CHAPTER 12

BENEFICIATION OF BAUXITE

The actual beneficiation processes adopted are determined by the nature and physical properties of ores and gangue minerals, their mode of association with each other, the method of exploiting the deposit and the end-use of the beneficiated product. In small-scale mining operations, selective mining is supplemented by hand sorting whereby ferruginous or siliceous impurities like laterite, quartz, etc. are separated from bauxite with the help of megascopic characteristics like colour, texture, specific gravity, etc. In large-scale mechanised mining, the upgradation of r.o.m. ore by simple manual dressing, sorting, screening and washing is not practicable. In such cases, mechanical beneficiation of the r.o.m. bauxite becomes inevitable particularly when the ore body is mixed up with deleterious constituents. The mechanical beneficiation methods for upgrading such bauxite can only be effective if the impurities are easily liberated from the ore by comminution. Metallurgical grade bauxites are beneficiated by mechanical screening and washing.

The beneficiation techniques that are employed in India and some important bauxite producing countries are not effective in beneficiating marginal or sub-marginal grade ores in which iron, kaolinitic clay and titanium minerals are finely dispersed in the crystal lattice of bauxite minerals. Although considerable research has been and is being carried out in various countries to develop method for beneficiating such ores, none of the physical or chemical processes tried so far on a laboratory-scale has been found to be commercially viable.

12.1 BAUXITE BENEFICIATION IN INDIA

The bauxite production of most of the operative mines in India is not so high as to require a capital-intensive beneficiation plant for up-grading of the run-of-mine product economically to meet the grade and size requirements of the various consuming industries like chemical, refractory, abrasive and metallurgical industries. However, whatever may be the production status of the mines, the run-of-mine bauxite has to be upgraded and/or prepared to make it despatchable to the consuming industries. The various steps taken to improve upon the grade of the run-of-mine bauxite in the country are as follows :-

(1) Manual breaking, dressing and sorting with or without screening

(2) Mechanised crushing

(3) Mechanised dry screening.

12.1.1 Manual breaking and sorting

The predominant deleterious constituents like silica and iron which are normally present in the form of soft and finely divided clay minerals or iron mineral like limonite are considerably reduced in the run-of mine product by manual breaking and sorting of bauxite lumps that can be conveniently picked out by hand. The maximum size of such lumps hardly exceeds 200 mm. The left over finer fractions containing bauxite pieces which cannot be effectively sorted out by hand are thrown out into the reject dumps since they, as a whole, contain more silica and iron compared to the sorted out lumpy fractions. With the exception of few mines, all the bauxite mines in the country practice manual breaking and sorting. In order to improve upon the recovery, the bauxite pieces upto a minimum size of 10 to 25 mm, which otherwise will be thrown out as rejects along with more fines materials, are recovered in some mines by the use of either fork-type hand shovels having 10 to 25 mm gap between the prongs or stationary inclined screens made of weld-wire fabric with 12 mm openings. These screens are occasionally made use of at the railway sidings where the quality of the residual stacks after progressive loading of the lumpy fractions is required to be improved upon by screening out the finer fractions containing high silica and iron as rejects.

12.1.2 Mechanised crushing

The sizing of the run-of-mine bauxite by manual breaking is possible as long as the daily production target is not high., In mechanised mining, the daily production is so high that the installation of mechanised crusher becomes necessary to prepare the bauxite before it is despatched to the destination.

12.1.3 Mechanised dry screening

The highly mechanised mine where the daily production is high, fails to meet with the grade requirements of the captive plant because of too much dilution by laterite and clay during the course of mechanised working. Wet screening, tumbling, attrition scrubbing followed by wet screening would be the most effective method for improving the grade of bauxite required by the plant. In areas where there is scarcity of water for wet screening, dry screening method has to be adopted. The dry screening method adopted in a mine is described here. The run-of-mine bauxite is tipped on to a vibrating grizzly feeder having 150 mm square opening. The oversize fraction of the run-of-mine ore will pass on to the crusher grizzly having 600 mm square opening for regulating the feed to the crusher. The crushed product is stored in bunkers, for direct loading and despatching. The under size from the vibrating grizzly feeder will be subjected to dry screening on a single deck vibrating screen of 25 mm opening. The undersize from this vibrating screen will be conveyed to the rejection dump. The plus 25 mm fraction will move slowly over 1000 mm wide slow moving picking belt before being discharged onto another belt terminating at the movable cross conveyor which will finally deliver it to the storage bunkers for later use. The slow moving picking belt is meant for separating laterite pieces from bauxite by hand picking.

In addition to the above methods high intensity magnetic separation and flotation are also practised for beneficiating bauxite. In flotation preliminary treatment often consists of a wash-scrubbing which leads to the discard of substantial amount of alumina rich tailing. This can be treated after a comparatively coarse grind and desliming with an 800 series collector in acid (sulphuric) circuit, with fuel oil to aid froth stabilization. Where the concentrate thus produced carries iron or titanium minerals, tabling or high intensity magnetic separation has been used for final cleaning.

12.2 BAUXITE BENEFICIATION ABROAD

In most foreign countries the r.o.m. bauxite is subjected to suitable mineral dressing operations before being despatched to the consuming industries. The various processes used (apart from crushing which forms the first stage in all the flowsheets) are :

1) Screening, scrubbing and washing
2) Magnetic separation, and
3) Drying and calcining.

12.2.1 Screening, scrubbing and washing

Nodular bauxites associated with kaolinite clays are amenable to beneficiation by these processes. The bauxite is crushed in one or more stages by jaw crushers to liberate the bauxite nodules. The crushed bauxite is then freed from the adhering sand and clay by screening, scrubbing and/or washing according to a suitably designed flowsheet. Bauxites of Australia, Guyana, Indonesia, Surinam and Rumania are beneficiated in this manner to produce high-alumina (50 to 60 percent Al_2O_3) and low-silica bauxites for metallurgical use[1,2].

