The Evolution of Alumina Production Technology in China, New Challenges and Trends

Gu Songqing
Chief Engineer
Science & Technology Division of Chalco, Beijing, China
Corresponding author: s.q.gu@163.com

Abstract

Great progress in alumina production technology has been achieved by the Chinese alumina industry in three development stages in the past 63 years. The first development stage was implementation of the Sinter and Bayer-Sinter combined processes to treat diasporic bauxite. The second stage was the wide application of the Bayer process for Chinese diasporic bauxite. The third stage has been the adaption of technology for processing medium and low grade Chinese diasporic bauxite based on the Bayer process. The greatest achievements in these stages include implementation of high capacity tube digestion, bauxite beneficiation for silica and sulfur by flotation prior to the Bayer process, high lime addition, and generally increased efficiency and productivity in the Bayer process. Now a series of major new challenges have emerged, where diasporic bauxite with high organic and high sulfur content has to be processed cost effectively, high energy and caustic consumptions have to be reduced, and the utilization of bauxite residues has to be improved. The major assumptions and possible technical solutions for the new challenges are discussed in this paper.

Keywords: China, alumina, Bayer process, sulfur, organics, energy, bauxite residues.

1. Introduction

About 61 million tons of alumina was produced in China in 2016, constituting over 53% of global production. There are 13 alumina companies with an annual production of over 2 million tons. The average production capacity for Chinese refineries is about 1.5 million tons per year.

It can be considered that Chinese alumina production technology has been developed in three major stages over the last 63 years. The Shandong refinery was the first commissioned using the Sinter process in 1954. Following this, the Bayer-Sinter combined process was developed for the local diasporic bauxite. In the recent times, the key production process has become the Bayer process following the successful implementation of high temperature and high caustic Bayer digestion for diasporic bauxite and the economic utilization of the Bayer process for medium and low grade bauxites [1].

Meanwhile, new technology challenges are confronting alumina production in a new era for the Chinese industry. These challenges include the introduction of high organic and high sulfur content bauxites bringing significant challenges to Bayer production stability and alumina quality. Production cost pressures have also increased significantly as the bauxite grade is reduced in the northern areas of China, and the prices of caustic soda and bauxite have increased. Furthermore, the security disposal and/or comprehensive utilization of bauxite residues become important and urgent since most of the Chinese refineries are located in the big population centers near bauxite mines.

New technically efficient and lower cost technology solutions are needed to meet these challenges. These future technology development requirements and trends for the Chinese alumina industry are discussed in this paper.

2. Evolution of Chinese Alumina Industry Technology

The Chinese alumina industry has undergone three development stages in the past 63 years.

Figure 1. Sinter Process in Chalco's Shandong Refinery.

The first stage was the development and application of the sinter process and Bayer-sintering combined process to treat Chinese diasporic bauxite. The diasporic bauxite reserve was explored in Henan and Shandong provinces in the 1950s. The sinter process similar to that used for cement production was applied and put into operation in the Shandong refinery since there was no Bayer technology available in China suitable for diasporic bauxite at that time.

High temperature digestion technology with direct steam injection into digesters was introduced from Russia in the 1950s, and this kind of Bayer process for Chinese diasporic bauxite was first applied in the Zhengzhou refinery in Henan. This technology had high energy consumption due to the direct steam heating. As mentioned above, the Bayer-Sinter combined process was developed in the 1960s, in which both bauxite residue from the Bayer process and low-grade bauxite were mixed with soda ash and limestone and fed into a sintering kiln. The Bayer-Sinter combined process was widely applied in many refineries such as in Henan, Shanxi and Guizhou and became the major refining process in China from the 1970s until the 1990s.

Figure 2. Bayer-Sinter Combined Process in the Chalco's Shanxi Refinery.

The second stage was development and application of the Bayer process with indirect

4.7. Reuse of Bauxite Residue in Environmental Protection Applications

Bauxite residues can be used to treat acidic waste water from flotation tails and other nonferrous metals metallurgical wastes, city river sludge, acidic waste residues from other industries, acidic soil as well as the waste gases containing SO2 owing to their caustic content

Such harmful metal elements as Cr, Pb and Cu can be adsorbed by the bauxite residues because of their high specific surface areas and mineral structures. This is why the bauxite residues are useful for acidic soil amendment. Furthermore, bauxite residues contain many other elements such as Al, Si, Na, Fe and Ca etc, which can be used for inorganic flocculants and agents for environmental management [9].

5. Summary

Three important development stages have been undergone for the Chinese alumina industry: 1) Development and application of Sinter and Bayer-Sinter Combined processes for Chinese diasporic bauxite; 2) Development and application of Bayer process with indirect heating for diasporic bauxite; 3) Development and application of the technology for the medium and low grade diasporic bauxite based on Bayer process.

The Chinese alumina industry faces three new great challenges: 1) High silica, high organic and high sulfur content bauxite to be treated by Bayer process; 2) Further reduction of energy, bauxite and caustic consumptions at lower operating cost; 3) Greater utilization of bauxite residues on the large scale.

The technology development trend for Chinese alumina industry is as follows: 1) Eliminating the hazards from organic and sulfur in the bauxite for the steady and efficient operation of Bayer process; 2) Developing an energy saving and efficient process with low operation cost for the low grade diasporic bauxite; 3) Realizing greater energy savings by waste heat recovery; 4) Developing 1 - 2 large scale bauxite residue utilization technologies for high value-added products.

6. References

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