Recent Research on Recovery of Iron and Aluminium from Bauxite Residue in China

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Abstract

Bauxite residue or red mud is a by-product of alumina extraction from bauxite. Bauxite residue is a very valuable secondary resource as it contains high alumina, iron oxide, titanium oxide, calcium oxide, silica and soda concentrations. In addition, it contains low concentrations of scandium, gallium, vanadium, and other minor elements. Extraction and utilization of metal resources such as iron and aluminum from the red mud can help solving the problem of large-scale storage of red mud, which is of great significance. This article summarizes the recent R&D focused on iron and aluminum recovery from red mud. It highlights the high degree of extraction and recovery (> 90 %) that have been achieved through high-temperature processing and leaching.

Keywords: Bauxite residue, Red mud, Iron and aluminum, Recovery.

1. Introduction

Bauxite residue or red mud is a solid by-product or waste produced during the extraction and production of alumina. This residue is essentially the components of bauxite that are do not dissolved fully in the digestion of bauxite ores and consists of sodium silicate, calcium silicate produced in the Bayer process. The production of 1t of alumina produces 1~2 t of red mud. In recent years the production of red mud in China has reached 100 million t/year. In Figure 1, the current trend covering Chinese production of red mud from 2012 to 2022 is shown. This upward trend is mainly due to the increased production rate of alumina in China. The production of red mud in the world is expected to exceed 150 million t/year, and currently, the estimated mass of stored red mud is about 4 billion tonnes.

At present, there are 53 alumina production enterprises in China, mainly distributed in nine provinces and regions of Shandong, Henan, Hebei, Shanxi, Guizhou, Chongqing, Guangxi, Yunnan and Nei Mongol. Red mud is often treated by open-air storage, which is mainly divided into wet storage and dry storage. In China, dry storage is the main method. Because a large amount of red mud has not been fully utilized for the time being, it not only occupies land for a long time, it has increased maintenance cost, and has an impact on the environment, which directly restricts the sustainable development of the alumina industry.

It is well known that red mud has strong alkalinity, which makes it difficult to process and achieve complete utilization. How to deal with it is still a worldwide problem. At present, the “green utilization” of red mud in China mainly includes extracting valuable metals [1-3], preparing cement and concrete [1,3], preparing ceramics [3], composite materials [4], and so on.

As mentioned earlier, red mud contains iron, aluminum, silicon, calcium, and a small amount of scandium, vanadium, zirconium, and other rare metals. The accumulated reserves of red mud are considerable, and this resource has a large recycling potential; thus, it can be considered a precious secondary resource. Due to the differences in the composition of bauxite ores and various practices used for the extraction of alumina in different countries, the composition of red mud

produced varies considerably. Table 1 lists the main components of red mud that are produced in some countries and shows that Chinese red mud has much lower concentration of iron oxide and higher levels of silica and lime.

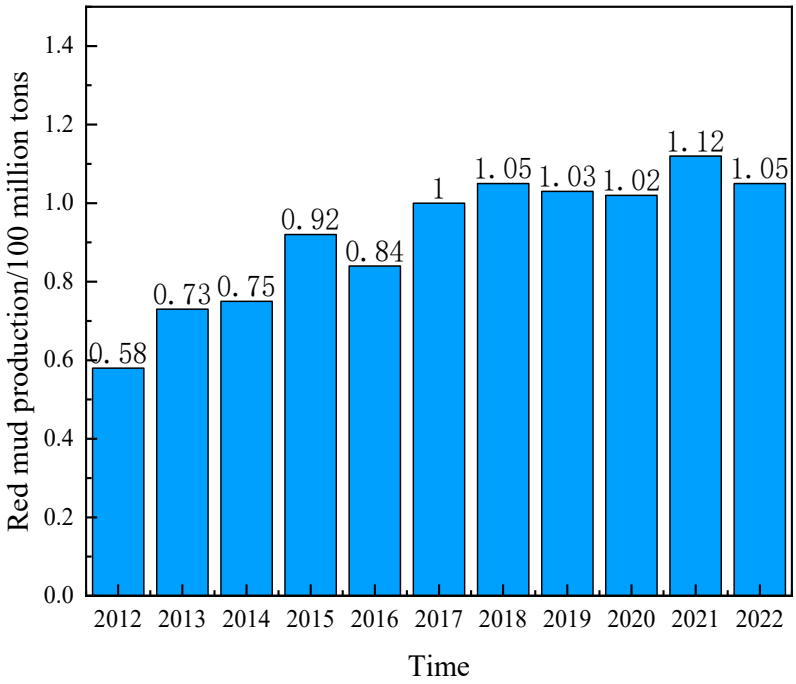

Figure 1. Red mud production in China from 2012 to 2022.

Table 1. Chemical composition of red mud from different countries (%).

Country	Fe_2O_3	Al_2O_3	SiO_2	CaO	Na_2O
France	42.00	14.00	6.00	/	2.00
Greece	45.03	17.22	7.15	8.47	2.65
India	36.69	20.01	6.51	1.43	5.09
Jamaica	46.78	16.32	6.35	4.76	3.56
Romania	44.06	18.51	10.94	4.28	5.0
United States	35.29	17.15	11.22	9.64	5.07
China	16.91	15.01	17.55	23.49	4.60

In the present paper the recent research progress on the recovery of iron and alumina from red mud in China and abroad are reviewed and compared. The main processing steps include direct magnetic separation, roasting reduction-magnetic separation, melting reduction-magnetic separation and leaching iron and aluminum from red mud. The purpose of this paper is to identify a new, simple, and efficient process for iron recovery and to provide a reference for the recovery of iron and aluminum in red mud.

2. Research Status of Iron and Aluminum Recovery in Red Mud

Red mud contains a rich variety of elements and can be used as an important secondary resource for recycling and utilization. Iron in red mud mainly exists in hematite, goethite and other minerals, and aluminum mainly exists in diaspore and tridiaspore and other minerals. At present, scholars at home and abroad have conducted extensive research on the recovery of iron and aluminum from red mud. The recovery process of iron from red mud mainly includes direct

comprehensive utilization of waste and has the advantages of low energy consumption and high alumina leaching rate, which is worthy of further study.

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