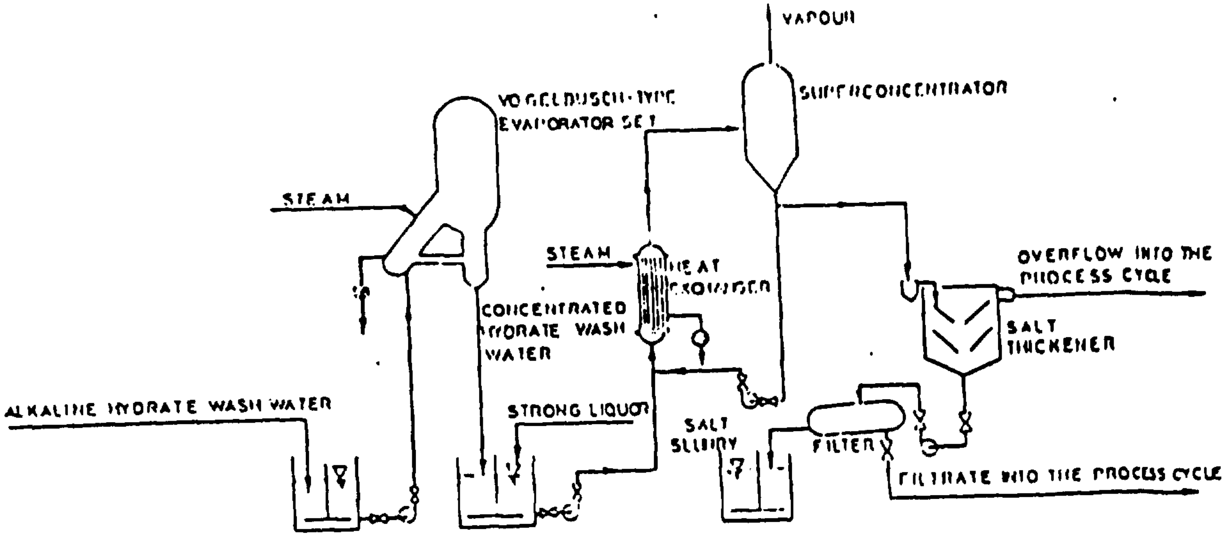
Organic carbon of 0.4-0.8 Kg/ton alumina can be removed by the evaportion of wash water upto 200-220 g/l caustic Na2O concentration.

The salt precipitated during the evaporation of the hydrate wash water contains 13-15% organic carbon and 70-80% of the total organics is present in form of sodium oxalate. The tecnological flow sheet is shown on **Figure-16**

TABLE-8
ORGANIC REMOVAL BY MEANS OF KIESERITE

LIQUOR	$MgSO_4.H_2O$ addition	Organic content gpl					
		C_{total}		C_{humate}		$C_{oxalate}$	
		Before	After	Before	After	Before	After
Pregnant Liqu. Na_2O 136gpl Mol.ratio 1.57	5	5.7	5.2	0.18	0.12	0.52	0.32
Evaporated Hyd.Wash. Water Na_2O 188 gpl Mol.Ratio 3.63	3	12.3	7.4	0.47	0.23	4.68	0.35
Filtered wash water Na_2O 194 gpl, Mol.ratio 3.82	3	9.3	7.8	0.30	0.17	0.84	0.33

Figure 16



TECHNOLOGICAL FLOW-SHEET OF ORGANICS REMOVAL FROM HYDRATE WASH WATER

An other group of the methods proposed for organics removal applies the **Wet Oxidation at different temperature using oxygen or air**.

Kaiser Aluminium has developed a partial wet oxidation process by dissolved oxygen (in the liquor) for destruction of high molecular weight compounds (Humates) (11). The continuous operation could not been justified economically inspite of the successful plant test.

New method has been developed in Hungary (9) using air for the wet at high temperature (240°C). The Wet oxidation does not remove the organic compunds from the process liquor but partly destroys them within the liquor. The HMW organic compunds can be oxidised partly to sodium carbonate, prtly to low mlolecaular weight organic sodium salts, which are (except sodium oxalate) usually less harmful than the higher molecular weight compunds.