The flowsheet used for beneficiating bauxite by wet screening at a large beneficiation plant is shown[3] in Fig.12.1. The r.o.m. ore is reclaimed by apron feeders from the stockpile and is passed through hammer mills to break up large lumps of cemented bauxite. It is then fed to a vibrating grizzly with 75 mm bar spacing. The oversize material is crushed in an impact crusher and conveyed along with the grizzly undersize material to triple deck primary screens. The top deck (19mm aperture) is used to disperse the ore with water and to scalp off the +19mm material which is fed to a wood removal screen. The oversize comprising of wooden material is rejected whereas the undersize is sent back to the impact crusher. The -19mm material is further washed on the middle deck (3 mm aperture) which carries most of the load. The undersize from the bottom deck (0.5 mm aperture) goes directly to the tailings sump. The intermediate

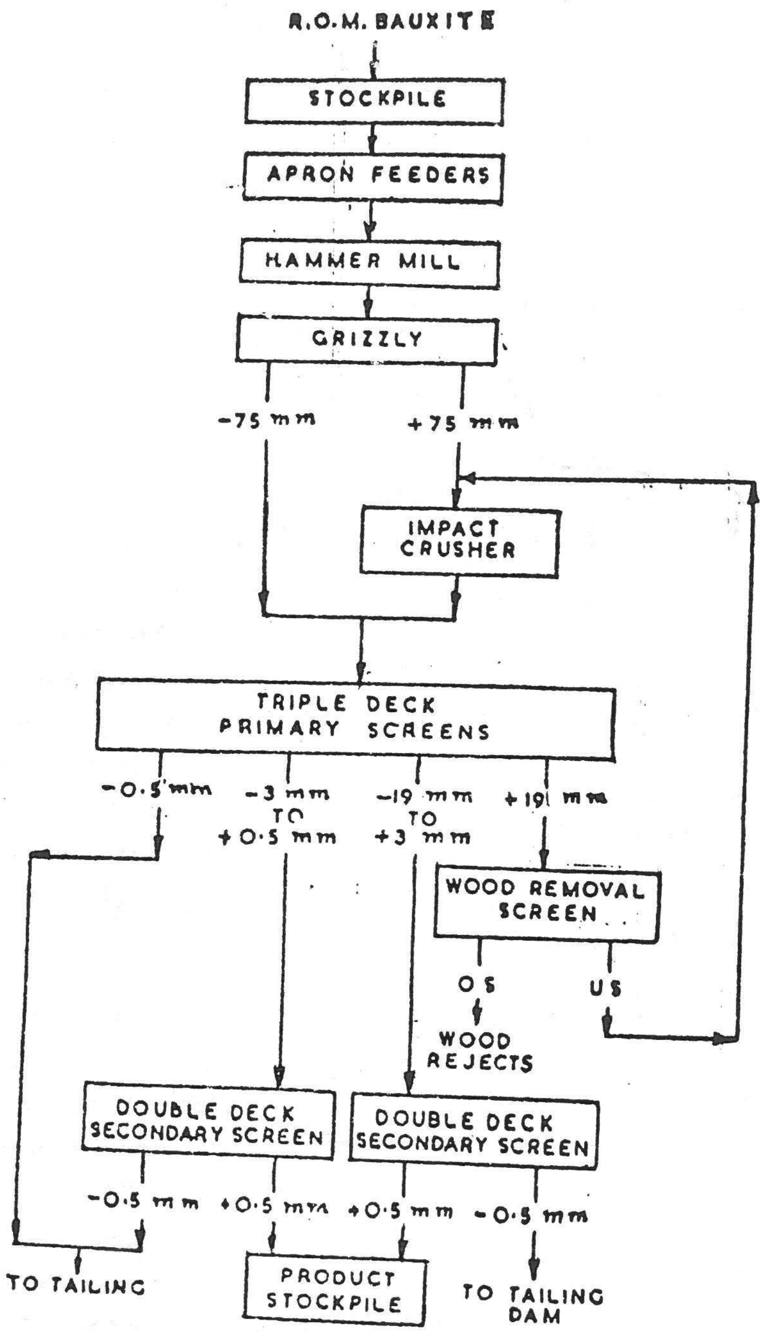

FIG.12.1 FLOWSHEET FOR BENEFICIATION OF BAUXITE BY WET SCREENING

products (i.e. - 19 to +3 mm and -3 to +0.5 mm fractions) are separately fed to double deck secondary screens fitted with 3 mm and 0.5 mm aperture wire cloths for final washing, slimes removal and drainage. The feed analyses to 30 to 50 percent Al_2O_3 and 10-32 percent SiO_2 while the -19 to 0.5 mm washed product contains 52.3 percent Al_2O_3 and 2.4 percent silica[2]. The low moisture content (12 percent) and the preponderance of coarse pissolites in the washed product imparts good material handling properties to it.

When the bauxite from another source was treated according to the same flowsheet, it yielded wet and sticky product with a large proportion of adhesive fines, a softer layer on the pisolites and a higher internal moisture content. Consequently, the flowsheet was modified by substituting 3.6 mm and 1.3 mm aperture screens for the middle and bottom decks of the primary triple deck screens, replacing the double deck secondary screens by single deck low head 1.25 mm aperture wedge wire screens and using 30 percent more wash water. A set of 69 cm hydrocylones and a pair of 0.3 mm aperture 1.8 m wide x 203 cm radius wedge wire sieve bends were installed to recover -1.3 to +0.3 mm saleable bauxite from the -1.3 mm undersize from the primary and secondary screens. A centrifuge was installed for final dewatering of this material[4].

The flowsheet of a typical bauxite beneficiation plant designed to eliminate silica from selected mine ore by scrubbing in trommels followed by processing in a rake classifier and wet screening is shown[1] in Fig. 12.2.

