BX08 - Experimental Research on Preparation of Low Density and High Strength Oil Fracturing Proppant with Bauxite Beneficiation Tailings

Junwei Ma[1,4], Guoliang Wu[2,5]and Jianqiang Zhang[3,6]
1. Senior engineer
2. Director of the institute
3. Assistant director of the institute
Zhengzhou Non-ferrous Metals Research Institute Co. Ltd. of CHALCO, Zhengzhou, China
4. Senior engineer
5. Director of the institute
6. Assistant director of the institute
National Aluminum Smelting Engineering Technology Research Center, Zhengzhou, China
Corresponding author: 33623290@qq.com

DOWNLOAD FULL PAPER

Abstract

In this work, the low density and high strength oil fracturing proppant was first prepared using bauxite beneficiation tailings as the main raw material. The effects of raw material pre-calcination, the iron content, sintering temperature, sintering time and additive dosage on proppant performance were studied. The results indicated that the iron content of bauxite beneficiation tailings was reduced to 2.0 % by magnetic separation, then was pre-calcined at 700 °C for 2 hours, the additive dosage of dextrin of 1.2 %, and the raw meal granules were calcined at 1360 °C for 160min, the formed oil fracturing proppant size was between 0.42 and 0.84 mm, its bulk density was 1.54 g/cm^3, apparent density was 2.81 g/cm^3, and breakage rate under 52 MPa closed pressure was 3.53 %.The prepared oil fracturing proppant can meet the SY/T 5108-2014 requirements according to the standard of proppant using for hydraulic fracturing and gravel packed.

Keywords: Bauxite, beneficiation tailings, low density and high strength, oil fracturing proppant, breakage rate.

1. Introduction

In the process of low-grade bauxite beneficiation, a large number of beneficiation tailings will be produced. The tailings output ratio was generally 25~40 %, and the yield of tailings was increased with the reduction of A/S of the raw ore. Beneficiation tailings was usually handled by tailings pond storage or solidified storage, which not only had huge investment in infrastructure in the early stage, but also had high cost of follow-up management and maintenance, which increased the economic burden of enterprises, occupied a large amount of land, and had potential environmental and safety hazards [1-4]. Bauxite beneficiation tailings contain a large number of clay minerals with extremely fine particle size, viscous properties and low alumina content. By reasonably controlling the contents of Fe_2O_3, K_2O and Na_2O in the tailings, it can be used to produce high-quality low-density oil fracturing proppant. At present, the oil fracturing proppant was mainly made from bauxite [5-8].At present, the production capacity of medium density oil fracturing proppant was seriously excessive in China, while the production capacity of high density high strength and low density high strength oil fracturing proppant was seriously insufficient, especially the demand for low density products was strong, and the domestic market production was very limited, which will be an important development direction of oil fracturing proppant in the near future. In view of the low comprehensive utilization rate of bauxite beneficiation tailings and the serious shortage of low density and high strength oil fracturing proppant in China, the experimental research on Preparation of low density and high strength oil fracturing proppant with beneficiation tailings was carried out.

2. Test

2.1 Test Materials

The bauxite beneficiation tailings used in the test came from a bauxite concentrator in Henan Province. The chemical composition analysis of the tailings is shown in Table 1, and the phase analysis results are shown in Table 2.

Table 1. The chemical composition analysis results of bauxite beneficiation tailings.

Element	Al_2O_3	SiO_2	Fe_2O_3	TiO_2	K_2O	Na_2O	CaO	MgO
Content, %	43.78	32.4	5.46	2.75	0.78	0.16	0.35	0.28

Table 2. The phase analysis results of bauxite beneficiation tailings.

Mineral	Diaspore	Kaolinite	Illite	Hematite	Calcite	Rutile	Anatase
Content, %	19.6	58.2	11.1	5.5	0.6	0.9	1.8

It can be seen from table 1 and table 2 that the beneficiation tailings sourced from Henan Province as raw materials, the main aluminum bearing minerals were diaspore, the main silicon bearing minerals were kaolinite and illite, the main ironbearing minerals were hematite, and the main titanium bearing minerals were rutile and anatase. Its chemical composition basically meets the requirements of low-density oil fracturing proppant for main raw materials.