The results of laboratory tests carried out by ALUTERV FKI laboratory are shown on **Figure- 17** It can be seen that this process is very effective in destruction of high nolecular weight humates. Flowsheet of the pilot scale wet air oxidation unit is shown on the **Figure-18**.

Plant scale wet oxidation unit (40 m^3/hr)designed by ALUTERV-DKI has been put into operation in 1986 at HINDALCO refinery.

Figure 17

Lab. scale wet air oxdiation at 240° C in the process liquor of Almásfüzitő refinery. Caust soda conc. 308 gpl as sodium carbonate, A/C = 0.29, initial total C_{org} 9.6 gpl, initial humic acid content 0.33 C_{org} gpl.

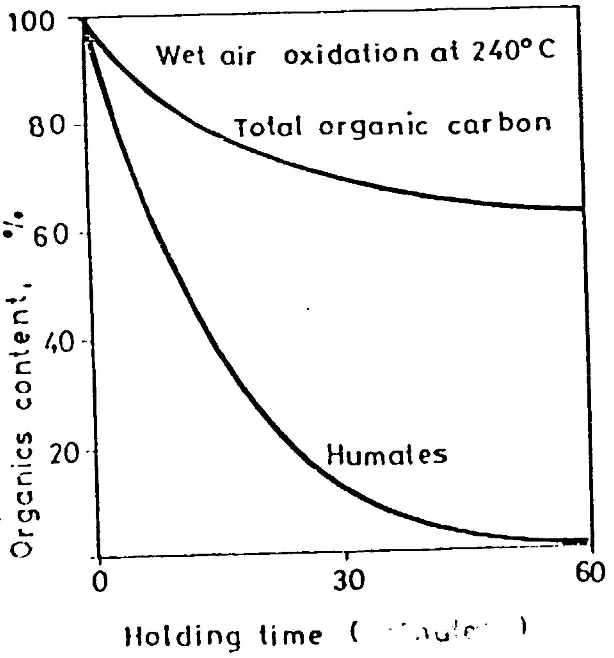
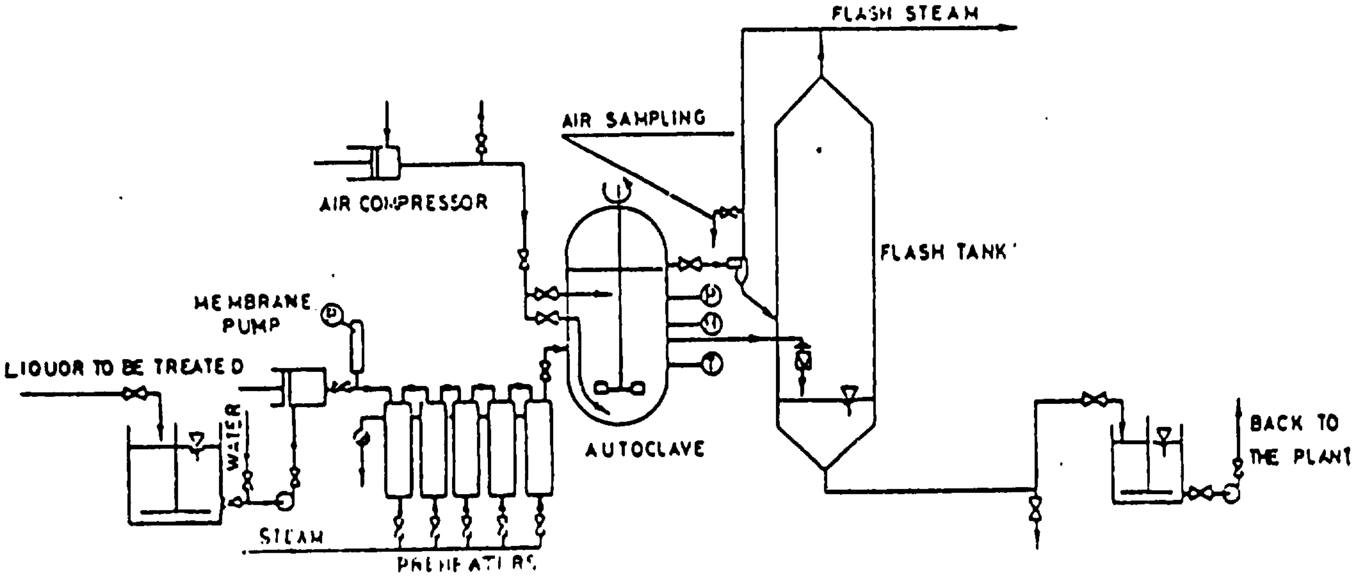


