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ScienceDirect

Procedia Environmental Sciences 31 (2016) 153 – 161

Procedia Environmental Sciences

The Tenth International Conference on Waste Management and Technology (ICWMT)

An study on preparation and utilization of tourmaline from tailings of an iron-ore processing plant

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Abstractt

This paper deals with a systematic research on preparation and utilization of tourmaline from tailings of an iron ore processing plant in Xinjiang, China. Tourmaline has the characteristics of piezoelectricity, thermoelectricity, spontaneous polarization and far-off infrared radiations. Ultra-fine powders of tourmaline have extensive applications in the fields of electrical, chemical and environment protection, as well as health protection. Tourmaline with finer particle size or larger specific surface area will have better industrial performance. After a brief introduction about the applications of tourmaline for functional material, the combined process with gravity separation, ultra-fine dry grinding, and ultra-fine wet grinding is introduced and the preparation technology of ultra-fine tourmaline powder discussed. Using this technology it is possible to produce tourmaline powder with particle size smaller than 100 nm, and a continuous production process can be realized. The final powder product has much superior performance such as high whiteness and large specific surface area, and its negative ions emission can reach the value of 7190 ions per cubic centimeter.

Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific

Keywords: Tourmaline; Ultra-fine grinding; Jet mill; Stirred ball mill; Particle size; Negative ion

1. Introduction

As the most abundant industrial waste material, the tailings from mines in China have amounted to a total mass of more than 20 billions tons, which occupy a lot of precious farming land. The utilization of tailings as new resources has become one of the hotspot topics and presents a real challenge for the Chinese mining industry. This paper deals with a systematic study on the recovery and enrichment of tourmaline from tailings of an iron-ore

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Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific
doi:10.1016/j.proenv.2016.02.021

processing plant in Xinjiang, China by high-intensity magnetic separation and gravity concentration, and the utilization of the prepared tourmaline product.Being called as "Emerald jade seal", tourmaline is a boron-bearing silicate mineral, with trigonal and trigonalrhombohedron crystal structure. The molecular formula of tourmaline is $Na(Mg,Fe,Mn,Li,Al)_3Al_6[Si_6O_{18}]\bullet[BO_3]_3(OH,F)_4$, containing trace elements such as: V，Cr，Zr，Mn，Ti，Sr and Ga. Based on its main components, tourmaline can be characterized into aphrizite, tsilaisite, uvite and buergerite. Occurring in prismatic form, tourmaline is produced in granite pegmatite or high temperature-gas hydrothermal minerals[1, 2]. Tourmaline has the characteristics of infrared emission, piezoelectricity, pyroelectricity and spontaneous polarization, and widely applied in electronics, chemical, environment protection and health field. A lot of experimental data showed that the effects of piezoelectricity and pyroelectricity increase as the fineness and the specific surface area of the tourmaline powder increase.

As a noble nature functional material, the application and preparation of tourmaline is still under development. Chen Xubo and etc[3]. made a review and prospection on the applications and development of modified tourmaline powder, while Huang Yunlong, zheng Shuilin[4] and others researched on the tourmaline processing techniques and its application prospects. Ji Liyuan[5] applied a technology of two stages grinding with a low-speed-stirring grinding circuit and a high-speed-stirring grinding circuit, obtaining an ultra-fine tourmaline powders with the fineness of d95 ≤-2 μm. Zheng Shuilin[6] and others obtained the super fine tourmaline powders with the fineness of d50 ≤0.8 μm and d97 ≤2.0 μm by using the agitating mill. Song Yu[7] studied the effect of the wet grinding in different conditions, such as different milling time, ratio of solid to liquid, solvents and amounts of grinding aid.

This paper mainly introduced the possible fields of applications of tourmaline powder, and studied gravity-pneumatic ultra-fine dry grinding-stirred ball milling composite process, which potentially can produce super-fine tourmaline powder with particle size in micron, sub-micron and nanometer range with narrow particle size distribution. By optimization techniques, high whiteness, fine particle size（d_{50}≤ 0.5 μm), narrow particle size distribution(d_{max}≤ 3.0 μm), and regularly particle shaped ultra fine tourmaline product can be produced.

2. The applications of tourmaline powder

The main production countries of tourmaline are Russia, USA, Burma, Brazil and etc. Africa is also rich in tourmaline. In China, tourmaline resources mainly distributed in Xinjiang, Inner Mongolia, Yunnan, Jilin, Shangdong and other pegmatite developing area. As a new type of mineral in the industry, stem from its unique properties, tourmaline is widely applied in electronics, chemical, environment protection and health field.

2.1. Water and waste water treatment

Tourmaline has permanent spontaneous electrode in nature, as well as the electrode produced from tourmaline has strong adsorption on heavy metals ions（Cu^{2+}、Pb^{2+}、Zn^{2+}、Cd^{2+}）and other impurities[8]. Infrared ray emitted from tourmaline can resonance with hydrogen bond in water and essentially activates the water molecular into small clusters, which could inhibit the proliferation and reproduction of bacteria in water. Therefore, tourmaline has widely application in activation of drinking water and sewage treatment. Industry applications are environmental washing ball, drinking water purification ceramic ball and so on.

2.2. Functional textile fibre

Tourmaline has the ability to emit negative ions and far-infrared radiation. Apply tourmaline powder with maximum particle size less than 3μm in the production of artificial fibre wire, producing "anion fibre", which have heat preservation and deodorizing effects. It can also enhance blood circulation inside human body, which could increase human physiological functions.

2.3. Medical care

Tourmaline can emit far-infrared electromagnetic wave with wavelength of 4-14μm, which matches the absorption spectrum of human body, and hence absorbed by human tissues, increase the temperature of human