Experimental Study on Preparation of Un-fired Bricks by Bauxite Residue and Other Industrial Solid Wastes

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Abstract

Utilization of bauxite residue is a worldwide problem. Bauxite residue with high desulfurization activity, can be used as a desulfurization agent for wet flue gas desulfurization, and the by-product of desulfurization is desulfurized bauxite residue. In this paper, the un-fired brick was prepared by adding desulfurization bauxite residue (red mud), fly ash and boiler slag as the main raw materials. The effects of different proportions of bauxite residue and desulfurized bauxite residue and the addition of slag, lime and cement on the properties of un-fired bricks were studied. Under the optimum ratio, the compressive strength of un-fired bricks cured at room temperature 28d was 22.5MPa, and the bulk density was 1.57g/cm^3. Its technical indicators met the MU20 grade requirements of "Un-fired rubbish gangue brick" (JC/T 422-2007). Using this process to prepare un-fired bricks, a variety of industrial solid wastes can be used in a large amount, with low cost, energy conservation and environmental protection.

Keywords: Bauxite Residue, Desulfurized Bauxite Residue, Un-fired Bricks.

1. Introduction

Bauxite residue is a strong alkaline waste generated from the production of alumina using bauxite as the raw material, which is difficult to utilize [1]. At present, more than 90% of alumina production in China adopts the Bayer process. Due to the difference in production process and bauxite grade, the production of 1t alumina produces about 1~2t bauxite residue [2]. The annual generation of bauxite residue in China is close to 100 million tons, and the cumulative stockpile stock is more than 1.2 billion tons, with a utilization rate of less than 5%. In a large number of cases, the bauxite residue deposits are stacked, which not only occupies a lot of land, but also poses great environmental risks.

The utilization of bauxite residue is a worldwide problem, especially Bayer bauxite residue. Bauxite residue has the characteristics of fine particles, large specific surface area, strong alkalinity, a high content of effective sulfur fixing components, and has strong adsorption capacity and reactivity to SO_2 gas [3,4]. Scholars have carried out a lot of research on bauxite residue for flue gas desulfurization [5-9], and achieved promising technical results. The application of Bayer bauxite residue in industrial flue gas wet desulfurization is the interaction of two harmful substances, which can not only reduce the emission of SO_2 in flue gas, but also realize the dealkalization of bauxite residue. The byproduct of bauxite residue used for flue gas desulfurization is desulfurized bauxite residue, whose Na_2O content can be reduced to less than 1.5%. It has the potential to be used in building materials after activation treatment.

In this paper, in order to find a way for the comprehensive utilization of desulfurized bauxite residue and bauxite residue, and the collaborative utilization of fly ash and boiler slag industrial solid waste. The desulfurized bauxite residue, bauxite residue, fly ash and boiler slag are used as the main raw materials and lime and cement are added to prepare un-fired brick. By compounding the two kinds of bauxite residues, the activity of fly ash is stimulated synergistically, and the strength of un-fired brick is improved, which has more advantages than the traditional preparation of un-fired brick by adding bauxite residue alone.

2. Materials

2.1 Bauxite Residue

In this study, Bayer bauxite residue from an aluminium oxide plant in Guizhou was selected as the raw material. The bauxite residue is reddish brown paste in appearance, with pH value of 11.75 and true density of 2.9g/cm3. Table 1 showed the main chemical composition of the bauxite residue (shown as the metal oxide). The main chemical composition of the bauxite residue is Al_2O_3, Fe_2O_3, SiO_2 and CaO, accounting for about 75.30% of the whole component, followed by Na_2O, MgO and K_2O.

Table 1. The main chemical composition of the bauxite residue.

Element	Al_2O_3	SiO_2	Fe_2O_3	Na_2O	CaO	MgO	K_2O	TiO_2
Content/%	22.20	16.43	21.40	4.37	15.27	1.50	1.04	4.55

The mineral composition of bauxite residue is analyzed by X-ray diffraction analyzer. The main mineral constituents of bauxite residue are shown in Table 2 and the XRD diffraction pattern of bauxite residue is shown in Figure 1. The mineral composition of bauxite residue is chlorite, cancrinite, hydrogarnet, calcite, illite, hematite, perovskite and diaspore.

Table 2. The phase analysis results of bauxite residue*.

Mineral	chlorite	cancrinite	hydrogarnet	calcite	illite	hematite	perovskite	diaspore
Content/%	18.3	18.0	12.5	7.5	6.7	18.5	7.4	5.8

*:XRD semi-quantitative analysis results

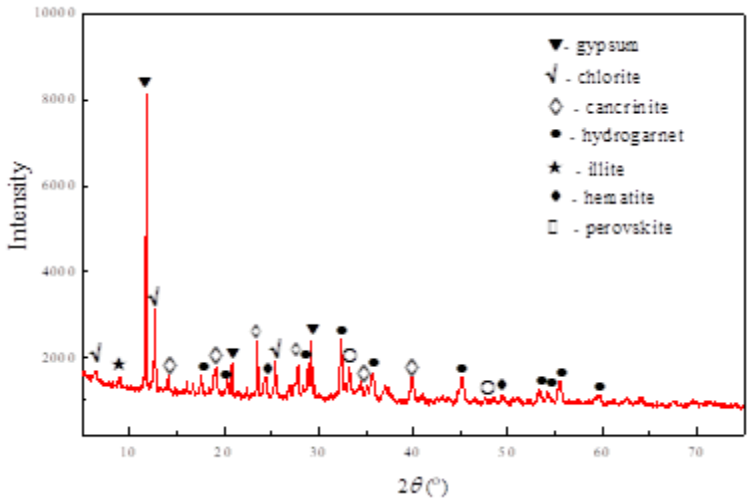

Figure 1. XRD diffraction pattern of bauxite residue.

and $A1_2O_3$, promotes the hydration process, generates more hydration products, and forms ettringite (AFt) with AlO_2^-, Ca^{2+} and OH^- in the system, which increases the stability of the crystal structure and improves the early strength of un-fired brick [11]. By adding lime and cement, fly ash is hydrated under the excitation of $Ca(OH)_2$ to produce hydrated calcium silicate, hydrated calcium aluminate and other components, which improves the later strength and durability of un-fired brick. In addition, during the preparation of un-fired brick, some boiler slag is added as aggregate, which is bonded with cementitious materials to play the role of skeleton support. The addition of aggregate boiler slag can reduce the bulk density of un-fired brick and further improve the strength of un-fired brick.

5. Conclusions

1. Un-fired bricks were prepared with desulfurized bauxite residue, bauxite residue, fly ash and boiler slag as the main raw materials. The optimum ration was found to be: desulfurized bauxite residue 23%, bauxite residue 15.5%, fly ash 15.5%, boiler slag 30%, lime 10% and cement 6%. The compressive strength of un-fired brick cured at room temperature for 28 days is 22.50MPa; its technical performance met the MU20 grade requirements of "Un-fired rubbish gangue brick" (JC/T 422-2007).
2. The alkaline nature of bauxite residue and gypsum component of desulfurized bauxite residue synergistically stimulate the activity of fly ash. At the same time, boiler slag is used as aggregate to improve the strength and durability of un-fired bricks.
3. In the next phase, the industrial test of using bauxite residue for flue gas desulfurization will be carried out on the in-house boiler of the alumina plant, and the industrial test of preparing un-fired bricks with desulfurized bauxite residue and bauxite residue as raw materials and compounding other industrial solid wastes will be carried out.

6. References

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