Analysis of the Break-Even Point of Guinea Bauxite Digestion at High and Low Temperature

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Abstract

By analyzing the effect caused by a change of the total alumina and the available alumina contents in the Guinea bauxite on the operating expense excluding overheads, a break-even point of the high and low temperature digestion process is predicted, to assist Chinese refineries that have the possibility to switch between low and high temperature digestion. The model is based on the price of bauxite at 350 Chinese yuan per tonne and of caustic soda at nearly 2,000 Chinese yuan per tonne when the content differential between the total alumina and the available alumina (TA-AA) at low temperature is between 6.7 and 7.8%. The break-even point decreases as the rise of the bauxite price and rises as the rise of the caustic soda price.

Key words: Guinea Bauxite, Break-even Point, Digestion, Alumina.

1. Introduction

With the continuous mining and utilization of bauxite resources in China, the bauxite grade is decreasing year on year, and the domestic bauxite resources are increasingly scarce. In recent years, the consumption of import bauxite is increasing in China, the amount of the import bauxite is approximately 111 million tonnes in 2020. A proportion of about 60% of China's bauxite consumption is from overseas. The following figure shows the distribution of import bauxite sources in 2020 [1].

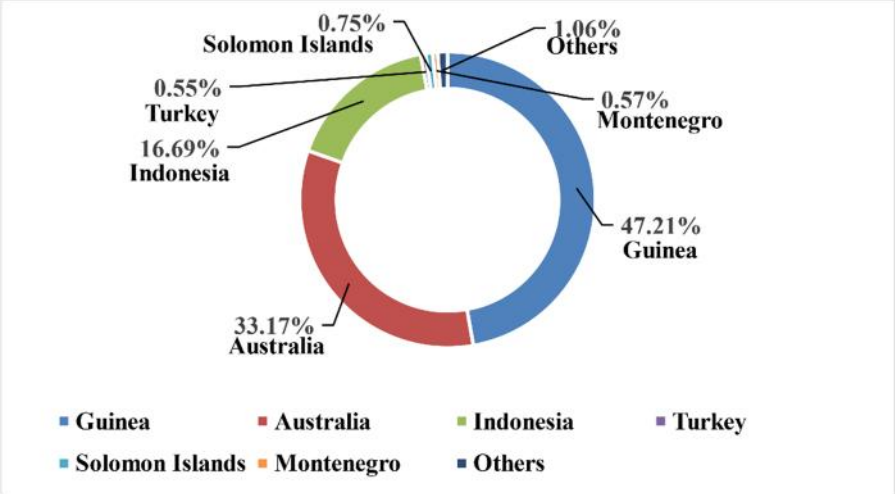

Figure 1. Distribution of import bauxite in China, 2020.

Figure 1 shows that the bauxite imported to China are mainly from Guinea (nearly 50%), Australia, and Indonesia. Processing Guinea bauxite using high or low temperature digestion is always a debate. Currently, most of the alumina refineries processing Guinea's bauxite use a low

temperature digestion process, while a few use high temperature, and some have the possibility to switch between low and high temperature digestion. This paper analyzes the advantages and disadvantages of high and low temperature with bauxite from Guinea in the perspective of operating expense. A break-even point is determined and provides a reference basis for operating strategy for alumina refining.

2. Quality of Guinea Bauxite

2.1 Reserves and Distribution

Guinea bauxite is a typical laterite ore, which is mainly gibbsite with some boehmite. Guinea's bauxite reserves are about 24 billion tonnes, of which 7.4 billion tonnes is proven, accounting for 1/3 of the world's reserves, and the total alumina content is in the 38 to 62 % range. The minerals are mainly distributed in Fria, Kindia, Boke and Telimele regions. Bauxite in the Central Guinea natural area is mainly distributed in Labe, Gaoual and Tougue areas. The minerals distributed in Kindia and Boke districts of Lower Guinea are about 5 billion tonnes. Among them, the average grade of bauxite in Kindia is 46 % Al_2O_3 and 2.8% SiO_2; the average grade of Boke is 44.6 to 60 % Al_2O_3 and 1.8 % SiO_2; in Central Guinea, bauxite in Labe Region is about 500 million tonnes, with Al_2O_3 of 46.7 % and SiO_2 of 2.3 %. There are about 500 million tonnes of high grade bauxite in the Gaoual area, with a resource of about 460 million tonnes, with an average grade of 48.7 % Al_2O_3 and 2.1% SiO_2; there are about 1.9 billion tonnes of bauxite resources in the Tugai and Dabola Provinces of Upper Guinea, with an average grade of 44.1 % Al_2O_3 and 2.6 % SiO_2.