2.2 Experimental Method

The iron minerals were removed from bauxite beneficiation tailings by high gradient magnetic separator; the beneficiation tailings after iron removal was pre-calcined at 650~800 ℃, and then mixed with a certain amount of dextrin as additive, and then crushed to a particle size less than 0.0374 mm. The above-mentioned materials were granulated by forced stirring granulator to make 18~35 mesh semi-finished products. The semi-finished granules were dried to moisture content less than 3%, and then sintered in a high-temperature tubular rotary furnace. The sintering temperature was 1280~1360 ℃, and the sintering time was 1-3 hours, and the low-density oil fracturing proppant with particle size of 20-40 mesh was prepared.

2.2.1 Pelletizing Process

The high-speed stirring granulator was used for granulation. Before granulation, the powder and water were added into the container, and then the high-speed mixing was carried out. The powder and water were fully mixed, and then the bulbar nucleus was slowly formed and gradually grew up. When the particle grows to a certain size, the needle rod on the stirring rod will smash the ball particles beyond the size again, and the process of ball growing again. After the particles grew to the target size, a small amount of reserved powder with the same formula was quickly put into use for surface coating and polishing, so that the surface of the particles will be smoother, the interior will be denser and easy to disperse.

2.2.2 Sintering Process

A High temperature tubular rotary furnace was used to sinter the products. The qualified raw meal granules were dried and added into the automatic feeding bin, the heating curve was set, the inclination angle and rotation speed of rotary furnace were adjusted, the proppant sintering test was carried out. The sintered products were screened for 20~40 mesh size, and the properties of

4. Conclusions

The bauxite beneficiation tailings used as raw materials was sourced from Henan Province, the iron content was reduced to 2.0 % by magnetic separation, then was pre-calcined at 700 ℃ for 2 hours, the additive dosage of dextrin of 1.2 %, the low density and high strength oil fracturing proppant was prepared after granulation and sintering. The raw meal granules were calcined at 1360 ℃ for 160 min, the formed oil fracturing proppant size was between 0.42 and 0.84 mm, its bulk density was 1.54 g/cm^3, apparent density was 2.81 g/cm^3, and breakage rate under 52 MPa closed pressure was 3.53 %. The prepared oil fracturing proppant met the SY/T 5108-2014 requirements according to the standard of proppant using for hydraulic fracturing and gravel packed.

Through the analysis of the micro morphology and phase of the sample, the main crystalline phase was mullite, the internal structure was dense, the crystal was fully developed, pore distribution was uniform, there was a certain amount of mullite grain in the pore, which improved the compressive strength of the product.

The low density and high strength oil fracturing proppant prepared by using bauxite beneficiation tailings, compared with using conventional raw materials to produce the low density and high strength oil fracturing proppant, can realize the efficient utilization of bauxite tailings, effectively reduce the environmental and safety risks in the process of ore dressing tailings stockpiling, with low production cost and has significant economic and social benefits.

5. References

1. Wang Erxing, Study on the paste stocking technology of bauxite flotation tailings, *Light Metals* 2013, (7): 4-7.
2. DuanWeiping, Guo Jinfeng, Wang Bin, Stacking process of metal mine tailings in china and its development trend, *Metal Mine*, 2013, (12):118-122.
3. Chen Dianzhu, Analysis and research of stacking process and comprehensive utilization of solid mine-tailings, *Hunan Nonferrous Metals*, 2016, (4): 5-8.
4. Chen Zhongxian, Risk analysis and countermeasure for safe operation of dry stacking tailings reservoir, *World Nonferrous Metals*, 2019, (15): 89-90.
5. ChenYe, Lu Jiaxuan, The development of a new oil fracturing proppant, *Journal of Guizhou University of Technology (Natural Science Edition)*, 2003, (4): 24-26.
6. Lv Baoqiang, Liu Shun, Bi Weiyu, Study on preparation process for low density ceramisite proppant, *Foundry Technology*, 2012, (7): 771-773.
7. Xu Na, Li Yonggang, XuYafei, Investigation of preparing oil fracturing proppant using low grade bauxite, *Mining & Metallurgy,* 2016, (5): 55-58.
8. Xu Yafei, Xu Na, Li Yonggang, Study on pelletizing process of oil fracturing proppant preparation by monohydrallite with high iron content, *Mining& Metallurgy*, 2016, (6): 55-59.
9. SY/T 5108-2014, The PRC oil and gas industry standards. Measurement of properties of proppants used in hydraulic fracturing and gravel-packing operations, *Petroleum Industry Press*, 2015, 5-22.
10. Lv Baoqiang, Liu Shun, Bi Weiyu, Study on preparation process for low density ceramisite proppant, *Foundry Technology*, 2012, 33 (7): 771-773.