EXPERIENCES WITH GAS SUSPENSION CALCINER ALUMINA

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ABSTRACT

Hindustan Aluminium Corporation Limited (HINDALCO) has installed and commissioned the first ever GAS SUSPENSION CALCINER (GSC) for their Alumina Plant in July, 1986 with a rated nominal capacity of 850 MTPD Alumina. This has been done in the course of their modernization cum expansion programme of the facilities. The Calciner has been designed by Messrs F.L. Smidth & Co. A/S of Denmark and has replaced three conventional Rotary Kilns operating till then.

The comparative properties, both physical and chemical have been discussed for GSC vis a vis Rotary Kilns. Due to change in granulometry and lower Alpha content of the product the Plant's Smelter located at the same site has been experiencing operating problems due to hard crust formation. The problems are being studied and by doing certain modifications in the GSC it has been possible to achieve upto 15 per cent Alpha content against the original 3 to 5 per cent Alpha content. Crusting problems are being further evaluated for possible causes and solutions.

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1.0 INTRODUCTION

Hindustan Aluminium Corporation Limited (HINDALCO) is operating the largest integrated aluminium complex in India at Renukoot, U.P. with an installed capacity of 300,000 tonnes per year Alumina, 150,000 tonnes per year primary aluminium metal and semifabricated products, E.C. grade properzi rods, Rolled sheets and extruded products. The plant was started in the year 1962 with a capacity of 40,000 tonnes per year alumina and 20,000 tonnes per year metal. During the subsequent years the capacity was increased in 4 phases to the present capacity. HINDALCO also has the unique advantage of having its captive power generation (Thermal) with a capacity of 280 MW.

2.0 BRIEF HISTORY

While expanding the plant HINDALCO has been very selective about technology and equipment, keeping in view the most important aspects of energy conservation, pollution control, latest hi-tech techniques and automation. The alumina plant had 3 rotary kilns with a total capacity of 600 MT per day alumina. While increasing the capacity detailed technical and economic evaluations were carried out with all available world wide technologies and for alumina calcination it was decided to go for a Stable Gas Suspension Calciner with a capacity of 850 MT per day. The Calciner was commissioned in July, 1986.

3.0 NOTATIONS

Standard notations used in this paper represent :

i. GSC : Gas Suspension Calciner
ii. SSA : Specific Surface Area m^2/gm (BET method)
iii. L.O.I. : Loss on Ignition (300°C - 1200°C)
iv. Mesh : Standard Tyler mesh
v. α Alumina: Alpha Alumina

4.0 SELECTION OF CALCINING EQUIPMENT

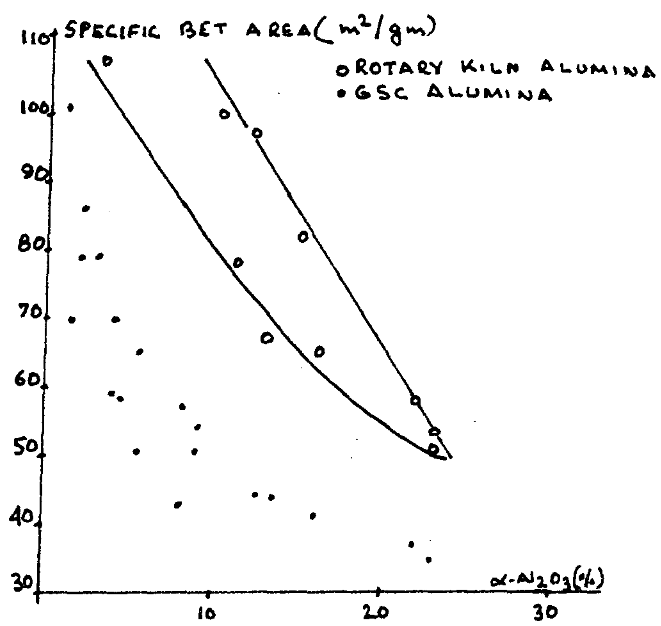
4.1 HINDALCO has studied in detail the various possibilities of selecting a suitable calciner for its alumina plant so as to achieve maximum benefits. This included visits to some installed stationary calciners of Lurgi, Alcoa, FCB and the pilot plant of Messrs F.L. Smidth & Co. Retrofitting of the then existing rotary kilns was also considered. After working out detailed techno-economic analysis it was decided to go for the Gas Suspension Calciner offered by Messrs F.L. Smidth & Co., on the basis of the following guarantee figures provided by them:

