Paper ID: 394 Topic: Production and Commercial Applications of Activated Carbons

An Investigation on Removal of Organic Pollutes in Water Using Biological Activated Bamboo Charcoal

*Lisi Zhu[1], Zheng-Hong Huang[1], Feiyu Kang[*1] and Donghui Wen[2]*

1 Laboratory of Advanced Materials, Department of Materials Science and Engineering, Tsinghua University, Beijing 100084, China

2 College of Environmental Sciences, Peking University, Beijing100871, China

Abstract

Bamboo charcoal, as a kind of biomass carbon, is suitable for water treatment because of its abundant resource, low cost, and rich micro-pores. The present work studies biological activated bamboo charcoal (BABC) for wastewater treatment. The activated bamboo charcoal (ABC) was prepared by a tube furnace and was characterized by nitrogen method at 77 K and scanning electron microscopy (SEM). It showed that ABC possesses a significant difference in pore characteristics, comparing with traditional activated carbon, thus it may be suitable for microorganism growing on. The microorganism was selected for its excellent decomposition ability to organic pollutes, and was loaded on ABC. For the treatment of phenol solution, the removal rate with BABC was higher than that with ABC only due to the synergic effect.

***Key words**:* Charcoal; Adsorption; Bioactivity

Introduction

In recent years, the potential of biological film reactors to remedy contaminated water has been recognised. Biofilm reactors are advantageous in that the biomass is active even at very low concentrations of target organic chemicals (Lee and Lu, 1994), and the system's usage life is prolonged and more stable comparing with the sorption effect of absorbent (Zhou and Hu, 2006). Bamboo is a green natural resource in China and has become popular in materials science research especially in carbon field. Activated bamboo charcoal is a good bacterial immobilization matrix as it is very adsorptive and rich in micron-sized pores (Jiang and Zhang, 2004). In this paper, we investigated on the adsorption and degradation effect of BABC.

Experimental

ABC was prepared from bamboo grown in Zhejiang Province by using a tube furnace: carbonized at 800 ℃ in nitrogen for 1 h and activated with CO_2 at 800 ℃ for 3 h. Then ABC was grinded and washed several times with deionised water to remove carbon fine particles, before dried in an oven at 120 ℃. A kind of facultative bacteria (W24—Ochrobactrum anthropi) was provided by College of Environmental Sciences, Peking University. Its good catabolism in phenol had been detected. The bacteria were immobilized on ABC following the procedure as below: under an aseptic condition, 1.5 g ABC was immersed in 200 ml enriched bacterial culture at a pH value of 7. After that, the flask was put onto an auto-shaker and was continuously shaken at 180 rpm at 30℃. 11 days later, bacterial culture

[*] Corresponding author: Prof. F. Kang

E-mail: fykang@tsinghua.edu.cn; Tel: 8610-62773752

medium was replaced by phenol solution with a concentration of 90 mg/L. The ever-changing concentrations of phenol solution with time were measured. Another reactor without inoculums was used as a reference group.

The N_2 adsorption-desorption isotherms of the ABC were measured at 77 K using ASAP2010 (Micromeritics, USA) in order to determine the specific surface areas and pore structure parameters. The specific surface area was calculated by using the BET equation and the total pore volume and the micro-pore volume can be obtained. Scanning electron microscope Quanta 200 (FEI) was employed to observe external morphology of both ABC and BABC samples. The concentration of phenol was detected by UV spectroscopy at 270 nm in spectrophotometer TU-1800pc.

Results and Discussion

Fig.1 shows that the nitrogen adsorption isotherm belongs to type□ according to the Brunauer classification, which exhibits a characteristic of microporous materials. Table 1 lists the specific surface area and volume, which suggest that the micropores in ABC dominate. However, Fig.2 shows that ABC inherited the microstructure of bamboo and existed micron-sized pores. Hence it may be suitable for microorganism to grow on.

