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Short Communication

Fixed-bed adsorption performance of oil palm shell-based activated carbon for removal of 2,4,6-trichlorophenol

I.A.W. Tan, A.L. Ahmad, B.H. Hameed *

School of Chemical Engineering, Universiti Sains Malaysia, Engineering Campus, 14300 Nibong Tebal, Penang, Malaysia

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ABSTRACT

This study investigated the adsorption potential of oil palm shell-based activated carbon to remove 2,4,6-trichlorophenol from aqueous solution using fixed-bed adsorption column. The effects of 2,4,6-trichlorophenol inlet concentration, feed flow rate and activated carbon bed height on the breakthrough characteristics of the adsorption system were determined. The regeneration efficiency of the oil palm shell-based activated carbon was evaluated using ethanol desorption technique. Through ethanol desorption, 96.25% of the adsorption sites could be recovered from the regenerated activated carbon.

1. Introduction

2,4,6-Trichlorophenol (TCP) has been reported to cause adverse effects on human nervous system and respiratory problems such as chronic bronchitis, cough and altered pulmonary function (Hameed, 2007). As one type of the most hazardous materials, TCP is carcinogenic, mutagenic and resistant to biodegradation, and thus has to be decomposed before discharging into receiving waters, in order to avoid the biomagnified toxicity to aquatic flora and fauna through various food chains. Various adsorbents have been tested to remove chlorophenols from aqueous solutions, such as activated clay, fly ash-based molecular sieves and zeolite (Hameed, 2007; Kamble et al., 2008; Kuleyin, 2007). Activated carbon adsorption is one of the most effective and widely used techniques in treating high strength and low volume of phenolic wastewaters compared to other physical and chemical techniques as they possess inherent limitations such as high cost, formation of hazardous by-products and intensive energy requirements. However, the usage of commercial activated carbon has been limited by its high cost mainly due to the use of non-renewable starting material such as coal, which is a major economic consideration. This has prompted a growing research interest in the production of low cost activated carbons from agricultural by-products such as rice husk (Kalderis et al., 2008), coffee endocarp (Nabais et al., 2008), apricot stone (Soleimani and Kaghazchi, 2008), olive husk/stone/kernel (Michailof et al., 2008; Kula et al., 2008; Zabaniotou et al., 2008), Avacado peel (Devi et al., 2008), coir pith (Kavitha and Namasivayam, 2007), palm pith (Sathishkumar et al., 2007) and oil palm fibre (Tan et al., 2007; Hameed et al., in press).

Palm oil mills in Malaysia produce about 4.3 million tonnes of shell annually. In practice, this biomass is burned in incinerator by palm oil mills which creates environmental pollution problems in nearby localities and also offers limited value to the industry. In order to make better use of this abundant agricultural waste, it is proposed to convert oil palm shell into activated carbon. Furthermore, not many studies have reported on the adsorption of TCP using continuous flow conditions, which are more useful in large-scale industrial wastewater treatment. Therefore, the focus of this research was to evaluate the adsorption potential of the oil palm shell-based activated carbon in removing TCP from aqueous solutions using a laboratory scale fixed-bed column. The feasibility of regenerating the spent activated carbon using ethanol desorption technique was then determined.

2. Methods

2.1. Preparation of activated carbon

Oil palm shell used for preparation of activated carbon was obtained from United Oil Palm Industries Sdn Bhd, Malaysia. The activated carbon preparation procedure was referred to our previous work (Tan et al., 2008) where the pretreated precursor

* Corresponding author. Tel.: +604 599 6422; fax: +604 594 1013.
E-mail address: chbassim@eng.usm.my (B.H. Hameed).

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