Figure 19



TECHNOLOGICAL FLOW-SHEET OF THE PILOT SCALE
WET AIR OXIDATION SYSTEM

During the first year of operation (in 1987) the total organic carbon content of the circuit was decreased by about 20% and the humate content by about 50%. In spite of these results lot of operational problems have been expeinced in filterability of fine dispersed, oxalate containing salt (formed after flashing) and cooling of the oxidised liquor. Wet air oxidation plant unit is in operation time to time only to control the level of humates in the circuit.

Showa Denko has developed the so called Liquor Burning Process (12). Bayer plant liquor and alumina hydrate is mixed and than calcined at the temperature of about 1200 C. The total amount of the organics is burned and the solid Na aluminate gained from this process after dissolution can be used advantageouly for producing special white hydrate. This method is used in plant scale but it is very expensive due to high energy consumption.

The latest development in the field of organics removal is the addition of synthetic cationic polymers to precipitate the humate content in the form of insoluble compounds NALCO Chemical company together with Kaiser Aluminium has patented (13) this new process.

Cationic polymer can be added at the dilution of blow off slurry after digestion or to the alumina hydrate slurry before digestion or to the alumina hydrate slurry before filtration of product hydrate. Solid phase is required to collect the precipitated organics. The rate of dosage is usually 20-50 g/m_3 .These cationic polymers can precipitate mainly humates and other colouring components.

This type of additives is used in plant scale at some alumina reineries. According to our information it is used continuously at Euroallunina Plant (Italy). This chemical is used at Ajka alumina plant (Hungary) for production of special white alumina hydrate.

A new chemical has been developed by Nalco Chemical Company which is a mixture of specific nonionic and anionic surfactants **Crystal Growth Modifier** or **CGM** is the name of this product due to its very advantageous impacts for coarsening of alumina hydrate in precipitation. This chemical additive is now being used in number of bayer alumina plants (Its commertial name is NALCO 7837).

The mechanism by which the crystal growth modifier works is explained as follows (13) :

- Increasing of the solubility of sodium oxalate.
- Coarsening the crystallized sodium oxalate, eliminating the seed effect of the fine particles.
- Promotion of the crystal growth of the alumina hydrate and agglomeration of the fine particles.

Sodium oxalate crystals usually precipitate from Bayer liquor in the form of fine needle shaped structures, usually less than 15 micron lengths. Sodium oxalate clusters as collect the precipitated organics. The rate of dosage is usually 20-50 g/m$_3$ .These cationic polymers can precipitate mainly humates and other colouring components.

This type of additives is used in plant scale at some alumina reineries. According to our information it is used continuously at Euroallumina Plant (Italy). This chemical is used at Ajka alumina plant (Hungary) for production of special white alumina hydrate.

A new chemical has been developed by Nalco Chemical Company which is a mixture of specific nonionic and anionic surfactants Crystal Growth Modifier or CGM is the name of this product due to its very advantageous impacts for coarsening of alumina hydrate in precipitation. This chemical additive is now being used in number of bayer alumina plants (Its commertial name is NALCO 7837).

The mechanism by which the crystal growth modifier works is explained as follows (13) :

- Increasing of the solubility of sodium oxalate.
- Coarsening the crystallized sodium oxalate, eliminating the seed effect of the fine particles.
- Promotion of the crystal growth of the alumina hydrate and agglomeration of the fine particles.

Sodium oxalate crystals usually precipitate from Bayer liquor in the form of fine needle shaped structures, usually less than 15 micron lengths. Sodium oxalate clusters as large as 400 micron are formed under the influence of 20 mg/l CGM additive.