12.2.2 **Magnetic separation**

Beneficiation by magnetic elimination of iron is practiced on a limited scale, primarily on ore consumed in abrasive and refractory industries.[1] The bauxite is usually dried or calcined before magnetic separation because the heating converts siderite ($FeCO_3$) to magnetite (Fe_3O_4), leaves pyrite (FeS_2) as a magnetic residue and makes hematite (Fe_2O_3) and other magnetic minerals strongly magnetic.

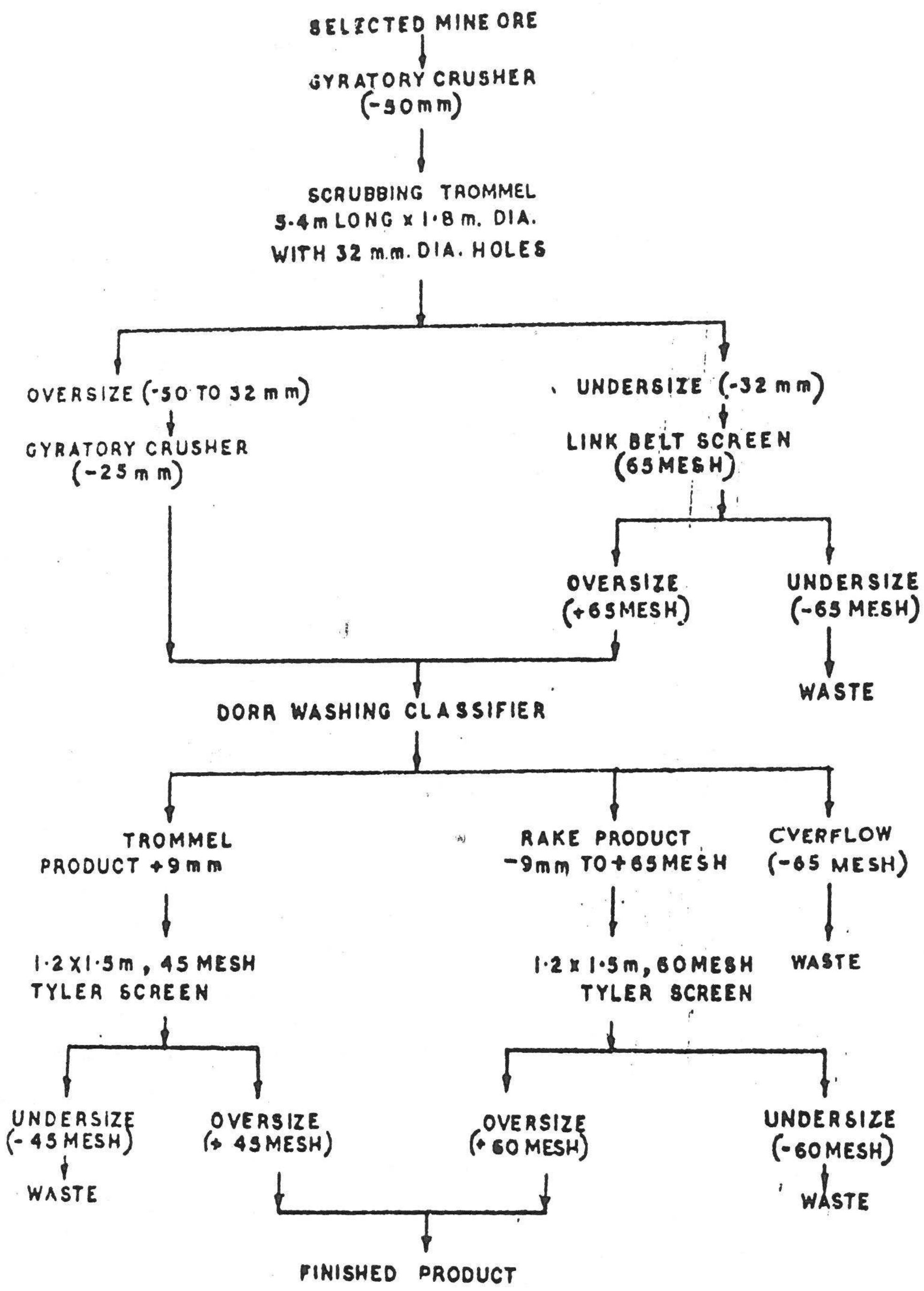

FIG. 12.2 TYPICAL BAUXITE WASHING PLANT

In one mine in Arkansas, U.S.A., r.o.m. bauxite averaging 10 percent Fe_2O_3 is crushed to -25 mm and calcined in a rotary kiln. The retention time in the kiln with fire box temperature maintained at about 1426°C is 40 minutes. The calcined bauxite is permeated with natural gas (a reducing agent) to regard the oxidation of iron oxide as it is discharged from the kiln. The calcined bauxite is cooled in a tube type cooler and crushed and screened to -6 mm size before being fed to a two-roll, high intensity induction magnetic separator. The non-magnetic product is abrasive grade bauxite. About 2.0 to 2.5 tons of dry bauxite is required to produce one ton of abrasive grade bauxite[1]. The magnetic fraction analyses 44.5 percent Al_2O_3, 5 percent SiO_2, 45 percent analyses 44.5 percent Al_2O_3, 5 percent TiO_2 and 1 percent L.O.I.

12.2.3 Drying and calcining

(1) Drying - Bauxites with 5 to 25 percent moisture content is subjected to drying when they are to be transported over appreciable distances. The drying is done by passing the bauxite (-25 mm size) through an oil or natural gas fired rotary kiln rotating at 1 or 2 rpm and inclined at 1 in 10 to 1 in 12 towards the discharge end. The diameter and length of the kiln may be around 1.8 to 2.4 m and 18 to 45 m respectively. The retention time of the bauxite within the kiln varies from 15 to 40 minutes depending upon the kiln size and the nature of bauxite processed. Temperatures within the kiln are limited to 593°C. to ensure that partial calcination (which reduces the solubility of the alumina hydrate in Bayer Process) does not occur[1]. The moisture content of dried bauxites is usually less than 3 percent although as much as 15 percent moisture is retained in case of Jamaican and Haitan bauxites to prevent generation of dust during transport[5].

