



Technical Note

Characterization of bauxite fines aiming
to minimize their iron content

H. Kahn *, M.M.L. Tassinari, G. Ratti

*Department of Mining and Petroleum Engineering, Polytechnic School, University of Sao Paulo., Av. Prof. Mello Moraes,
2373, 05508-900 Sao Paulo, SP, Brazil*

Received 3 May 2003; accepted 25 July 2003

Abstract

Samples of the fine and superfine bauxite products from Porto Trombetas were studied in order to make possible the evaluation of the occurrence of iron bearing minerals and to verify the possibilities of minimizing their content. These samples are constituted by gibbsite, 63–68% in weight, iron oxy-hydroxides, 23–21% (basically hematite and goethite), clay minerals, 3–4%, and minor amounts of quartz, anatase, zircon and bohemite. Microscopy studies indicated that the iron is associated with gibbsite as classical locked particles or is presenting a very intimate intergrowth; discrete particles of hematite–goethite are responsible for 50–60% of the iron content. Mineral separations made by both magnetic and heavy liquids with two cut points each were carried out; magnetic and gravity separability curves showed that is possible to achieve a very substantial reduction of the iron content in association with very high recovery levels. The study showed that for bauxite fine and superfine products, Fe₂O₃ grades of 8% and 6%, respectively (53–55% of total Al₂O₃), would be achieved with potential aluminum recoveries at about 90% by gravity concentration or magnetic separation.

© 2003 Elsevier Ltd. All rights reserved.

Keywords: Ore mineralogy; Liberation analysis; Non-ferrous metallic ores; Mineral processing**1. Introduction**

The bauxite deposit of Porto Trombetas is located at the Low Amazon Basin, North of Brazil. The bauxite ore resulted from an in situ geochemical evolution of a thick layer of sediments (Boulangé and Carvalho, 1996). The deposit, showing an average thickness of 6 m, is exploited by Mineracao Rio do Norte (MRN). The bauxite ore from three mines are processed in a single plant; after crushing it is washed and classified by wet screens followed and two sets of hydrocyclones, generating the granulated (–76 + 1.2 mm) fine and superfine products.

In some areas of the deposit the fine and superfine products present high iron contents with free alumina far below the specifications. Fine and superfine pilot plant products with iron grades above 18% of Fe₂O₃ were studied to evaluate the occurrence of the iron

bearing minerals and the possibilities of upgrading the free alumina content above 48%, or, in other terms, to reduce the iron grades to 10–11% of Fe₂O₃.

2. Methods

The samples were submitted to a particle size distribution by wet screening followed by chemical and mineralogical analyses as well as to magnetic and gravity separability studies. Mineralogical analysis were performed by X-ray diffraction, optical microscopy and scanning electron microscopy with energy disperse X-ray spectrometer (SEM-EDS).

Separability analyses were performed by size fraction considering two cut points either for magnetic and gravity separations. Gravity separability curves were attained by heavy liquid separations at 2.53 and 2.95 g/cm³ and the magnetic separability curves with the Frantz barrier field magnetic separator at magnetic fields of 0.4 and 0.65 T.

* Corresponding author.

E-mail address: henrkahn@usp.br (H. Kahn).

3. Results

3.1. Chemical composition and particle size distribution

The chemical composition of the studied samples is presented on Table 1. Free alumina represents the amount of Al_2O_3 relative to gibbsite and reactive silica the SiO_2 the content related to clay minerals.

Particle size distributions presented as undersized cumulative curves are given on Fig. 1 for weight, free Al_2O_3 , Fe_2O_3 and reactive silica grades distributions. Fine and superfine products present 90% of weight below 1.4 and 0.55 mm, respectively, and 15% and 40% below 0.10 mm; the contents below 0.044 mm are almost the same for both products, 10–12%. The behavior of free alumina, Fe_2O_3 and reactive silica grades along the size fractions are quite similar, being relatively homogeneous for the size fractions above 0.044 mm. below 0.044 mm Fe_2O_3 and reactive silica grades increase significantly and the free alumina grades drastically drops; the alumina distribution related to this size fraction is close to the half of the value of the weight distributions.