TABLE 1

* Production Capacity TPD	:	850
* Maximum Capacity TPD	:	1100
* Specific Fuel Consumption	:	740 KCal/Kg
* Hydrate Moisture	:	10 %
* Alpha - Alumina	:	2 - 10% Normal (15% Maximum)
* BET Surface Area	:	50 - 80 M^2/gm
* Power Consumption	:	19 kWh/ton
* Particle breakdown	:	3 %
* L.O.I.	:	0.4 - 0.9 %
* Dust - emission from stack	:	80 Mg/NM3

4.2 An agreement was signed with the party in February, 1984. Only those equipments which were sophisticated and absolutely necessary to be imported were purchased from the collaborators. The balance majority equipments were either procured or fabricated in India. The comparison of alumina properties obtained in rotary kilns with expected alumina properties from GSC, as given by the collaborators is given below:

FIGURE 1



4.3 The calciner was commissioned in July, 1986 and the performance tests was completed by September, 1986.

5.0 PERFORMANCE OF CALCINER & QUALITY

The main aims of selection of the calciner was with regard to the following properties and expected improvements:

i.	Specific heat consumption	:	740 KCal/Kg Alumina
ii.	Alpha Alumina	:	2 - 10% Normal (15% maximum)
iii.	L.O.I.	:	0.4 - 0.9 %
iv.	Particle breakdown	:	3 %
v.	Specific Surface Area	:	50 - 80 M^2/gm.

Apart from the above due to the strict control of process conditions HINDALCO has been able to reduce the soda content in the alumina from 0.4% of rotary kilns to 0.3% in the GSC. The silica content in the product had also shown improvement from 0.028% to 0.02%. The guaranteed oil consumption was achieved at a temperature of 950 - 1000°C in the calcining zone.

Figure - 2 shows the flow diagram of the Gas Suspension Calciner

5.1 The other significant advantages obtained in the Calciner are as under: (i)

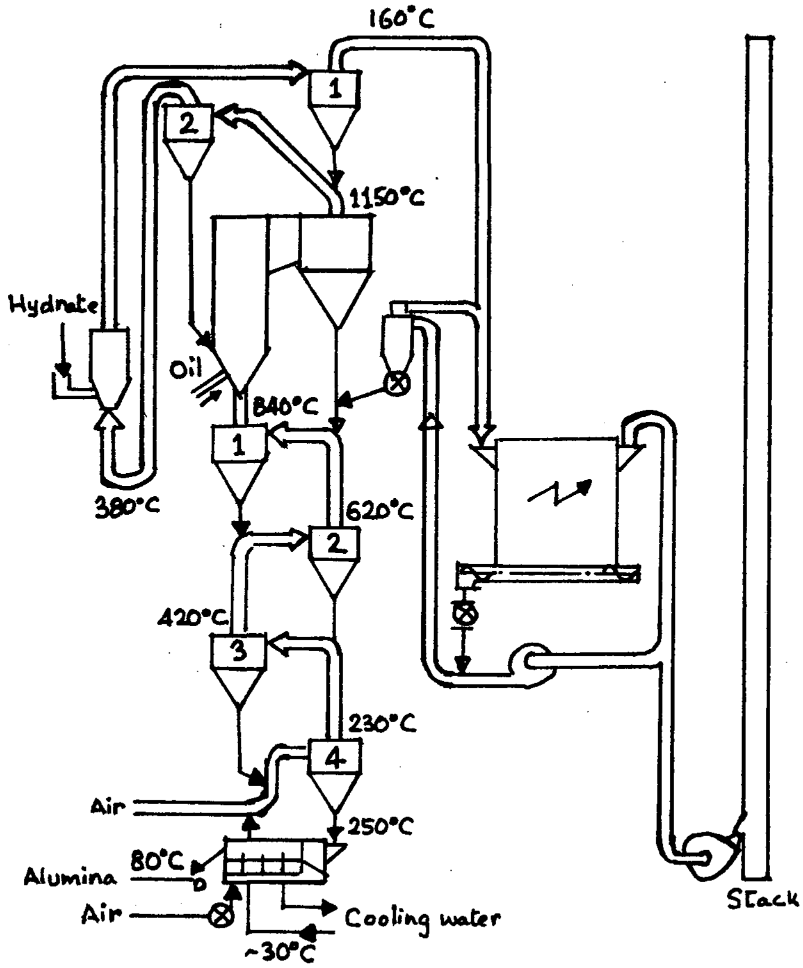
i. Low maintenance cost owing to simple design and operation.