(2) Calcining : Bauxites intended for abrasive and refractory industries are calcined at 930 to 1590°C to reduce volatile matter including chemically combined water to less than one percent. Calcining kilns have a slope of

1 in 24 and are lined with alumina bricks. The ore remains in the kiln for 1 to 1½ hours. On an average 2 tons of crude bauxite is required to produce 1 ton of calcined product. The hot calcined ore is cooled in a rotary kiln partly immersed in water or equipped with a water spray and then stored under cover[1]. A 45 tph calcining kiln commissioned in Guyana is 94 m long and incorporates a dual drive system, a variable flame burner and a Cottrell Cooling system[6].

12.3 RESEARCH ACTIVITIES ON BAUXITE BENEFICIATION

12.3.1 Research in India

Research in India is aimed at beneficiation of four types of bauxites[7,8] viz., (1) high-silica bauxites which cannot be directly used in the Bayer Process because the silica ratio (i.e. $Al_2O_3 : SiO_2$) is less than 9, (2) high-iron low-alumina bauxites, (3) high-silica, high-iron bauxites and (4) high-calcium abrasive grade bauxites.

Indian Bureau of Mines has carried out detailed beneficiation investigations on a large number of samples of Indian bauxites. The results of the investigations, and the beneficiation methods adopted are given in table No:12.1.

An economic evaluation of the more promising processes on a pilot scale will be necessary before they are actually tried out in the mines on commercial scale.

12.3.2 Research abroad

Research in foreign countries has been directed at developing suitable techniques for (1) separating silica occurring in intimate association with the bauxite in order to increase the silica ratio ($Al_2O_3 : SiO_2$) to make the ore suitable for metal industry, (2) removal of iron oxides from bauxite, and (3) upgrading of high-iron high-silica low grade bauxites.

Separation of silica occurring in intimate association with bauxite - The laboratory procedures for separation of finely disseminated silica minerals call for selective flotation of the different ore and gangue minerals liberated by stage grinding to fine size. They are not commercially viable at present.

Removal of iron oxides from bauxite - The methods investigated for the removal of iron oxides fall into four broad groups, viz. (i) acid leaching, (ii) selective chlorination (iii) recovery of high alumina slags, and (iv) physical methods like flotation and magnetic separation[9]. Of these the last named i.e., magnetic separation has found limited application for beneficiation of high iron abrasive and refractory grade bauxites. In actual practice the magnetically separated rejects contain 44.5 percent Al_2O_3. Although a part of the Al_2O_3 can be recovered by light grinding and magnetic separation, it cannot be used in Bayer Process because of the high temperature calcination which precedes the initial magnetic separation. It is also unsuitable for use in the manufactureof abrasives because the alumina particles are rendered too small by grinding. The U.S. Bureau of Mines have investigated this problem during the second World War and developed a modified process for magnetic beneficiation of abrasive grade bauxites in which an upgraded metal grade bauxite is recovered from the magnetic material separated from the abrasive grade bauxite. In this process high-iron abrasive grade bauxite is subjected to low temperature (450°C) reduction roasting followed by high intensity magnetic separation. The non-magnetic fraction is upgraded bauxite, suitable for the manufacture of abrasives. The magnetic fraction is ground to -65 mesh and then passed through a low intensity magnetic separator to recover metal grade bauxite as the non-magnetic fraction. The magnetic fraction is an iron concentrate which can be used as a potential source of iron[10]. The modified process has however not come into commercial use as abrasive grade bauxite was readily available to the American industry from other sources at the end of Second World War.

Upgrading of high-silica high-iron bauxites - The flowsheet developed in the U.S.S.R. for treating bauxite with 42.77 percent Al_2O_3, 8.59 percent SiO_2 and 19.96 percent Fe_2O_3 and obtaining a concentrate with 49.42 percent Al_2O_3, 5.42 percent SiO_2 and 16.21 percent Fe_2O_3 is shown[11] in Fig.12.3. The yields, compositions and recoveries of various products indicated in the flowsheet are given in Table 12.2 This flowsheet has not yet been tried out on a plant scale.