3.2. Mineralogical assemblages

Mineralogical compositions are shown on Table 1 for both studied samples; they are essentially constituted by

gibbsite and iron oxy-hydroxides (basically hematite and goethite, with minor content of lepidocrocite). Kaolinite, quartz and anatase occur as minor minerals and zircon and bohemite as trace.

Microscopy studies by optical microscopy and SEM-EDS pointed out that significant amount of iron shows a very intimate intergrowth with the gibbsite or is present as classical locked particles. Discrete free particles of hematite-goethite that would be possible separated by physical methods without further comminution represent 50–60% of the total iron content.

3.3. Gravity separability

A summary of the gravity separability results expressed as Al_2O_3 and Fe_2O_3 grades versus Al_2O_3 recoveries curves are presented on Fig. 2 for the material above 0.037 mm. For the fine product sample, it would be possible to minimize the iron content to 8% of Fe_2O_3 reaching a free alumina grade of 50% and total Al_2O_3 of 54% with recoveries of 85% in weight and above 96% for Al_2O_3 . The superfine product presenting a higher liberation degree for the iron bearing minerals allowed a greater reduction; considering a grade of 6% Fe_2O_3 the attained free and total alumina grades are 53% and 56%, respectively, with associated recoveries of 85% in weight and above 97% for the Al_2O_3 content.

Table 1
Chemical and mineralogical composition of the studied samples

Product	Chemical composition (%)						
	Al_2O_3	Fe_2O_3	SiO_2	TiO_2	LOI	Al_2O_3 free	SiO_2 reactive
Fine	46.7	19.5	7.78	1.44	23.8	41.3	3.03
Superfine	48.2	18.4	5.67	1.36	26.3	44.3	3.92
Product	Mineralogical composition (%)						
	Gibbsite	Iron bearing minerals	Quartz	Kaolinite	Anatase	Others	
Fine	63	23	4	8	1.5	<1	
Superfine	68	21	3	7	1.5	<1	

Notes: LOI=loss of ignition at 1100 °C.

Iron bearing minerals: hematite and goethite, with minor content of lepidocrocite.

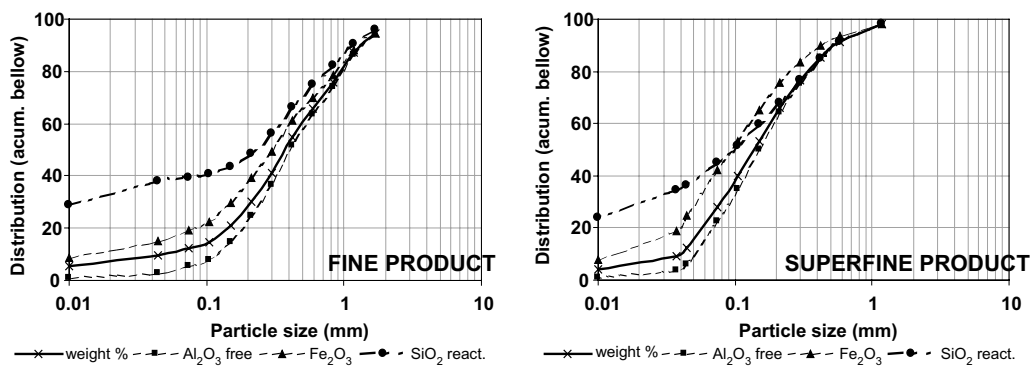


Fig. 1. Particle size distributions for weight, Fe_2O_3 , free Al_2O_3 and reactive silica grades—cumulative undersized distributions.