The shape of the sodium oxalate clusters is shown in **Figure-19**.

The impacts of the CGM for the coarsening of alumina hydrate are shown in **Figure 20/A** (in plant liquor), **Figure 20/B** (clean synthetic liquor) **Figure 20/C** (synthetic liquor and 0.5 g/l sodium humate).

Due to coarsening of the alumina hydrate in presence 15-20 gm/m3 CGM by changing the operating parameters (temperature, seed ratio) yield of precipitation can be increased by 6-15% Plant results where CGM was used and operating parameters were changed are shown in **Table-9**.

The ssynthetic polymers have a good potential both for organic removal and for the conversion of floury aluminba to sandy alumina. It showld be mentioned that they can be used praactically without any investment cost.

Figure 19

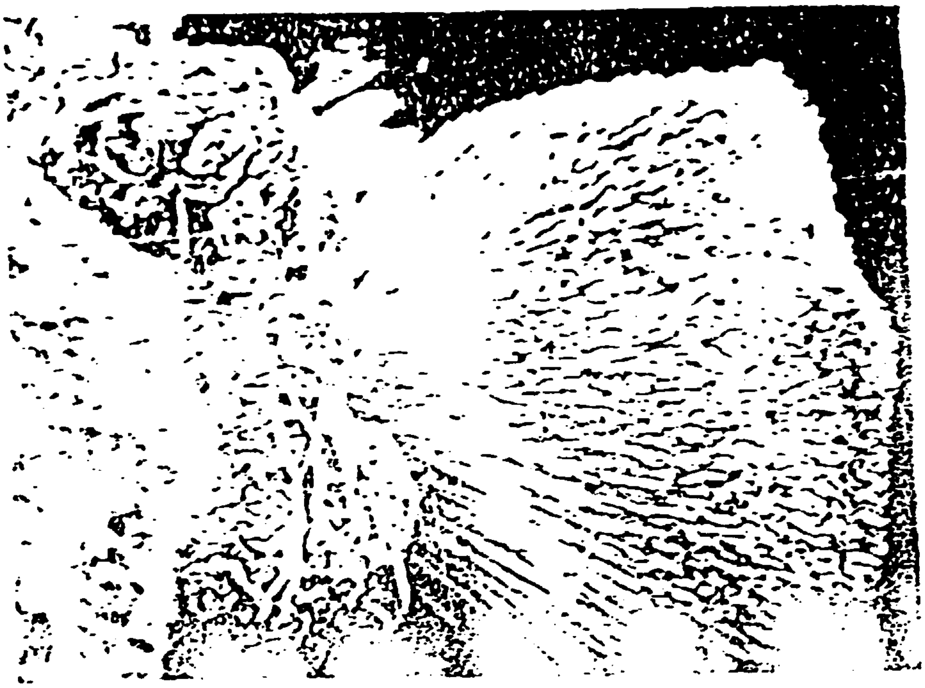


Figure 20/A

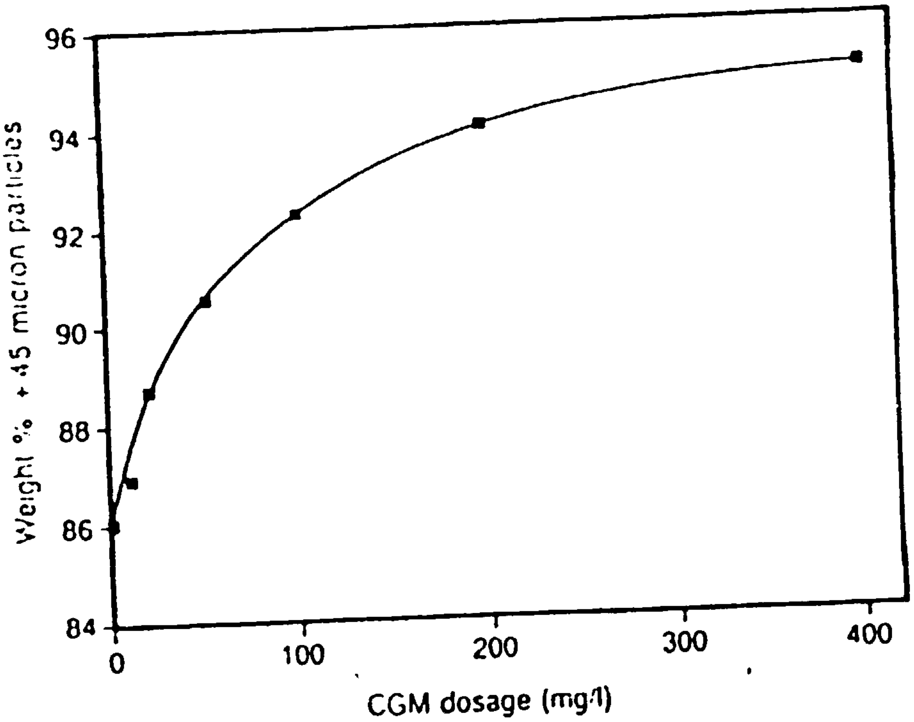


Figure — Yield of +45 μm particles (by mass) as a function of CGM dosage, using actual plant liquor and seed.

Figure 20/B

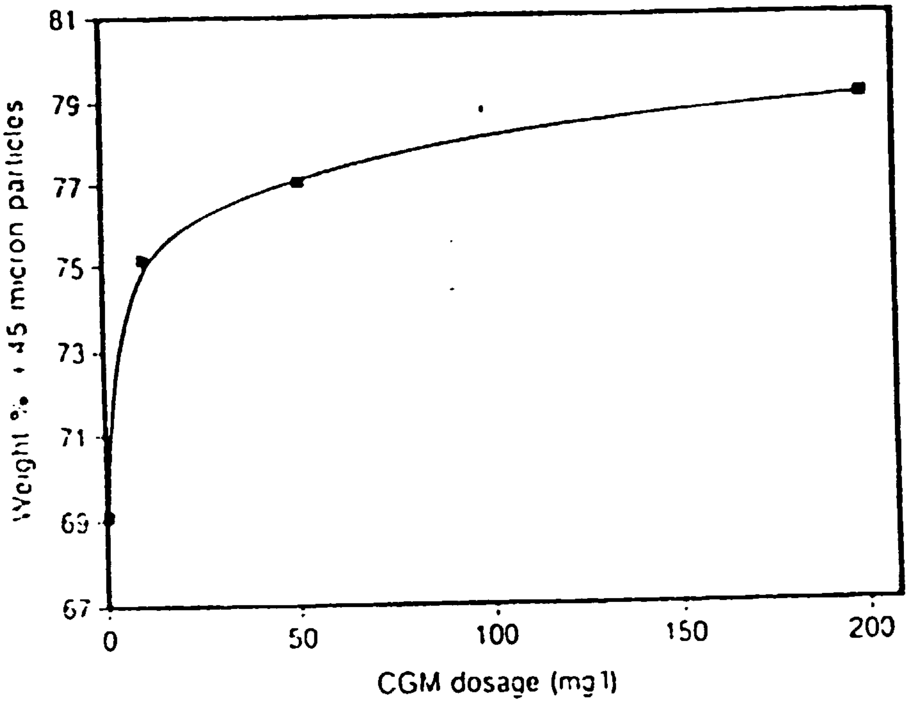


Figure · — Yield of +45 μm yield as a function of dosage in clean liquor (coarse seed).