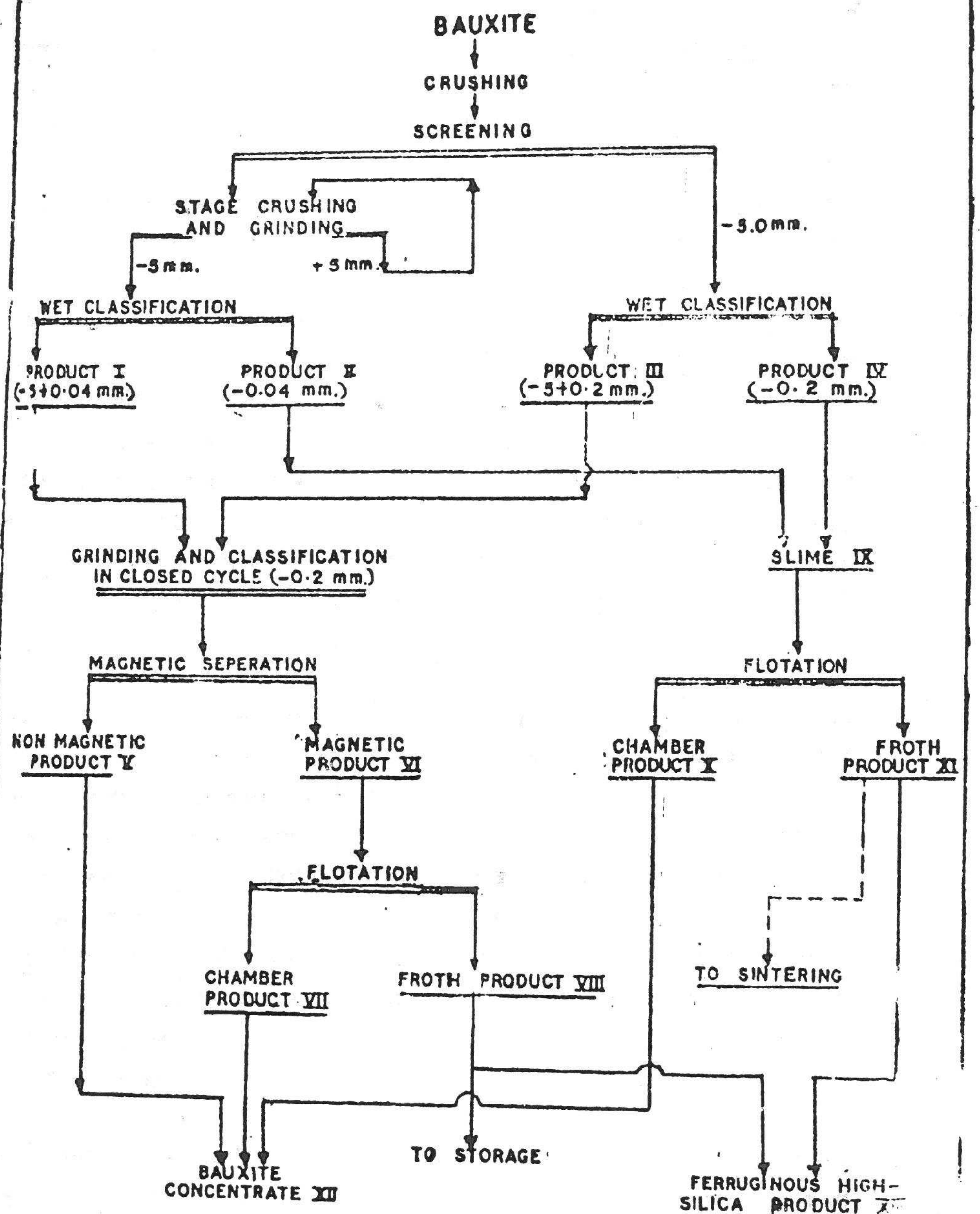

Fig. 12.3-FLOWSHEET USED IN THE LABORATORY FOR BENEFICIATION OF HIGH SILICA, HIGH IRON BAUXITES.

TABLE 12.1 : RESULTS OF SOME LABORATORY INVESTIGATIONS CARRIED OUT BY IBM FOR BAUXITE BENEFICIATION

Sl. No.	IBM/RI No.	SAMPLE NO. & TITLE OF INVESTIGATION.	ORIGINAL ASSAY %	MINERALOGY	Wt.%	CONCENTRATE ASSAY %	RECOVERY% Al_2O_3	PROCESS ADOPTED
1	2	3	4	5	6	7	8	9
1.	205	Beneficiation of bauxite sample from Kot-pahar area, Balaghat distt., Madhya Pradesh.	Al_2O_3 - 48.34 Fe_2O_3 - 18.20 SiO_2(T) - 1.87 TiO_2 - 6.49 LOI - 24.94 Al_2O_3/SiO_2 - 25.85	Valuable mineral gibbsite gangue : goethite and hematite	82.97	Al_2O_3 - 50.35 Fe_2O_3 - 16.52 SiO_2 - 2.50 Al_2O_3/SiO_2 - 20.14	86.61	Tabling
2.	210	Beneficiation of bauxite ore from Vishakhapatnam distt., Andhra Pradesh.	Al_2O_3 - 41.43 Fe_2O_3 - 30.16 SiO_2(T) - 0.74 TiO_2 - 2.33 LOI - 22.50 Al_2O_3/SiO_2 - 56.00	Valuable mineral: gibbsite gangue goethite & hematite	69.38	Al_2O_3 - 51.13 Fe_2O_3 - 20.79 SiO_2 - 0.90 Al_2O_3/SiO_2 - 56.81	78.53	Tabling

1	2	3	4	5	6	7	8	9
3.	211	Beneficiation of low grade bauxite sample from Lohardaga, Ranchi distt., Bihar.	Al_2O_3 - 46.52 Fe_2O_3 - 17.47 SiO_2(T) - 6.92 LOI - 22.94 TiO_2 - 7.30 Al_2O_3/SiO_2 - 6.7	Valuable minerals: gibbsite and cliachite Gangue: Hematite, goethite, clay	64.40 63.3 to 68.6	Al_2O_3 - 47.80 SiO_2 - 3.55 Al_2O_3/SiO_2 - 13.50 or Al_2O_3 - 46.47 to 47.75 SiO_2 - 3.4 to 4.41	66.10 66.3 to 70.5	Wetsiveing
4.	217	Beneficiation of bauxite ore sample from Hadmatia Village, Jamnagar distt., Gujarat	Al_2O_3 - 56.16 Fe_2O_3 - 2.24 SiO_2 - 7.04 TiO_2 - 2.50 CaO - 0.70 LOI - 30.78 Al_2O_3/SiO_2 - 8.0	Valuable minerals: gibbsite and cliachite. Gangue: clay, quartz & iron oxides.	94.61	Al_2O_3 - 58.16 Fe_2O_3 - 2.47 SiO_2 - 5.80 Al_2O_3/SiO_2 - 10.00	95.30	Tumbling

