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Beneficiation of Bauxite by Acid Leaching

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ABSTRACT

Bauxite is the important ore for the production of Aluminum and also used for non-metallurgical purposes. Bauxite consists of hydrated aluminum oxide in the form of minerals like Gibbsite, Boehmite and Diaspore with impurities like Silika as Kaolinite & Quartz, Iron as Al-goethite & Hematite, Titania as Anatase & Rutile and other minor minerals. India having the limited reserve of naturally occurring high grade Bauxite except small deposits of Gujrat, and Maharashtra states. Bauxite deposits of Orissa are associated with the Eastern Ghats Super Group of rocks which form the East coast Bauxite deposits reserves about 2200 million tons. Despite the huge resources and good quality bauxite in the Eastern Ghats regions, but some industries located nearby are starving for suitable grade of Bauxite for their alumina production. This bauxite is mostly Gibbsitic in nature and quite suitable for production of metallurgical grade alumina. However, the average Fe2O3 content in Eastern Ghats bauxite is quite high (between 22 – 29%), which is mainly in the form of alumo-goethite and hematite which has to be removed by beneficiation processes and upgrade the quality of ore as per the requirement of the industries. The non-metallurgical grade of bauxite has to fulfill more rigid compositional requirement than that used for aluminium extraction. The average Fe2O3 content in Eastern Ghats Bauxite vary between 22-28% which is mainly in the form of alumo-goethite and hematite and have inverse relationship with the alumina value. Any technique which can reduce only iron content can make this bauxite suitable for non-metallurgical industries and also open up prospects of their export to aluminum industries.

The present study has been taken up for reduction of iron of Eastern Ghats Bauxite by chemical dissolution of iron in Hydrochloric acid and experimental tests shows that this beneficiated Bauxite may be suitable for abrasive and refractory industries. It is found that by this processes the iron content can be reduced below three percent.
Keywords: Beneficiation, Bauxite, Reduction of Iron, Acid leaching.

I. INTRODUCTION

Bauxite is a naturally occurring Ore, but it has a number of impurities, like Iron, Silica, Titania, Calcium, and small quantities of phosphorous, sulfur, zinc, magnesium and various carbonate and silicate minerals. These impurities not only create quality problems, but also increase production costs. Impurities in the ore also reduce the capacity utilization, productivity and efficiency of the plant. Therefore, they have to be removed using beneficiation techniques. Bauxite is one of the important ore used for the extraction of aluminium and which is also consumed in the manufacturing of refractories and ceramics. Eastern Ghats bauxite is extensively used in metallurgical, chemical and refractory applications. The total reserve of bauxite in the country is estimated as 3,037 million tones. As per the latest estimation of Indian Bureau of Mines, of about 89% bauxite production is used in metallurgical industry, 4.2% in refractory, 4.06% in cement, 1.46% in abrasive and rest 1.18% in chemical, iron and steel, ceramics and alloy steel sectors etc. [1].

The mined bauxite ore has to be beneficiated so as to remove undesirable mineral constituents before it could be considered a suitable raw material for the above purposes. Iron and Calcium are the major impurities in this bauxite affecting its industrial use in refractories and

ceramics. Physico-chemical processes such as gravity separation, reduction roasting, froth flotation and magnetic separation could be used to beneficiate such bauxite.

The large Eastern Ghats Lateritic Bauxite deposits of India, where more than 2000 million tons of metallurgical grade bauxite is concentrated, is found almost free of impurities except that of iron. Reduction of iron by techno-economical viable method can make this bauxite suitable for the industrial uses. The pit head cost of typical bauxite in the mine of Eastern Ghats works out to less than US$ 5 per ton [2]. The Indian Bureau of Mines applied various beneficiation techniques such as tabling, magnetic separation, acid leaching, isodynamic separation and high intensity magnetic separation etc. on some Indian Bauxite mainly to reduce iron and silica content [3]. Literature survey reveals that under optimum conditions it is possible to achieve 96.46% dissolution of iron [4]. Accordingly, the present study carried out for the up-gradation of high iron content bauxite of Eastern Ghats region of Orissa state by dissolution of iron from Eastern Ghats Bauxite in Hydrochloric acid solution.

II. METHODS AND MATERIAL

The dissolution of iron from bauxite study carried out with different Hydrochloric acid concentration, different temperature, leaching time and fixed solid liquid ratio in reflex condenser with magnetic stirrer. The advantage of reflex condenser is to maintain the solid liquid ratio and acid concentration. The objective of this leaching processes is that Hydrochloric acid as a leachant allows comparatively easier recovery of the useful free acid from its waste solution in comparison to Sulfuric acid. The separation of chemicals through solvent extraction, and $Fe_2O_3$of higher than pigment grade is to be recoverable with free HCl from the back-extracted solution by thermal decomposition method. The recovered acid is to be suitable for the purpose of recycling [5].