ii. Easy control of product specifications by adjusting the calciner temperature.

iii. Low specific power consumption of about 17 kWh per ton, due to small overall pressure drop and low specific air consumption.

iv. Low in-plant solids inventory minimizing production loss during start-up and shut-down operations caused by power failure.

FIGURE 2



Flow Sheet of stationary Gas Suspension Calciner process for Alumina.

5.2 The actual performance of the calciner with certain relevant figures have been as under:

TABLE 2

Date	PO 4 outlet Temperature °C	LOI %	Alpha Alumina %	PO 1 M.Bar outlet	Inlet ESP °C
27.7.86	1150-1225	0.5	16	60	213-190
28.7.86	1150-1240	0.44	14	55	210-220
29.7.86	1150-1210	0.40	15	55	180-210
23.7.86	1100-1150	0.5	3	50-52	190-240
02.8.86	1050-1100	1.08	2	55-60	185-210
25.9.86	940-980	0.93	3	54-55	175-180
26.9.86	930-940	1.09	3	55-58	180-200
27.9.86	950-975	0.91	3	56-58	190-200
28.9.86	920-960	0.91	4	52-54	185-210
1.10.86	940-975	1.21	2	50-65	185-195

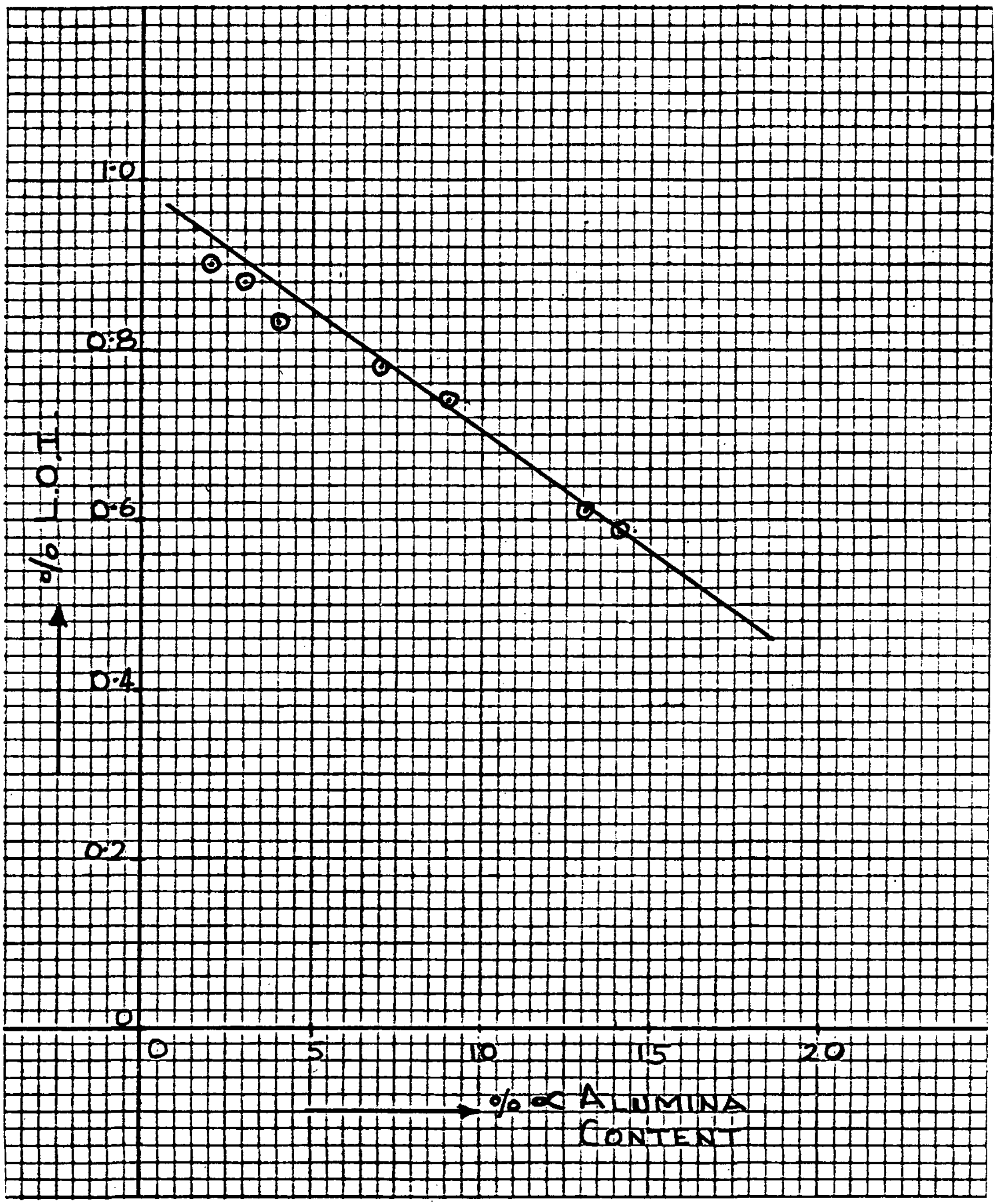
5.3 Table 3 gives analysis of HINDALCO's Rotary Kiln Alumina