Table 1. Porosity of ABC characterized by nitrogen method at 77K

Area (m^2/g)		Volume (cm^3/g)	
BET Surface Area	Micro-pore Area	Total Pore Volume	Micro-pore Volume
632	565	0.300	0.262

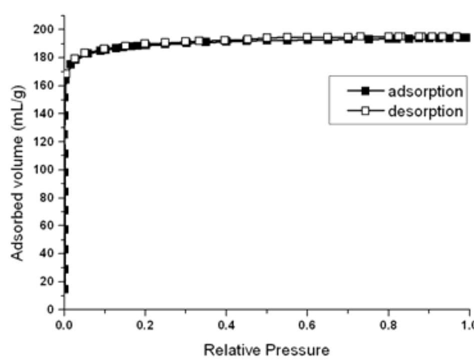

Fig. 1 Nitrogen sorption isotherms of ABC

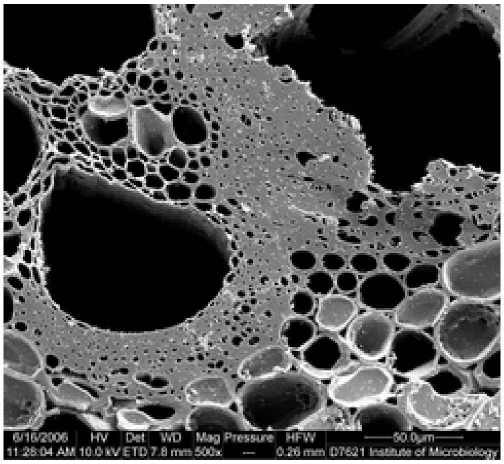

Fig.2 SEM micrograph of ABC

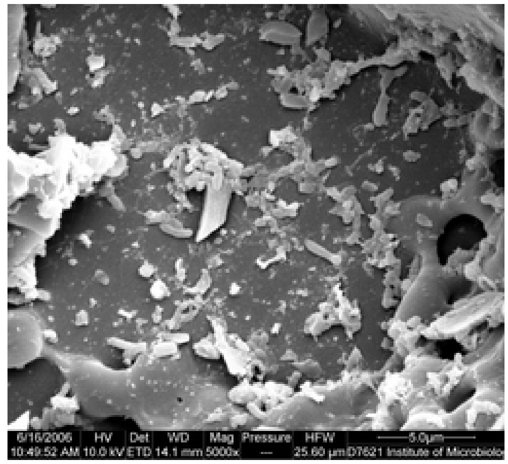

Fig.3 SEM image of microorganisms on ABC

After 11 days of operation, aggregation of biomass was observed. Fig.3 illustrates the surface of BABC observed by SEM. Many rod-shaped bacteria can be found living on the ABC. The rough surface and micron-sized pores of ABC provides a suitable dwelling for bacteria to reside. Fig.4 shows the comparison of phenol's concentration declined only by absorption with the combined effect of absorption and biodegradation with time. The total amount of phenol eliminated by BABC (20.13 mg/g) at the equilibrium is a little more than ABC (16.91 mg/g), and the concentration decline of phenol treated with BABC is a little more stable than that with ABC. The concentration of phenol for these experiments was low due to the consideration of the endure ability of W24, which are also coincident with the report (Lee and Lu, 1994) that biofilm reactors are advantageous at very low concentrations of target organic chemicals. The result of this study is similar to several reports (Lee and Lu, 1994; Caldeira and Heald, 1999) both in the extent of microorganism aggregation and the degradation proportion.

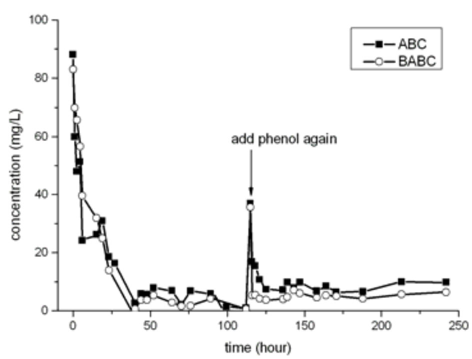

Fig.4 Concentration of phenol declined by absorption and by the combined effect of absorption and biodegradation

Conclusion

Activated bamboo charcoal is a good bacterial immobilization matrix because of its high specific surface area and many micron-sized pores. While biological activated bamboo charcoal appeared to exhibit an advantage over pristine carbon adsorbent in water treatment. The removal of phenol was the combined effect of adsorption and degradation of BABC. The BABC needs to be improved further.

Acknowledgements

The authors truly appreciate the National Natural Science Foundation of China for financial support under the Grant No.550672046.

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