The bauxite sample was collected from Eastern Ghats deposit of Orissa and representative sample was drawn by conning quartering procedure whichscreened through 150 mm size sieve and same sample crushed by jaw crusher followed by roll crusher. The entire sample was screened through 4 mm size sieve. After conning and quartering a representative experimental studies. The chemical and mineralogical analysis of above Eastern Ghats bauxite sample is given in the following tables as

Table 1. Chemical composition of Bauxite by AAS and wet chemical method.

Constituents	**%**
Al2O3	45.76
Fe2O3	25.69
SiO2	1.84
TiO2	1.57
LOI	24.55
	In ppm
Cu	29
Pb	73
Zn	54
Cd	6
Mn	71
Bi	48
Co	98
Ni	52

Table 2. Mineralogical composition of Bauxite by X-ray diffractogram.

Alumina as	**%**
Gibbsite	42.53
Al-goethite	1.06
Kaolinite	1.56
Total	45.15
Silica as	
Kaolinite	1.79
Quartz	-
Total	1.79
Fe2O3 as	
Al-goethite	9.34
Hematite	16.02
Total	25.36
Titania as	
Anatase	2.00
Rutile	-
Total	2.00

Magnetic separation experiments were conducted with Eriez Laboratory Model Ferrous Wheel Separator having two permanent magnets with magnetic intensity strength 2,200 gauss and different size of matrix i.e. wire mesh. A flux converging Matrix is placed in the magnetic field. This produces a myriad of high gradient collection zones that capture magnetic particles as the feed material passes through the matrix. This high gradient magnetic separator represents the state of the art for collection of paramagnetic particles. When matrix is placed in a magnetic field, the function of matrix is three fold i.e. (i) amplifies the magnetic field (ii) converges the lies of the flux to produce localized regions of extremely high magnetic field gradient and (iii) provides the collection sites for the magnetic particles.

The wet high intensity magnetic separator lab model was also used for above study. It has magnetic field intensity strength ranging from 4,000 to 19,000 gauss with variable operating current in amperes. Different size of balls were used as matrix in the process.

Experimental Procedure was used as the slurry of bauxite sample was poured into the canister of Eriez Ferrous Wheel Separator / WHIMS. Non-magnetic particles are washed with sufficient quantity of water. The underflow of the equipment known as non-magnetic portion of bauxite is collected in a separate container. The canister containing the magnetic portion of bauxite is removed from the holder and washed with water several times and collected in another container.

III. RESULTS AND DISCUSSION

The wet high intensity magnetic separation tests were carried out from 7,000 to 19,000 gauss magnetic intensity with varying solids percentage and with different mesh size of (minus 100 to 325) bauxite sample. The matrix used consisted of iron balls of different size as well as metal wire mesh of 18 nos.

The above study was also carried out with Eriez Ferrous Wheel Separator (EFWS) having two permanent magnets of 2200 gauss magnetic intensity at various percentage solids and mesh size of bauxite sample using iron balls as well as 18 and 24 nos. wire mesh as matrix. The result indicated that

- ✓ Alumina (Al2O3) content can be increased from 45.6% to 51-54% and iron as Fe2O3 can be reduced to 16-18% from an initial value of 25.16%. The recovery of nonmagnetic portion was observed to be 76-78% resulting in overall recovery of alumina to 86-88%.
- ✓ With Eriez Ferrous Wheel Separator (EFWS), the results were found to be more encouraging with wire mesh as the matrix in comparison to than that with iron balls.
- ✓ No appreciable change is increase in Al2O3 content and reduction in iron was observed with change in percentage solids, mesh size of bauxite sample and wire mesh matrix.

The above study with two different types of magnetic separator units concludes that East coast Bauxite can be upgraded up to 52-54% alumina and iron content can be reduced up to 16-17% by the using above technique. This beneficiation of bauxite can easily be used in centrally located alumina plants like M/s. Hindalco Industries Ltd., Renukut and Bharat Aluminium Co., Korba for sweetening purposes which can increase the production capacity and productivity in this alumina plants.

IV. CONCLUSION

The above study leads to the following conclusions:

- ✓ As the magnetic field intensity is increased, the alumina content of bauxite (non-magnetic) increases from an initial value of 45.15% to 50-54%. However, the recovery of non-magnetic portion also decreases 76% to 48% resulting in net recovery of alumina content 83% to 56%.
- ✓ There is no appreciable change in mesh from minus 100 to minus 325 ground bauxite and with varying (20% to 30%) percentage solids.
- ✓ The magnetic separation tests were found to be more encouraging with iron bolls as the matrix in comparison to wire mesh.

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