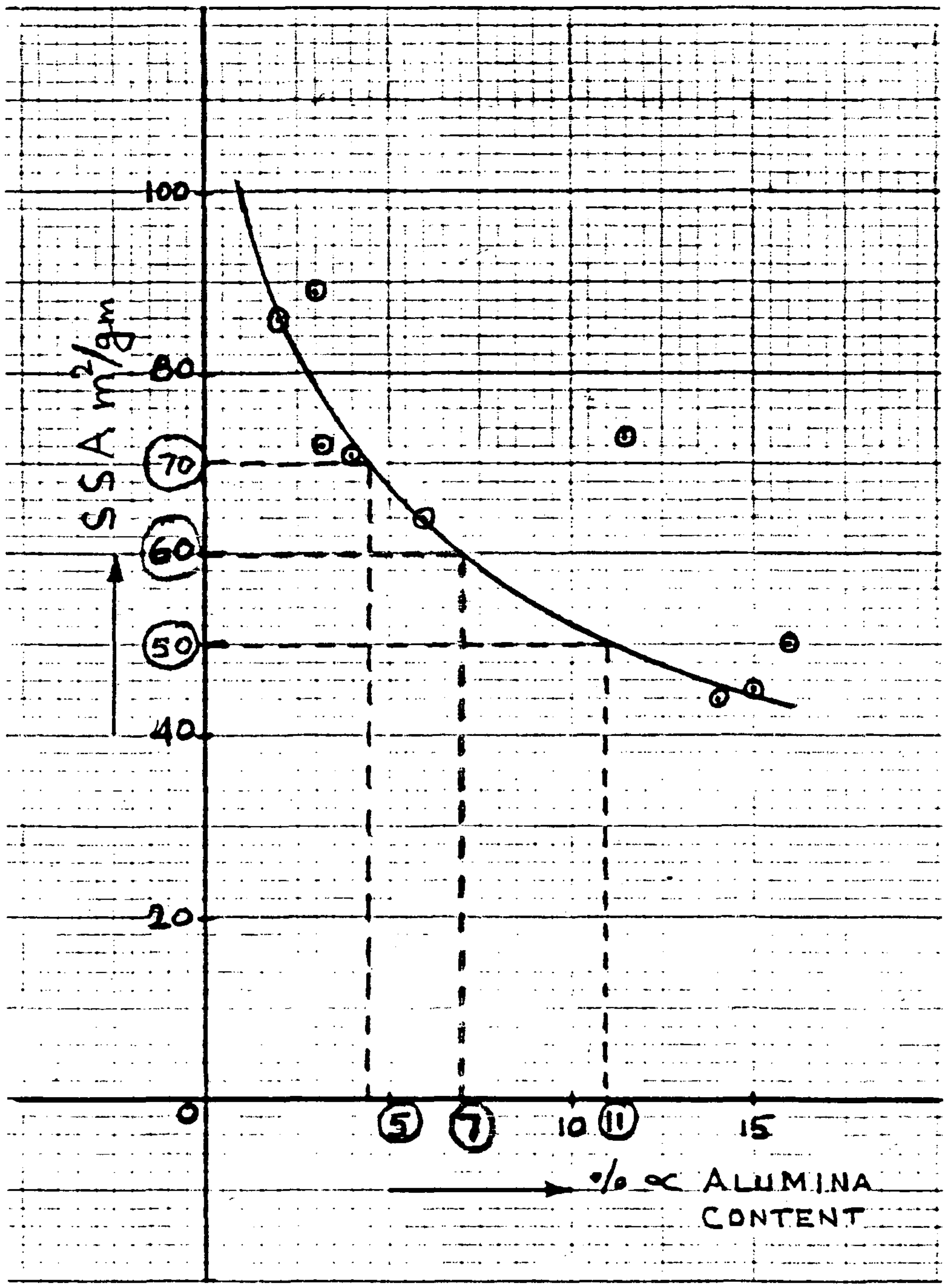
TABLE 3

Properties (%)	March 1986	August 1982
SiO_2	0.021	0.016
Na_2O	0.38	0.73
Fe_2O_3	0.019	0.019
L.O.I.		1.26 wt.% (0-300°C) 0.85 wt.% (300-1200°C)
Alpha content	13.00	13.1
+ 100 mesh	2	0.2
+ 200 mesh	34	37.5
+ 325 mesh	54	45.5
- 325 mesh	10	16.8
V_2O_5	0.013	0.008
P_2O_5	0.002	0.003
CaO	0.033	0.023
TiO_2	0.002	0.003

