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Adsorption capacity and removal efficiency of heavy metal ions by Moso and Ma bamboo activated carbons

Sheng-Fong Lo[a], *Song-Yung Wang*[b], *Ming-Jer Tsai*[b,*], *Lang-Dong Lin*[c,d,*]

[a] *Department of Forestry and Natural Resources, National Ilan University, I-Lan, Taiwan, ROC*
[b] *School of Forestry and Resource Conservation, College of Bio-Resource and Agriculture, National Taiwan University, No.1, Sec. 4, Roosevelt Road, Taipei 10617, Taiwan, ROC*
[c] *Department of Cultural Heritage Conservation, National Yunlin University of Science and Technology, Yunlin, Taiwan, ROC*
[d] *Department of Forest Products Science, National Chiayi University, Chiayi, Taiwan, ROC*

ABSTRACT

In order to understand the adsorption capacity and removal efficiency of heavy metal ions by Moso and Ma bamboo activated carbons, the carbon yield, specific surface area, micropore area, zeta potential, and the effects of pH value, soaking time and dosage of bamboo activated carbon were investigated in this study. In comparison with once-activated bamboo carbons, lower carbon yields, larger specific surface area and micropore volume were found for the twice-activated bamboo carbons. The optimum pH values for adsorption capacity and removal efficiency of heavy metal ions were 5.81–7.86 and 7.10–9.82 by Moso and Ma bamboo activated carbons, respectively. The optimum soaking time was 2–4 h for Pb^{2+}, 4–8 h for Cu^{2+} and Cd^{2+}, and 4 h for Cr^{3+} by Moso bamboo activated carbons, and 1 h for the tested heavy metal ions by Ma bamboo activated carbons. The adsorption capacity and removal efficiency of heavy metal ions of the various bamboo activated carbons decreased in the order: twice-activated Ma bamboo carbons > once-activated Ma bamboo carbons > twice-activated Moso bamboo carbons > once-activated Moso bamboo carbons. The Ma bamboo activated carbons had a lower zeta potential and effectively attracted positively charged metal ions. The removal efficiency of heavy metal ions by the various bamboo activated carbons decreased in the order: $Pb^{2+} > Cu^{2+} > Cr^{3+} > Cd^{2+}$.

Keywords: Bamboo; Activated carbon; Adsorption capacity; Removal efficiency; Heavy metal ion

1. Introduction

Recently, the heavy metal compounds in wastewater from high industry activities have caused environmental pollution and serious symptoms of poisoning. Heavy metal pollution caused by cadmium, chromium, copper, lead, mercury, nickel and arsenic is most serious to the human body (WHO, 2004). Concentrations of 0.005 mg/l (for Pb^{2+} and Cr^{3+}), 0.001 mg/l (for Cd^{2+}, Ni^{2+} and As^{5+}) and 0.1 mg/l (for Cu^{2+}), will cause illness in humans and can even be fatal (Kawarada et al., 2005). The removal of heavy metal ions is an important problem in the field of water purification.

Activated carbon is one of the materials used to remove impurities from liquid solutions. It has been widely used to treat industrial and household water (Sirianuntapiboon and Ungkaprasatcha, 2007) because of its excellent adsorption properties, characterized by a high specific surface area (Cao et al., 2006). It is also used to remove metal ions from solution (Issabayeva et al., 2006). The increasing variety and amounts of potentially hazardous impurities in water have led to the increased use of activated carbon. The problem associated with its use as a water purifier is largely economic; activated carbon is expensive. As this problem limits its use on a large industrial scale, more economical materials are needed. Although much work has been done on the use of activated carbon for water purification, heavy metal pollution is still a problem.

In order to reduce the cost of activated carbon, Pulido et al. (1998) used carbonized sugi wood powder to remove mercury and other metal ions from aqueous solutions of their

* *Corresponding authors*. Tel.: +886 2 33664641; fax: +886 2 23686335.
E-mail addresses: tmj@ntu.edu.tw (M.-J. Tsai), ldannlin@ntu.edu.tw (L.-D. Lin).
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