1	2	3	4	5	6	7	8	9
5.	219	Beneficiation of a bauxite sample from Dipakujam area, Ranchi distt., Bihar (Deposit No. 53)	Al_2O_3 - 45.58 Fe_2O_3 - 21.28 SiO_2 - 3.55 TiO_2 - 6.50 LOI - 23.47 Al_2O_3/SiO_2 - 12.84	Valuable minerals: gibbsite and cliachite Gangue: goethite	92.23	Al_2O_3 - 48.26 Fe_2O_3 - 19.52 SiO_2 - 3.03 Al_2O_3/SiO_2 - 15.93	95.24	Magnetic separation
6.	225	Beneficiation of calcareous bauxite sample, from Mewasa area, Jamnagar distt., Gujarat.	Al_2O_3 - 56.86 Fe_2O_3 - 2.84 SiO_2(T) - 4.42 TiO_2 - 2.35 CaO - 3.50 LOI - 29.00 Al_2O_3/SiO_2 - 12.90	Valuable minerals: gibbsite. Gangue: calcite	-	Al_2O_3 - 63.28 CaO - Less than 0.2	Almost 100.00	Acid leaching.

1	2	3	4	5	6	7	8	9
7.	227	Beneficiation of bauxite from Paduvana area, Mysore State (Sample No. 2)	Al_2O_3 - 45.23 Fe_2O_3 - 22.71 SiO_2(T)- 3.90 TiO_2 - 2.46 LOI - 25.13 Al_2O_3/SiO_2 - 11.30	Valuable minerals: gibbsite and cliachite Gangue: goethite	41.70	Al_2O_3 - 56.68 Fe_2O_3 - 10.83 or Al_2O_3 - 51.00	52.26 70.00	Isodynamic separation.
8.	228	Beneficiation of bauxite sample from Amarkantak Madhya Pradesh (Sample No. A-5)	Al_2O_3 - 34.11 Fe_2O_3 - 27.88 SiO_2(T)- 19.12 TiO_2 - 3.29 LOI - 15.93 Al_2O_3/SiO_2 - 1.78	Valuable minerals: Cliachite and gibbsite Gangue: goethite, quartz and clay	15.50	Al_2O_3 - 52.89 Fe_2O_3 - 12.58 SiO_2(T)- 6.45 Al_2O_3/SiO_2 - 8.20	24.03	Desliming & magnetic separation.
9.	234	Beneficiation of a bauxite sample from East Phutka-Pahar mines, Madhya Pradesh	Al_2O_3 - 48.50 Fe_2O_3 - 15.33 SiO_2(T)- 7.86 TiO_2 - 7.60 LOI - 22.20 Al_2O_3/SiO_2 - 6.17	Valuable minerals: gibbsite and cliachite Gangue: goethite	88.88	Al_2O_3 - 51.48 Fe_2O_3 - 14.19 SiO_2(T) 4.55 Al_2O_3/SiO_2 - 11.31	92.03	Screening

1	2	3	4	5	6	7	8	9
10.	235	Beneficiation of bauxite sample from Jardapahar, Ranchi distt., Bihar	Al_2O_3 - 57.00 Fe_2O_3 - 7.94 SiO_2(T)- 5.36 TiO_2 - 8.8 LOI - 20.86 Al_2O_3/ SiO_2 - 10.63	Valuable minerals: gibbsite and cliachite Gangue : goethite	90.37 95.80	Al_2O_3 - 57.73 Fe_2O_3 - 7.54 SiO_2 - 4.70 Al_2O_3/SiO_2 - 12.28 or Al_2O_3 - 58.25 Fe_2O_3 - 7.97 SiO_2 - 4.88 Al_2O_3/SiO_2 - 11.94	91.07 96.54	Dry screening. Tumbling & screening
11.	237	Beneficiation of a low grade bauxite sample from (Cebtral Phutka pahar mines, Madhya Pradesh)	Al_2O_3 - 48.54 Fe_2O_3 - 19.55 SiO_2(T)- 4.00 TiO_2 - 3.70 LOI - 22.50 Al_2O_3/SiO_2 - 12.13	Valuable minerals: gibbsite and cliachite. Gangue : goethite	86.00	Al_2O_3 - 52.19 Fe_2O_3 - 16.83 SiO_2(T)- 3.06 Al_2O_3/SiO_2 - 17.05	90.17	Tumbling & Screening
12.	244	Beneficiation of bauxite sample from Amarkantak mines, Madhya-Pradesh (Sample No. A-1)	Al_2O_3 - 45.19 Fe_2O_3 - 22.92 SiO_2(T)- 6.16 TiO_2 - 5.23 LOI - 20.83 Al_2O_3/SiO_2 - 7.34	Valuable minerals: gibbsite and cliachite Gangue: goethite	65.70	Al_2O_3 - 53.60 Fe_2O_3 - 14.53 SiO_2 - 4.28 Al_2O_3/SiO_2 - 12.68	75.90	Isodynamic separation.

1	2	3	4	5	6	7	8	9
13.	251	Beneficiation of a low grade bauxite sample from North Phutkapahar mines, Madhya Pradesh (Channel sample No. BPC-8)	Al_2O_3 - 44.75 Fe_2O_3 - 22.42 SiO_2(T) 4.64 TiO_2 - 6.42 LOI - 22.59 Al_2O_3/SiO_2 - 9.65	Valuable minerals : gibbsite and cliachite Gangue: goethite	64.00	Al_2O_3 - 52.52 Fe_2O_3 - 12.66	73.65	Desliming & Magnetic separation.
14.	252	Beneficiation of a low grade bauxite sample from Amarkantak mines, Madhya pradesh (Channel sample No.2)	Al_2O_3 - 47.32 Fe_2O_3 - 17.33 SiO_2(T) 3.56 TiO_2 - 8.60 LOI 21.74 Al_2O_3/SiO_2 - 13.34	Valuable minerals: gibbsite and cliachite Gangue: goethite	70.00	Al_2O_3 - 52.65 Fe_2O_3 - 10.65	77.10	Magnetic separation
15.	276	Beneficiation of a composits channel sample from Central & East Phutka Pahar Mines, M.P. of BALCO (Channel samples No.BPC-1 to 5)	Al_2O_3 - 44.98 Fe_2O_3(T) 20.40 SiO_2(T) 5.30 TiO_2 - 4.94 P_2O_5 - 0.58 LOI - 23.31	Valuable minerals : gibbsite and cliachite Gangue : goethite, hematite & clay	62.00	Al_2O_3 - 52.52 Fe_2O_3 - 11.03 SiO_2 - 3.09 Al_2O_3/SiO_2 - 17.00	71.41	Desliming & magnetic separation

