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Saudi Journal of Biological Sciences

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ORIGINAL ARTICLE

Desulphurization characteristics of bamboo charcoal from sulfur solution



Shengbo Ge ^{a,1}, Zhenling Liu ^{b,1}, Rende Li ^a, Yuzo Furuta ^c, Wanxi Peng ^{a,c,*}

^a School of Materials Science and Engineering, Central South University of Forestry and Technology, Changsha 410004, China

^b School of Management, Henan University of Technology, Zhengzhou, Henan 450001, China

^c Laboratory of Biomaterials Science, Kyoto Prefectural University, Kyoto, Japan

Received 28 June 2016; revised 31 August 2016; accepted 1 September 2016

Available online 22 September 2016

KEYWORDS

Bamboo charcoal;
Adsorption;
Desulfuration;
Fe₂(SO₄)₃;
Na₂SO₄;
Na₂S₂O₈;
S;
Na₂SO₃

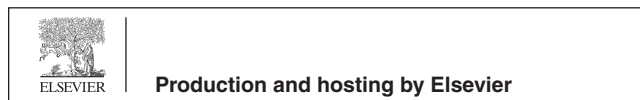
Abstract Sulfur powder and sulfur dioxide (SO₂) often floated in air, produced acid rain and algal blooms, and could cause diseases. Bamboo charcoal could have adsorption and filtration properties. In order to figure out the optimal adsorption condition and the intrinsic change of the bamboo charcoal, five chemicals were adsorbed by bamboo charcoal and were analyzed by FT-IR. Fe₂(SO₄)₃'s, Na₂SO₄'s, Na₂S₂O₈'s, S's, and Na₂SO₃'s optimal adsorption condition was the concentration of 19 g/1000 g and stir time of 20 min, 21 g/1000 g and stir time of 60 min, 7 g/1000 g and stir time of 120 min, 11 g/1000 g and stir time of 120 min, 21 g/1000 g and stir time of 60 min, respectively. FT-IR spectra showed that for FT-IR spectra of Fe₂(SO₄)₃, the transmissivity of the peaks at 3435 cm⁻¹ and 2925 cm⁻¹ achieved the maximum for 60 min and the concentration was 19 g/1000 g, the transmissivity of the peaks at 1630 cm⁻¹, 1060 cm⁻¹ and 660 cm⁻¹ achieved the maximum for 60 min and the concentration was 7 g/1000 g. For FT-IR spectra of Na₂SO₄, the transmissivity of the peaks at 1630 cm⁻¹, 1060 cm⁻¹ and 660 cm⁻¹ achieved the maximum for 20 min and the concentration was 13 g/1000 g. For FT-IR spectra of Na₂S₂O₈, the transmissivity of the peaks at 3435 cm⁻¹, 2925 cm⁻¹, 1630 cm⁻¹ and 1060 cm⁻¹ achieved the maximum for 120 min and the concentration was 19 g/1000 g. For FT-IR spectra of S, the transmissivity of the peaks at 3435 cm⁻¹, 2925 cm⁻¹, 1630 cm⁻¹ and 1060 cm⁻¹ achieved the maximum for 20 min and the concentration was 11 g/1000 g, 17 g/1000 g and 21 g/1000 g. For FT-IR spectra of Na₂SO₃,

* Corresponding author at: School of Materials Science and Engineering, Central South University of Forestry and Technology, Changsha 410004, China.

E-mail address: pengwanxi@163.com (W. Peng).

¹ Co-first author.

Peer review under responsibility of King Saud University.



the transmissivity of the peaks at 3435 cm^{-1} achieved the maximum for 120 min and the concentration was 5 g/1000 g, the transmissivity of the peaks at 2925 cm^{-1} , 1630 cm^{-1} and 1060 cm^{-1} achieved the maximum for 120 min and the concentration was 11 g/1000 g. In these states, the number of the transmissivity of the maximum peaks is the largest.

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1. Introduction

The majority of sulfur comes from industrial waste water, such as chemical fertilizers, processed meat, leather and other industries, city life sewage and farmland irrigation are also the main sources (Luo, 2013; Wang, 2010). Sulfur is a rich nutrient pollutant, after entering water can cause algal blooms, cause eutrophication of the water body, their spread will pollute the environment and disrupt the ecological balance, will also harm human health through food chain channels, it is likely to lead to drinking-water toxicosis. Sulfide formation of acid rain in the air and water and other substances reaction (Chen and Yao, 2009). In Shanghai, the researchers found that: SO_2 concentrations in the atmosphere for every $10\text{ }\mu\text{m}^3/\text{m}^3$, respiratory disease deaths in increments of 5% (Zou, 1991). Sulfur powder and sulfur dioxide (SO_2) often floated in air. Whenever and wherever, it could cause diseases.

