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Original Research Article

A Review on the Generation and Composition Analysis of Phosphogypsum

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Abstract: As a large amount of solid waste, the treatment of phosphogypsum is closely related to the environmental protection and economic development. At present, with the production of phosphate fertilizer, the amount of phosphogypsum is still rising. This paper summarizes the generation process and composition of phosphogypsum. It is hoped that the summary in this paper can provide some useful information for the impurity removal of phosphogypsum.

Keywords: Phosphogypsum; Generation process; Chemical composition

1. Introduction

Secondary gypsum is the typical representative of bulk solid waste. China is a large country of calcium resources, with abundant reserves of natural gypsum and a large number of secondary gypsum resources. Natural gypsum is mainly gypsum ore, which is divided into dihydrate gypsum ore ($CaSO_4 \cdot 2H_2O$) and anhydrite ore ($CaSO_4$) according to the chemical composition, mainly used for manufacturing cement retarder, to enhance the mechanical properties of cement, the dosage of which accounts for 4-5% of the cement [1-3]. Phosphogypsum (PG) is the representative of the typical secondary gypsum resource, with the development of industry, phosphogypsum production increased year by year, but most still open storage processing ways, accumulative total amount is 400 million tons and in increased year by year, leading to the increasingly serious environmental problems and the safe hidden trouble, more dam and environmental pollution incident have happened [4-7]. In the process of gypsum storage, various impurities and ions soaked by rain and snow will cause pollution to the soil, surface and groundwater, so it is necessary to conduct harmless treatment to the seepage wastewater [5]. Therefore, the sustainable development of chemical enterprises is facing great environmental pressure [8-10].

2. Generation process of phosphogypsum

Phosphogypsum is in the process of wet phosphoric acid production of phosphate rock and sulfuric acid reaction with $CaSO_4 \cdot 2H_2O$ as the main composition of byproduct, it contains a small amount of other impurities, such as phosphorus, fluoride and organic matters [11]. As to wet phosphoric acid production process, phosphate ore is decomposed by sulfuric acid to produce extraction slurry, and then phosphoric acid is filtered and phosphogypsum is produced at the same time. The main reaction equation is as follows:

$$Ca_5F(PO_4)_3 + 5H_2SO_4 + 10H_2O = 5CaSO_4 \cdot 2H_2O + 3H_3PO_4 + HF$$

The phosphate is available in many countries, Figure1 shows the 15 top phosphate-producing countries [12].

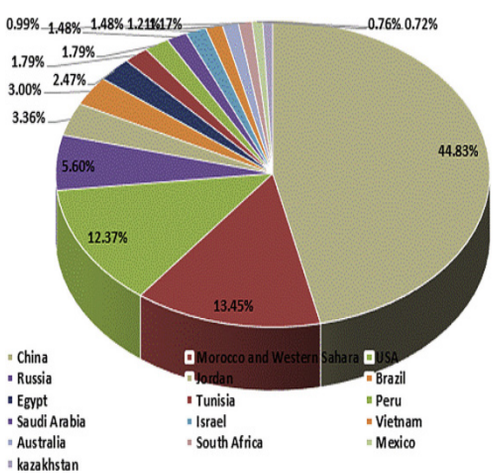

Fig.1 The 15 top phosphate-producing countries.

For every 1.0t phosphoric acid produced, 4.5~ 5.0t phosphogypsum is produced [13-17]. At present, the annual emission of phosphogypsum in the world is up to 150 million tons, and about 80 million tons in China. The emission of phosphogypsum is increasing year by year with the rapid development of high-efficiency compound fertilizer industry. At present, about 200 million tons of phosphogypsum have been accumulated in China, most of which are in idle state. The comprehensive utilization rate of phosphogypsum is only 20%. Because of the phosphogypsum containing phosphorus, fluorine more harmful impurities, arbitrary discharge and the long-term accumulation can cause the pollution of surface water and groundwater, it had a great environmental problem [18-19], therefore, China during the twelfth five-year in bulk solid waste comprehensive utilization plan requires 30% phosphorus gypsum utilization.

3. The composition analysis of phosphogypsum

The main chemical composition of phosphogypsum is basically the same as that of natural gypsum, which also contains P_2O_5, SiO_2, Al_2O_3, Fe_2O_3, organic compounds and a small amount of cadmium, lead, sodium

doi: 10.18282/l-e.v10i1.2120

and other elements [20-22]. The chemical composition of phosphogypsum in different production enterprises and batches is slightly different, which is mainly related to the control of phosphoric acid production process conditions and the variety of phosphate ore. Phosphogypsum still has higher water content, free water content is as high as 19~25%, show dispersive fine grain, pH is about 3~5, the aged phosphogypsum mostly presents off-white, some presents earthen yellow, whiteness is about 35~60 [22]. Phosphogypsum mainly exists in the form of plate crystal, polycrystalline crystal, dense crystal and acicular crystal [23-24]. In the process of wet process phosphoric acid production, some phosphorus ores are not decomposed, phosphogypsum washing is not complete, and isomorphic substitution is the main reason that phosphogypsum contains phosphorus, silicon and other impurities. The presence of impurities makes the performance of phosphogypsum inferior to natural gypsum [25], which cannot be directly applied to the production of gypsum building materials and high-end gypsum products. Therefore, it is necessary to pretreat phosphogypsum to remove impurities before high value utilization can be realized.