Figure 20/C

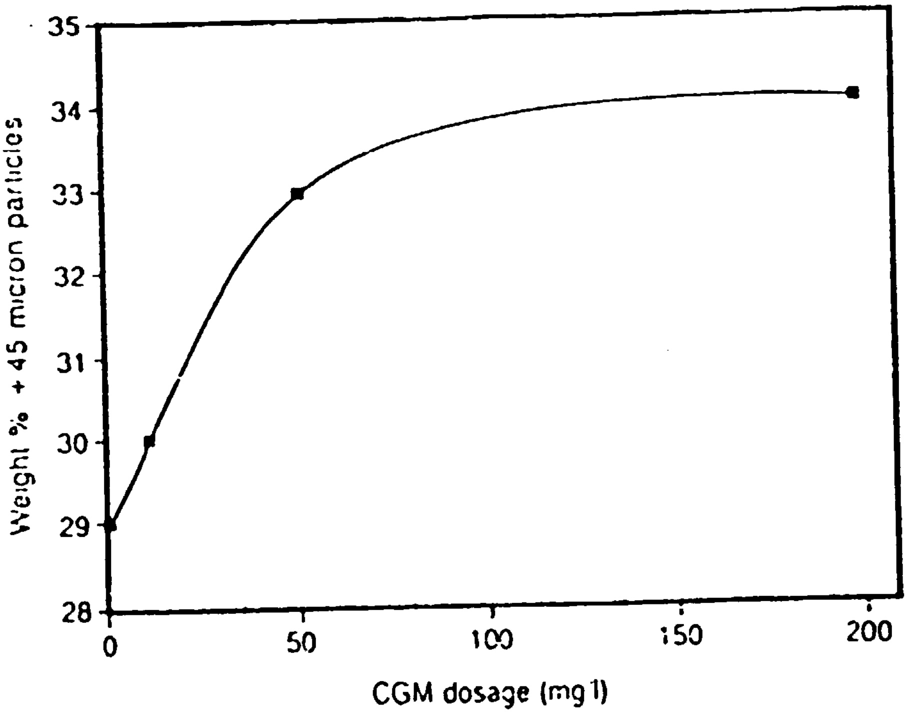


Figure — +45μm yield as a function of dosage in clean liquor with 500 mg/l sodium humate (fine seed).

Table 9

PLANT RESULTS WHERE CGM IS USED AND OPERATING PARAMETERS CHANGED TO IMPROVE LIQUOR PRODUCTIVITY.

	Plant Type	CGM Dosage mg/l	Liquor . temp. redu. ^{0}C	Increase in seed charge %	Precipi-pitation Yield %
Plant A	Batch	15-20	8	33	6-8
Plant B	Batch	16-20	none	50	7-9
Plant C	Contin-uous.	20	3	55	12-15

CONCLUSIONS.

- Different types of bauxite contain different quantity of the extractable organics.

- Organic contents of ores is variable depending on the geographical location and on the depth inside the ore body. Distribution of the extractable organic content should be determined based on the bore hole samples for the planning of mining activity and processing of given bauxite deposit.
- Levels and compositions of organics are different in process liquors of different alumina plants. Total organic levels of the Indian allumina refineris are in the medium position in comparison with these of the other alumina refineries abroad, but the levels of the sodium oxalate and humate are relatively high (except Nalco refinery where the organic level is extremelly low).

- The sodium humate and sodium oxalate are the most harmful components of organics. These compounds affect adversely mainly the precipitation process and the salt seperation too. These organic compunds are to be controlled first of all.

- Organic balances are to be calculated before the selection of the proper method to control the organics.

PROPOSALS

- Determination of distribution of extractable organics in the Mainpat bauxite deposit based on bore hole samples at different depths.

- Finalisation of the total organic balances for the Balco and Nalco alumina refineries.

- Change of the use of the starch with use of synthetic flocculant to decrease the total organic and oxalate input in plant liquor.

- Increase the tempperature of strong liquor at the salt seperation to avoid the gel formation (BALCO).

- Use of crystal growth modifier to compensate the adverse effect of oxalate and to increase the liquor productivity (BALCO).

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Annexure-6

RECORD NOTES OF THE WORKSHOP ON" ORGANIC CONTAMINATION IN BAYER CYCLE"

The workshop on impact of organic constituents on Bayer cycle of alumina extraction with method of chemical analysis for determination was held on 1st February 1994 in which the speakers were Dr.J.Zoldi and Dr. Ibolya Molnar Perl,UNIDO experts.

The outlines of the presentation were as follows -

- Nature of organic constituents of Bayer cycle with the appropriate method of determination /analysis.
- Extraction and formation rates of organics in the process of digestion with composition of type of organic in different alumina plants.
- Organic balances detemination of BALCO alumina plant.
- Adverse effects of different compounds in Bayer process especially in precipitation with methods to control of organic imputities.