In China, Bamboo planting is very large, it has a kind of short growth cycle and timber fast biomass resources. Therefore, bamboo charcoal is a natural, renewable environmental protection material and functional material. Bamboo charcoal was created by heating bamboo at temperatures of $600\text{--}900\text{ }^\circ\text{C}$, then the charcoal itself was processed and mixed in with fabrics as part of the growing field of nanotechnology (Yang et al., 2005; Abe et al., 2001; Kawashita et al., 1994; Mizuta et al., 1994; Wang et al., 2006; Xue et al., 2014; Cui et al., 2014, 2015; Peng et al., 2012a, 2014a,b). Bamboo charcoal has a lot of positive qualities (Yang et al., 2005; Abe et al., 2001; Kawashita et al., 1994). The highly porous structure of the bamboo fabric, could absorb sulfur-based compounds (Abe et al., 2001; Kawashita et al., 1994; Mizuta et al., 1994; Wang et al., 2006; Xue et al., 2014; Cui et al., 2014). What's more, bamboo charcoal, which contained potassium, calcium and other minerals, could have adsorption and filtration of extractives, oil, and other substances (Peng et al., 2013a,b,c, 2012a,b, 2011; Xiao et al., 2013; Wang et al., 2013; Liu et al., 2008; Zhang et al., 2008; Qi et al., 2012). That was beneficial for people's health. But so far, the bamboo charcoal in coal-fired flue gas pollution control in the field of study is less reported. In order to figure out the optimal adsorption condition and the intrinsic change of the bamboo charcoal, five chemicals were adsorbed by bamboo charcoal and were analyzed by FT-IR.

2. Materials and methods

2.1. Materials

Bamboo charcoal, $\text{Fe}_2(\text{SO}_4)_3$, Na_2SO_4 , $\text{Na}_2\text{S}_2\text{O}_8$, S, and Na_2SO_3 were purchased from the market.

2.2. Methods

$\text{Fe}_2(\text{SO}_4)_3$ powder was weighed in amounts of 7 g, 19 g, and 21 g. These powder and 4 g over dry bamboo charcoal were put into beaker which equipped with 1000 ml water, respectively. It was stirred in a beaker for 20 min, 40 min and 60 min. Na_2SO_4 powder was weighed in amounts of 13 g, 19 g, 21 g. These powder and 4 g over dry bamboo charcoal were put into beaker which equipped with 1000 ml water, respectively. It was stirred in a beaker for 20 min, 60 min and 80 min. $\text{Na}_2\text{S}_2\text{O}_8$ powder was weighed in amounts of 7 g, 13 g, 19 g. These powder and 4 g over dry bamboo charcoal were put into beaker which equipped with 1000 ml water, respectively. It was stirred in a beaker for 40 min, 100 min and 120 min. The S powder was weighed in amounts of 11 g, 17 g, 21 g. These powder and 4 g over dry bamboo charcoal were put into beaker which equipped with 1000 ml water, respectively. It was stirred in a beaker for 20 min, 100 min and 120 min. The Na_2SO_3 powder was weighed in amounts of 5 g, 11 g, 21 g. These powder and 4 g over dry bamboo charcoal were put into beaker which equipped with 1000 ml water, respectively. It was stirred in a beaker for 40 min, 60 min and 120 min. Each bamboo charcoal was removed, dried, and weighed, respectively.

FT-IR spectra. FT-IR spectra of the above samples were obtained using a Thermo Scientific Nicolet iN10 FT-IR microscope as previously (Lin et al., 2015; Peng et al., 2014c; Sun et al., 2014).

3. Result and analysis

Based on the above test, the results of adsorption were obtained and listed in Table 1.

3.1. SC effect

Based on Table 1, when the concentrations of $\text{Fe}_2(\text{SO}_4)_3$ were 7 g/1000 g, 19 g/1000 g, 21 g/1000 g, $\text{Fe}_2(\text{SO}_4)_3$'s adsorption capacity were 0.99 g/100 g, 6.84 g/100 g, 2.98 g/100 g, 1.26 g/100 g, 0.75 g/100 g, 5.32 g/100 g, 0.74 g/100 g, 0.5 g/100 g, 3.79 g/100 g for the stir time of 20 min, 40 min, 60 min, respectively. When the concentrations of Na_2SO_4 were 13 g/1000 g, 19 g/1000 g, 21 g/1000 g, Na_2SO_4 's adsorption capacity were -0.7 g/100 g, 0.5 g/100 g, 0.5 g/100 g, 0.25 g/100 g, 1.26 g/100 g, 4.23 g/100 g, 0.25 g/100 g, 2.01 g/100 g, 1.99 g/100 g for the stir time of 20 min, 60 min, 80 min, respectively. When the concentrations of $\text{Na}_2\text{S}_2\text{O}_8$ were 7 g/1000 g, 13 g/1000 g, 19 g/1000 g, $\text{Na}_2\text{S}_2\text{O}_8$'s adsorption capacity were 1.76 g/100 g, 1.52 g/100 g, 1.77 g/100 g, 0.75 g/100 g, 1 g/100 g, 0.5 g/100 g, 4.36 g/100 g, 0 g/100 g,

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