4. Summary and outlook

As a kind of bulk solid waste, the treatment of phosphogypsum is closely related to the improvement of economic development and the protection of resources and environment. At present, the comprehensive utilization rate of phosphogypsum resources in China is still far behind that in developed countries, and there is still a lot of work to be done. It is necessary to explore a way of comprehensive, continuous and efficient impurity removal of the phosphogypsum according to the generation process and composition analysis of phosphogypsum, laying a foundation for large-scale clean and high value utilization of phosphogypsum resources.

References:

[1] Liu Hongyan, Shi Huisheng. Research status and typical process of desulfurization gypsum application technology [J]. Mining and metallurgy, 2006, 15 (4): 56-60

[2] Wei Xin, Hong Caixia. Basic performance analysis and application development of FGD gypsum [J]. Application technology, 2006, (11): 64-66

[3] CongGang, Xing Shijian, Zhang Hu. Study on properties of desulfurized gypsum [J]. New building materials, 1997, (12): 10-12

[4] Li Yichen, Yang zaiyin, development trend of comprehensive utilization technology of phosphogypsum, phosphate fertilizer and compound fertilizer, 2018, 33 (2), 1-6.

[5] Zheng Lei, Chen Hongkun, Wang Huaili, Qi Yingjie, Gao Luyang, Zhang Susu, comprehensive utilization status and development suggestions of phosphogypsum in China, phosphate fertilizer and compound fertilizer, 2017, 32 (3), 33-35.

[6] Ye Xuedong, utilization status, existing problems and suggestions of phosphogypsum in China in 2016, phosphate fertilizer and compound fertilizer, 2016, 32 (7), 1-3.

[7] Li Chunhong, Qin Gang, Huo Jichuan, progress in industrial resource utilization of phosphogypsum, Sichuan building materials, 2011, 3, 1-3.

[8] Zhang Tianyi, Hu Hong, he Bingbing, Jietian, ammonium sulfate production from phosphogypsum and by-product calcium sulfate process, chemical minerals and prices, 2017, 2, 31-34.

[9] Wang Xinlong, Zhang Zhiye, Yang Shouming, Yang Xiushan, Zhong Xiangang, Zhong Benhe, Hu Wei, Zhang Yong, key technologies and engineering progress of sulfuric acid production from sulfur decomposing phosphogypsum, phosphate fertilizer and compound fertilizer, 2017, 32 (12), 24-28.

[10] Gong Jiazhu, phosphogypsum sulfur resource recycling production technology, fertilizer industry, 2017, 6, 11-20 + 25.

[11] Shen, Y.; Qian, J.; Chai, J.; Fan, Y. Calcium sulphoaluminate cements made with phosphogypsum: Production issues and material properties. Cem. Concr. Compos. 2014, 48, 67-74.

[12] Mineral Commodity Summaries, 2016. Department of the Interior, U.S. Geological Survey, pp. 1-202.

[13] Singh M. An Improved Process for Purification of Phosphgysum[J].Construction and Building Materials, 1996, (8): 597-601.

[14] Wang Xiaocen, Li Shuqin, Xu Jinggang. Prospect of agricultural application of phosphogypsum [n]. China agronomy bulletin, 2010, 26(4): 287-294.

[15] Wu Peizhi. Wet process phosphoric acid [M]. Chemical Industry Press, 1991

[16] Ma Lei, Liu Li, Yang Lin, et al. Resource utilization of phosphogypsum [J]. Guizhou chemical industry, 2004, (2): 14-17

[17] Han Qing, Luo Kangbi, Li Huping, et al. Development and utilization of phosphogypsum [J]. Chemical technology, 2012, 20 (1): 53-58

[18]Al-Hwaiti, M.; Al-Khashman, O. Health risk assessment of heavy metals contamination in tomato and green pepper plants grown in soils amended with hosphogypsum waste materials. Environ. Geochem. Health 2015, 37(2), 287-304.

[19] Rashad, A. M. Potential use of phosphogypsum in alkali-activated fly ash under the effects of elevated temperatures and thermal shock cycles. J. Cleaner Prod. 2015, 87, 717-725.

[20] Taher M A. Influence of thermally treated phosphor gypsum the properties of Portland slag cement[J]. Resources Conservation and Recycling, 2007, 52(1): 28-38.

[21] Feng Jinhuang. Phosphogypsum and its comprehensive utilization [J]. Inorganic salt industry. 2001, 33(4):34-36.

[22] Marusia Renteria Villalobos, 19nacio Vioque. Juan Mantero, et a1, Radiological, chemical and morphological eharacterizations of phosphate rock and phosphogypsum from phosphoric acid factories in SW spain[J].Journal of Hazardous Materals, 2010, 181(1-3):1934203.

[23] Zhuo Ronghui. Characteristics of phosphogypsum and development and application approach [J]. Shandong building materials, 2005, 26 (1): 46-48

[24]Wang Qinfang, Zhang Chaohui, Yang Jiangjin. Characteristics of phosphogypsum and its resource utilization of building materials [J]. Brick and tile. 2008,16(5):57-59.

[25] Singh, Manjit. Role of phosphogypsum impurities on strength and microstruction of selenite plaster[J]. Construction and Building Materlais, 2005, 19: 480-486.