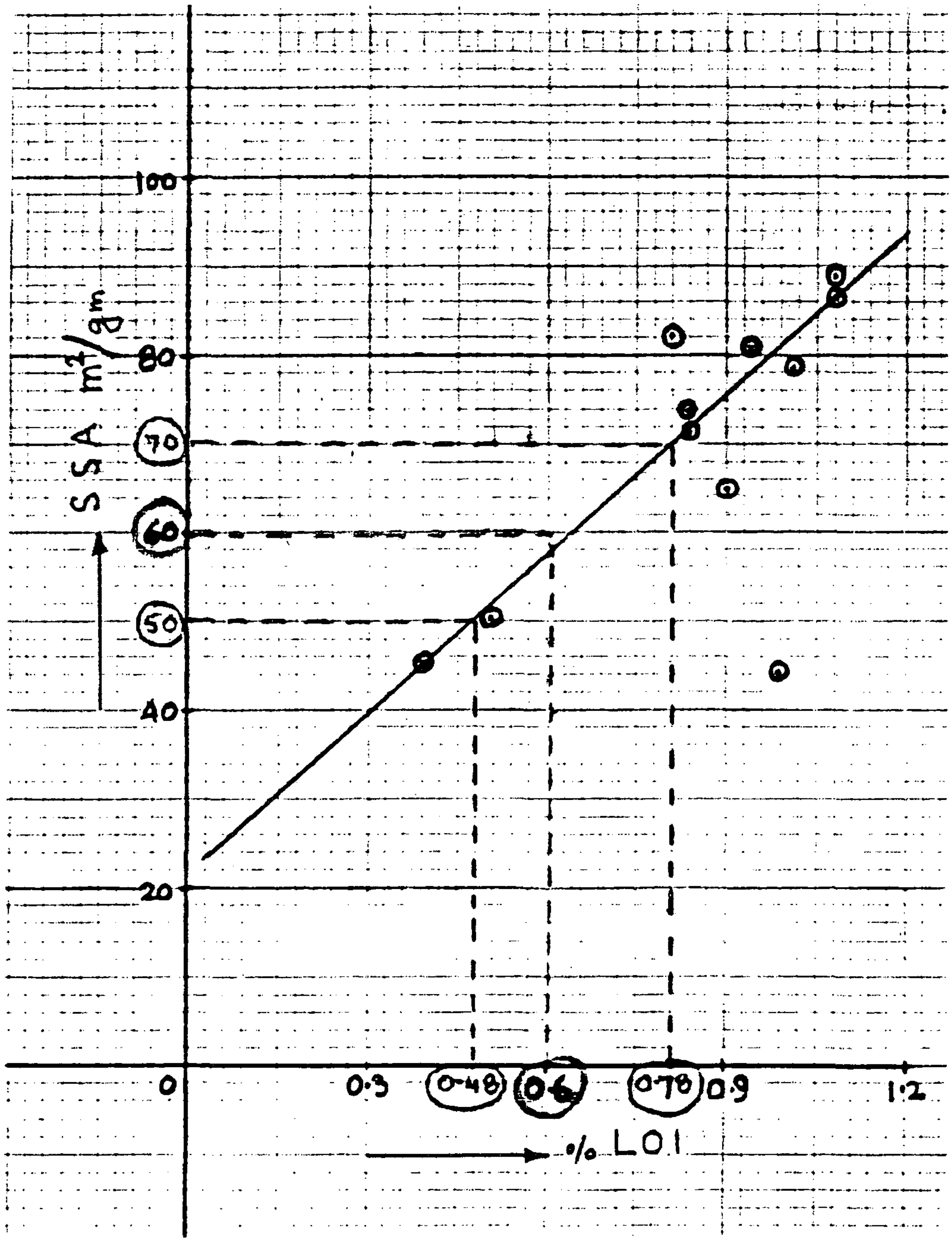
5.4 Actual Performance

The actual performance of the calciner is given in the following graphs, particularly with respect to relationship between L.O.I., Alpha Content and S.S.A.





SSA m²/gm
100
80
70
60
50
40
20
0
5
7
10
11
15
% ∝ ALUMINA CONTENT


SSA m²/gm
100
80
70
60
50
40
20
0
0.3
0.48
0.6
0.78
0.9
1.2
% LOI

5.5 Apart from the above, the following achievements are noteworthy:

i. Guaranteed heat consumption of 740 KCal/Kg of Alumina was achieved.

ii. The particle breakdown has been well below 3 %.

iii. The stack emission has been less than 100 mg/NM^3.

iv. The maintenance problems as compared to the rotary kilns have been reduced considerably.

v. There has been a reduction in man power required for the operation to the extent of nearly 50%.

vi. Electrical energy consumption per ton of alumina has been achieved within 18 kWh/ton.

6.0 APPARENT PROBLEMS

6.1 The calciner does not have provision for increasing or reducing the retention time in calcining zone and hence any adjustment for Alpha content in the alumina has to be achieved only by varying temperature of the calcining zone. This evidently limits the maximum alpha content which can be obtained to about 10 to 12 %.

6.2 Frequent variation in the temperature of the calcining zone may affect the life of the refractories.

7.0 EXPERIENCES IN THE SMELTER

HINDALCO's smelter was started in the year 1962 with Kaiser technology similar to that existed at Mead, Spokane, USA. HINDALCO has open side worked pre-bake pots operating at 58 to 60 KA. There are about 900 pots for the licenced capacity of 150,000 tonnes per annum.

7.1 The operation of these pots have by and large being manual for the last 20 years or more. Of late under HINDALCO's modernization programme the following modifications are being done:

i. Point Feeder system for alumina feeding and crust breaking.

ii. A central computer with microprocessors for individual pots, performing the operation of crust breaking, alumina feeding, voltage control and anode effect termination.

iii. Anode size are being optimised.

iv. At the same time HINDALCO is also installing Dry Scrubbing System for pollution control and recovery of fluorine gases.

7.2 While doing all these modifications, another change in the parameter has been the change with respect to the quality of alumina from the captive alumina plant.