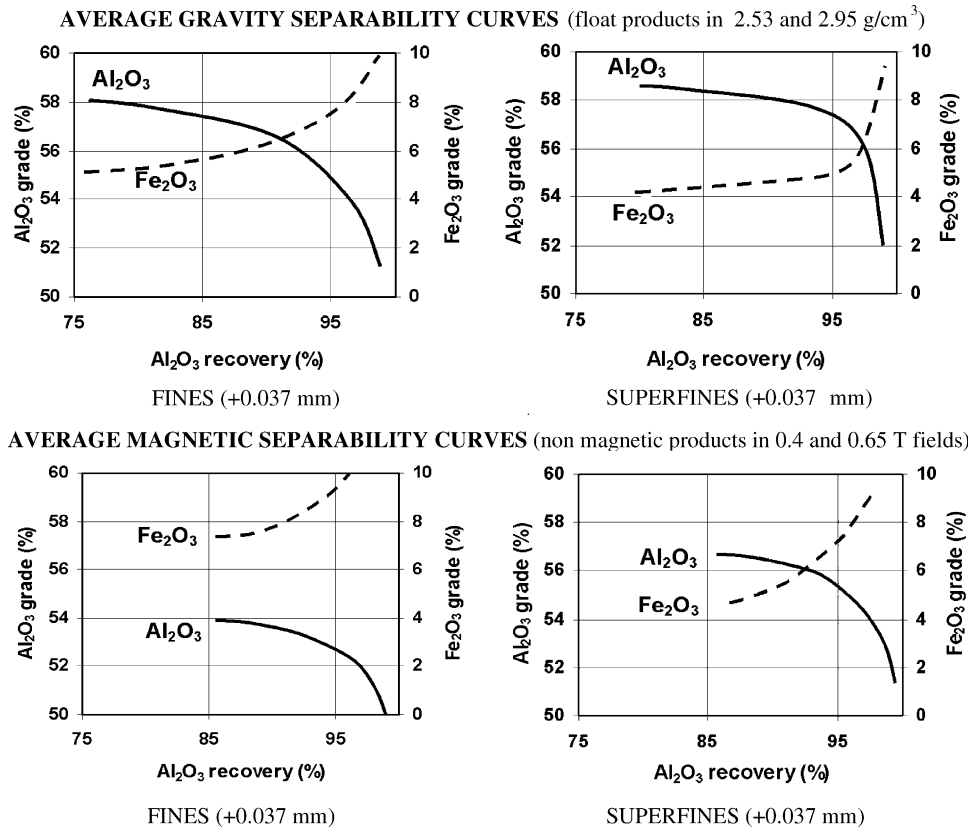


Fig. 2. Gravity and Magnetic separability results expressed as Al_2O_3 and Fe_2O_3 grades versus Al_2O_3 recoveries curves for the material above 0.037 mm.

3.4. Magnetic separability

A summary of the magnetic separability studies expressed as Al_2O_3 and Fe_2O_3 grades versus Al_2O_3 recoveries curves are shown on Fig. 2 for the material above 0.037 mm. The results indicated lower separation efficiencies comparatively to those attained by gravity separation.

Considering an iron content of 8% Fe_2O_3 and free and total alumina grades of 50% and 53%, respectively, the recoveries for the fine product sample are 79% in weight and 91% for Al_2O_3 . Taking into account for superfine products the same above-mentioned grades of gravity separation (6% Fe_2O_3 and 53% and 56% respectively for free and total alumina) the weight and Al_2O_3 recoveries comparatively drops around 4%.

4. Conclusions

Mineralogical studies indicated that the fine and superfine studied products are constituted by gibbsite, 63% and 68% in weight, iron bearing minerals, 23% and 21% (basically hematite and goethite), kaolinite, 3–4%, and minor amounts of quartz, anatase, zircon and bohemite. Microscopy studies showed that a significant amount of iron is related to discrete free particles of hematite–

goethite that would be possibly separated by physical methods without further comminution.

Both gravity concentration and magnetic separation methods would possibly be applied to achieve the desirable decrease on the iron content with high-related alumina recoveries.

Further mineral dressing studies in pilot scale must be performed for a proper evaluation of the best option in face of the very high throughput of the bauxite fine and superfine products, unsteady products flow and local limitations on power supply. Reichert cones and spirals must be considered for gravity concentration after an additional desliming step and WHIMS for magnetic separation.

Acknowledgements

The authors would like to acknowledge Mineracao Rio do Norte for their permit to publish the present data results.

Reference

- Boulangé, B., Carvalho, A., 1996. The bauxite of Porto Trombetas. In: Carvalho, et al. (Eds.), Brazilian Bauxites. USP/FAPESP/ORSTOM. pp. 55–73.