1	2	3	4	5	6	7	8	9
16	296	Beneficiation of low grade bauxite sample from Central Phutkapahar, M.P. of BALCO (Sample No. BFC-29)	Al_2O_3 - 26.34 Fe_2O_3 - 48.68 SiO_2(T) 3.50 SiO_2(R) 3.29	Valuable minerals : cliachite & gibbsite. Gangue : goethite & hematite	13.26	Al_2O_3 - 52.89 Fe_2O_3 - 14.76 SiO_2(T)- 2.12 SiO_2(R)- 1.73		Magnetic separation.
17	345	Beneficiation of bauxite sample from Pottangi Area Koraput distt., Orissa (S.No.P-9052) for Mineral exploration Corporation Ltd.	Al_2O_3 - 45.70 Fe_2O_3 - 25.29 SiO_2(T) 1.85 SiO_2(R) 1.57 TiO_2 - 2.50 LOI 23.70	Valuable mineral gibbsite. Gangue : goethite & hematite. i)	90.09	Al_2O_3 - 47.62 Fe_2O_3 - 25.26 SiO_2 - 1.58	91.84	Wet screening & sizing
				ii)	89.40	Al_2O_3 - 49.13 Fe_2O_3 - 20.93 SiO_2 - 1.80	94.69	Dry high intensity magnetic separation
18	346	Beneficiation of bauxite sample from Pottangi area, Koraput distt., Orissa (S.No.P-9061) for Mineral Exploration Corporation Ltd.	Al_2O_3 - 46.35 Fe_2O_3 - 24.39 SiO_2(T) 0.94 SiO_2(R) 0.55 TiO_2 - 2.50 LOI - 25.07	Valuable mineral : gibbsite. Gangue: goethite & hematite.	87.75	Al_2O_3 - 49.95 Fe_2O_3 - 20.27 SiO_2(T) 0.94	93.21	Dry Magnetic separation.

1.	2	3	4	5	6	7	8	9
19	348	Beneficiation of bauxite sample from Pottangi, Koraput distt., Orissa, (S.No.P-9002)	Al_2O_3 - 48.95 Fe_2O_3 - 22.00 SiO_2(T) 1.28 TiO_2 - 1.30 LOI - 24.70	Valuable mineral : gibbsite Gangue: goethite, limonite & hematite.	i) 71.96	Al_2O_3 - 49.93 Fe_2O_3 - 19.45 SiO_2 - 1.02	74.49	Wet screening of sample crushed to -25 mm (-25 mm+ 5 mm)
					ii) 91.11	Al_2O_3 - 50.56 Fe_2O_3 - 21.97 SiO_2 - 1.34	93.81	Wet screening of sample crushed to -12 mm size (-12mm +100 mesh).
					iii) 81.88	Al_2O_3 - 50.03 Fe_2O_3 - 20.46	84.37	Tumbling of -25 mm sized traction (-25 mm) + 100 mesh)
20	350	Beneficiation of bauxite sample No. A-13006 from Galikonda Block, Araku area, Visakhapatnam distt., Andhra-Pradesh.	Al_2O_3 - 48.21 Fe_2O_3 - 22.10 SiO_2(T) 2.34 SiO_2(R) 1.47 TiO_2 - 2.50 LOI - 24.71	Valuable mineral : gibbsite. Gangue: goethite & hematite.	91.30	Al_2O_3 - 49.59 Fe_2O_3 - 21.66 SiO_2 - 2.48	93.60	Wet screening of the as received sample.

1.	2.	3.	4.	5.	6.	7.	8.	9.
21.	394	Wet High Intensity Magnetic Separation tests on a bauxite sample from Chintapallic area, Andhra-Pradesh (Sample No.13002).	Al_2O_3 - 46.25 Fe_2O_3 - 24.43 SiO_2(T) 3.15 TiO_2 - 1.57 P_2O_5 - 0.12 LOI - 23.88	Valuable minerals; gibbsite. Gangue: goethite, hematite, lepidocrocite	88.0	Al_2O_3 - 49.80 Fe_2O_3 - 20.00 SiO_2 - 3.11 LOI - 25.27	94.80	Wet high intensity magnetic separation. (Feed:100 mesh)
22.	442	Wet High intensity magnetic separation tests on a bauxite sample from Panchpatmali, Orissa. Sample No.PPM-II (for Mineral Exploration Corporation)	Al_2O_3 - 44.47 Fe_2O_3 - 29.00 SiO_2 - 0.93	Valuable mineral : gibbsite. Gangue : Hematite & goethite.	79.75	Al_2O_3 - 51.80 Fe_2O_3 - 20.84 SiO_2 - 0.89	92.05	Wet High Intensity magnetic separation.
23.	443	Wet High intensity magnetic separation tests on a bauxite sample from Panchpatmali, Orissa Sample No.PPM-I (for Mineral Expl. Corporation)	Al_2O_3 - 40.41 Fe_2O_3 - 32.29 SiO_2(T) 1.54	Valuable mineral : Gibbsite. Gangue: goethite & hematite.	75.61	Al_2O_3 - 47.40 Fe_2O_3 - 22.02 SiO_2 - 1.50	87.90	Wet high intensity magnetic separation.