A comparison of the more important characteristics are as follows:

TABLE 4

Properties	Rotary Kiln	GSC
L.O.I. (300 - 1200°C)	0.85 - 1%	0.8 - 0.9%
Alpha Alumina	12.00 -14%	2.0 - 7.0%
S.S.A.	40 - 60	50 - 80
Granulometry		
+ 100 mesh	2%	2-3%
+ 200 mesh	34%	42%
+ 325 mesh	54%	45%
- 325 mesh	10%	10 - 11%

7.3 HINDALCO's requirement for smooth and proper operation of its smelter, calls for alumina having the following properties:

i. It should make a crust to avoid dissipation of heat and loss of energy from top surface.

ii. The crust should be soft to break (in small pieces) for:

a. Easy breaking of side crust for proper setting of anodes, low Rod-Stub drop and uniform current distribution.

b. Easy central break for alumina feeding and better control of anode effect duration.

c. Fragile and easy to remove from anode stubs/butts to avoid carbon contamination and higher consumption of carbon.

iii. It should provide heat insulation on the top surface of the pot to maintain the proper thermal balance and specially in energy efficient pots.

iv. It should be easy to dissolve when fed in molten bath to avoid sludging, poor current distribution and excessive lights.

To fulfil above requirements, the following physical properties are emphasised while specifying the alumina characteristics:

i. Alpha contents (LOI) affecting crusting characteristics.

ii. BET surface area which indicates the surface assessable porosity affecting absorption and penetration of molten bath and ultimately affecting the insulating value of alumina and adsorption of fluoride gases.

iii. Particle size which affects dissolution rate and insulation value of alumina.

7.4 Lot of experiments and development jobs have been reported to high light the various physical properties affecting crusting, dissolution, thermal values, etc. in smelting cells.

8. PROBLEMS IN HINDALCO'S SMELTER

Hindalco's smelter operation started facing problems from about the beginning of 1987 due to various reasons and part of the reasons was attributed to the change in the quality of alumina obtained from the Gas Suspension Calciner.

The comments of the potroom operation are as under:

"Since we started using low alpha alumina, it was not possible to increase the metal pad which is necessary for a stable operation in our pots. We tried at a number of times to increase the metal pad very gradually, but as and when it was increased, we had to cut it back due to excessive lights and further hardening of crust.

Low alpha alumina having high BET surface area are capable of adsorbing higher molten bath than those of high alpha alumina. Once the molten bath is adsorbed in alumina, its insulating value is affected considerably. Realising this, we conducted experiments to find out the heat dissipation with low alpha and high alpha alumina side covers.

We have observed that with high alpha alumina (which was produced from 7.11.1987 to 15.11.1987 by our Rotary Kiln) the surface temperature of side crust are 30 - 35°C lower than those pots which are covered with low alpha alumina.

Low Alpha Alumina Observations	Temperature Range 4 hours	24 hours	48 hours	72 hours
(Fresh Alumina)				
1.	105	182	204	203
2.	108	220	229	233
3.	123	200	235	242
4.	133	223	225	242
5.	-	219	224	225

High Alpha Alumina observations				
1.	121.75	175.5	182	183
2.	129.4	176.75	192	184
3.	-	170.65	182.75	185.17
4.	-	171.27	185.16	184.25
5.	-	161.66	159.54	183.70
6.	-	148.25	161.33	184.70

During this period when the rotary calciner was started and high alpha alumina was produced and fed to potrooms, our observations have been as under.

i. Crust was soft

ii. Frequency of anode effect gone down in Line 4, 5 and 2 where major portion of this alumina was delivered.

iii. Practically there was no pot failure in these lines during this period.

During recent operation of rotary kiln it has been observed that alpha contents had varied from 28% to 60%. For our manual operation, based on our own observations and literature available with us, for smooth operation alpha contents should be 20% to 30%.

9. CONCLUSION

Though there has been lot of controversy on the actual cause of the total problems, it could seen that low alpha content in the alumina causes hard crust formation and resultant difficulties in operating the pots. Some modifications have been carried out in the calciner and the alpha content has been increased to about 7 to 10%. Though some of the problems in potroom are persisting, the hard crust formation has reduced considerably. The change in granulometry of the + 200 and + 325 factions does not appear to have any significant effect in the operations.

It is rather difficult to predict a standard formula for the smelter grade alumina. It would appear that the quality is plant/smelter specific, particularly for the existing operating plants.

References: (i) F.L. Smidth & Company, Industrial Equipment "Energy Saving Production of Alumina with Gas Suspension Calciner" AIME 11th Annual Meeting, Dallas, USA February, 1982.