The workshop had the technical session of discussions of Unido experts with participants of various existing alumina plants like BALCO, HINDALCO and NALCO.

The role of organics for deciding the type of processing with effective measures in case of east coast bauxite based on which new alumina refineries are expected. The participants from Larsen and Toubro had been aprised with C-organic role in bauxite mining and its probable effects on the process cycle of refining. This awareness regarding this has been realized very well by them right in the inception /planning and characterisation of bauxite based on which new alumina refinery is expected.

In the afternoon sesseion the visit in different departments and to make the participants to be aware of the capabilities of JNARDDC in the field of alumina, aluminium, and analytical techniques.

The concluding session of round table conference was presided over by Director and CTA with participants and UNIDO experts in which all participants shared their experince in plant critical situation due to organic with the possible and applied measures to control. All participants had been furnished with the theoritical understanding of the plant problem and the applied control measure. The participants had been convinced to under take the projects on the subject by the center in near future.

In case of Balco refinery the change of starch as settling aid to synthetic flocculant has been suggested as an immediate measure. The characterisation of Mainpat bauxite borehole samples at different depths is necessary seeing the present condition of the process liquor. The hydrate wash water evaporation for organics control had been also considered the measure to control.

It was concluded that there is no uniform/general solution for organic removal. It is dependent on type of bauxite, technology and process conditions . JNARDDC will be able to provide methods of total analysis of bauxite, liquor and process variants which are the means to handle the organic impurities problem. Hence it is recommended that co operative project of alumina refineries can be prepared for implementation of the organic problems in the process liquors.

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3.	Mr. R.C.Shrivastva,	HINDALCO.
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5.	Mr. V.K.Sood,	NALCO.
6.	Dr.B.K.Satpathy,	NALCO.
7.	Mr.P.Ashwadhama,	L & T.
8.	Mr. M.Kapadia,	L & T.

LIST OF PARTICIPANTS ON IST FEB 94 WORKSHOP
ON
IMPACT OF ORGANICS ON BAYER CYCLE AND THEIR CONTROL

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Annexure - 7

21st January 1994

Discussion with representatives of BALCO ALUMINA PLANT, on the salt removal from the Bayer circuit.

Participants

JNARDDC

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Mr. R.N. Goyal, Head of Alumina Department
Mr. H.K. Chandwani, Scientist, Alumina Department.

BALCO ALUMINA PLANT

Mr. A. Mehrotra, Manager (Alumina Technical)

Mr. R.S. Singh, Dy. Manager (Operation)

Mr. O.N. Sharma, Asst. General Manager (R & D)

Subject of the discussion

The problems arising at V_2O_5 and Na_2CO_3 containing salt separation at Balco Alumina Plant were discussed.

Gel formation was observed in the highly evaporated (Caustic soda concentration about 240 gpl Na_2O) liquor at the salt separation. It was supposed that this phenomena is connected with organic compounds present in the Bayer liquor mainly with Na-humates. Increasing the temperature of the evaporated liquor (up to 100 - 105°C) was proposed, based on the Hungarian plant experiences and the laboratory investigations carried out at ALUTERV-FKI Laboratory. Detailed investigation of organic contents of Mainpat bauxite, which is to be processed was also proposed.

ANNEXURE - 8

BAUXITE SAMPLES FOR C_{org}. & EOC DETERMINATION

[A] Lateritic Bauxite Profile - PUNCHPATMALI - NALCO.

[FOR Corg. DETERMINATION]

Appron

1. Sample No. 2 - At 13 m depth
2. Sample No. 5 - At 8 m depth
3. Sample No. 8 - At 5 m depth
4. Sample No. 9 - At 2.5 m depth
5. Sample No. 10 - At 1 m depth

[B] Individual Bauxite Deposit of India

[For Corg.]

6. Mainpat - Sample No. 69
7. Amarkantak - Sample No. 27
8. Kutrumali - Sample No. K1[A]
9. Samri - Sample No. 911
10. Lohardaga - Sample No. 31

[C] Bauxite samples for EOC - DETERMINATION

11. Panchpatmali (Eastern Ghats) - Sample No. 38
12. Mainpat (Central India) - Sample No. 69