The Boke mining area, including the Boffa Province, is currently the area where Chinese companies are concentrated: WCS, SPIC, CHINALCO, CHICO, and TBEA are all mining bauxite in this area. Most of the bauxite exported to China is from the Boke region.

2.2 Mineral Composition

Guinea bauxite is typically gibbsitic and a series of typical mineral compositions are given in Table 1, for samples from different mine areas. By combination of XRD measurement, chemical analysis and necessary calculation, this set of data shows that the boehmite in the bauxite is highly variable among the analysed samples, and that the percentages of the alumo-goethite and hematite are generally high. In these samples, approximately 20% molar Fe is substituted by Al in goethite.

Table 1. Typical mineral compositions of a suite of Guinea bauxite samples.

Compositions	Gibbsite	Boehmite	Alumo-goethite	Hematite	Kaolinite	Others
Sample 1	60.00%	1.00%	17.00%	15.00%	3.50%	3.50%
Sample 2	62.00%	-	15.00%	10.00%	3.00%	10.00%
Sample 3	61.62%	2.67%	18.46%	8.00%	1.07%	8.18%
Sample 4	54.60%	0.30%	18.80%	16.70%	3.30%	6.30%
Sample 5	50.80%	0.70%	20.80%	18.39%	1.50%	7.81%
Sample 6	76.30%	1.49%	12.84%	4.35%	0.30%	4.72%
Sample 7	58.00%	6.80%	19.24%	11.70%	0.28%	3.98%
Sample 8	60.70%	3.79%	18.86%	9.99%	0.59%	16.07%

6. Conclusions

By accounting for the alumina operation expense, excluding manufacturing costs, based on a bauxite price of 350 Chinese yuan per tonne and a caustic soda price of 1999 Chinese yuan per tonne, for Guinea bauxite, the LTD vs HTD break-even points of the T.A-A.A are 6.7 % or 7.8 % for Group 1 (fixed T.A) and Group 2 (fixed A.A) scenarios, respectively. This means that for a fixed T.A, HTD is more advantageous for bauxite having a T.A-A.A above 6.7 %. On the opposite, for a fixed A.A, LTD is preferred for T.A-A.A above 7.8 %. These break-even point are however variable as well and go down with increasing bauxite price and go up with increasing caustic soda price. Therefore, when processing Guinea bauxite, the financial advantage of operating a high or a low temperature digestion process will vary depending on bauxite, caustic soda and coal price.

7. Reference

1. Dongfeng Zhao, Analysis of the advantages and disadvantages of production cost on imported and domestic bauxite after the surge of sea freight, *Aladdiny Bauxite Industry Development Forum 2021*.
2. Xiaobin Li, Lianlian Kong, Tiangui Qi, Qiusheng Zhou, Zhihong Peng and Guihua Liu, Effect of alumo-goethite in Bayer digestion process of high iron gibbsitic bauxite, *The Chinese Journal of Nonferrous Metals,* Vol. 23, No. 2, (2013), 543-547.
3. Murray, J., Kirwan, L., Loan, M. Hodnett, B. K., In-situ synchrotron diffraction study of the hydrothermal transformation of goethite to hematite in sodium aluminate solutions, *Hydrometallurgy* 2009, 95(3/4): 239−246.
4. Suss, A. G., Maltz, N. S., Aluminium and chromium containing goethites: composition, properties, behavior in soda aluminate liquors in presence of silicon, titanium and calcium compounds, *TMS Light Metals* 1992, 1343−1347.
5. Mal'ts N. S., Mozzhukhina, L., High-temperature Leaching of Bauxites with a High Concentration of Aluminogoethite, *Tsvetnye Metally*, 1981(11): 6−9.