1.	2.	3.	4.	5.	6.	7.	8.	9.
24.	457	Wet High intensity magnetic separation test on a bauxite sample from Jerrala (Korukonda) Andhra-Pradesh Sample No. 40000 (for Mineral Exploration Corporation. Ltd.	Al_2O_3 - 43.93 Fe_2O_3 - 24.92 SiO_2(T)- 3.78 LOI - 24.18 TiO_2 - 1.50 P_2O_5 - 0.33	Valuable mineral : gibbsite Gangue: goethite hematite.	77.7	Al_2O_3 - 48.90 Fe_2O_3 - 17.68 SiO_2 . 3.53 TiO_2 - 1.32 LOI - 26.35	85.5	Wet High Intensity Magnetic separation
25.	480	Beneficiation of a bauxite sample from Jamirapat plateau, Sarguja Distt., Madhya Pradesh.	Al_2O_3 - 38.06 Fe_2O_3 - 31.18 SiO_2(T) 7.98 TiO_2 - 5.47	Valuable mineral : cliachite & gibbsite. Gangue: goethite, hematite and lepidocrocite.	54.60	Al_2O_3 - 47.90 Fe_2O_3 - 21.28 SiO_2 - 5.28	66.90	Wet High Intensity Magnetic separation
26.	510	Beneficiation of a low grade bauxite sample from Mainpat Plateau, Sarguja District, Madhya Pradesh.	Al_2O_3 - 41.23 Fe_2O_3 - 22.85 SiO_2 - 5.82 TiO_2 - 8.57 LOI - 19.76	Valuable mineral : gibbsite and boehmite Gangue: hematite goethite anatase & Kaoline	60.47	Al_2O_3 - 47.45 Fe_2O_3 - 14.97 SiO_2(T) 3.44 TiO_2 - 8.50 LOI - 23.51	70.06	Desliming & magnetic seperation

1.	2.	3.	4.	5.	6.	7.	8.	8.
27.	511	Beneficiation of a low grade ferruginous bauxite sample from Pandrapat, Raigarh district, Madhya Pradesh	Al_2O_3 - 41.36 Fe_2O_3 - 29.05 SiO_2 - 2.43 TiO_2 - 5.40 LOI - 19.00	Valuable mineral: gibbsite & boehmite Gangue : hematite, goethite	33.36 82.00	Al_2O_3- 51.13 Fe_2O_3- 12.81 SiO_2 - 1.61 Al_2O_3- 44.52 Fe_2O_3- 27.81 SiO_2 - 2.48	40.81 86.76	Desliming & dry magnetic seperation Wet High Intensity magnetic seperation
28.	654 NGP	Beneficiation of a Bauxite Sample No.7452 from West Coast Bauxite Project, Shahuwadi, Distt. Kolhapur Maharashtra, (for MEC).	Al_2O_3 - 38.54 Fe_2O_3 - 30.53 SiO_2 - 4.64 TiO_2 - 2.70 CaO - 0.39 MgO - 0.20 P_2O_5 - 0.25 LOI - 22.13	Valuable mineral : Gibbsite Gangue : hematite, goethite, pyrite, Quartz, mica.	59.75	45.16	69.18	WHIMS
29.	6 BNG	Beneficiation of a a Bauxite sample No.7453 from Dhangarwadi Plateau, Kolhapur Distt. Maharashtra (for MEC)	Al_2O_3 - 46.08 Fe_2O_3 - 20.77 SiO_2(T) 6.15 TiO_2 - 3.85 LOI 23.10	Valuable minerals : gibbsite Gangue: goethite quartz	83.7	49.12	87.5	Wet scrubbing followed by WHIMS

TABLE 12.2 - YIELD, CHEMICAL COMPOSITION, ETC. OF PRODUCTS OBTAINED AT VARIOUS STAGES DURING TREATMENT OF BAUXITE BY FLOWSHEET SHOWN IN FIG.12.3

Operation	Product type	Yield percent	Content percent				Modulus	Recovery percent			
			Al_2O_3	SiO_2	Fe_2O_3	CO_2		Al_2O_3	SiO_2	Fe_2O_3	CO_2
Classification	Starting	100.00	42.77	8.59	19.96	2.69	4.9	-	-	-	-
	I	43.74	43.97	4.62	21.71	3.04	9.6	44.98	23.53	49.57	47.78
	II	8.33	41.62	12.19	16.00	0.88	3.41	8.11	11.82	6.70	2.72
	III	25.94	40.10	6.26	22.24	4.08	6.56	24.99	18.91	29.01	39.37
	IV	21.99	42.64	17.86	15.00	1.02	2.38	21.91	45.74	16.51	8.32
Magnetic Separation	V	44.79	49.11	5.48	14.93	0.90	8.96	51.77	28.59	33.65	15.02
	VI	24.89	31.15	4.78	34.50	7.99	6.52	18.23	13.90	43.13	73.93
Carbonate Flotation	VII	8.89	41.80	5.01	21.43	1.30	8.36	10.49	5.18	9.76	4.75
	VIII	16.00	20.42	4.64	42.57	11.63	4.41	7.74	8.69	33.54	69.21
Slime	IX	30.32	42.36	16.30	15.30	0.98	2.60	30.02	57.56	23.21	11.04
Flotation of slime	X	12.00	49.50	5.30	18.71	0.80	9.35	13.89	7.40	10.35	3.60
	XI	18.32	37.70	25.51	14.06	1.05	1.6	16.10	50.14	13.02	7.34
Concentrate	XII	65.68	49.42	5.42	16.21	0.95	9.1	76.15	41.20	53.57	23.37
	XIII	34.32	29.66	15.03	27.40	5.98	1.97	23.84	58.83	46.56	76.55

Note : (1) Product XII is the total bauxite concentrate.

(2) Product XIII consists of the tailings which can be mixed with red mud and converted to pig iron and aluminium-calcium silicates.

Modulus = Al_2O_3 : SiO_2 ratio

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