Southeast Asian Water Environment 4

Edited by Kensuke Fukushi, Futoshi Kurisu, Kumiko Oguma, Hiroaki Furumai and Psyche Fontanos

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Preparation and characterization of powdered activated carbon from empty fruit bunch

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Abstract Different powdered activated carbon (PAC) samples were prepared from oil palm industrial residue namely empty fruit bunch (EFB). The prepared EFB samples were carbonized and activated in a horizontal furnace. Physical activation consisted of carbonization for 30 minutes using nitrogen gas followed by activation with CO_2 gas at different flow rates, temperatures and times were used to optimize production conditions. The PAC samples produced were investigated through adsorption study using phenol aqueous solution of 50 mg/L concentration. Characterizations of the best quality PAC sample produced were also determined. The results of this work demonstrated that activation temperature had significant effect on the adsorption properties of the activated carbons. The PAC produced at activation temperature of 800°C, CO_2 gas flow rate of 0.1 L/min and activation time of 15 minutes proved to be the best quality adsorbent as it had given 95.54% of phenol removal at initial 15 minutes contact time. Characterizations of EFB based-PAC showed good quality adsorbent with highly active sites and well-developed pores with BET surface area of 374.73m^2/g. The experimental results indicated that the activated carbon prepared from EFB is a promising product in industrial applications as well in water and wastewater treatment.

Keywords adsorption, BET surface area, empty fruit bunch, powdered activated carbon, phenol removal

INTRODUCTION

Activated carbon (AC) has been widely used in the sorption of chemical species from aqueous solutions as a versatile adsorbent with optimal sorption properties (Aksu and Yener, 2001; Alam *et al.*, 2006a; Alam *et al.*, 2007a; Amaya *et al.*, 2007; Muyibi *et al.*, 2008; Alam *et al.*, 2008; Ameen *et al.*, 2008; Achaka *et al.*, 2009). Phenolic compounds are considered to be hazardous wastes, which are released into the aquatic environment by industries such as coke ovens in steel plants, petroleum refineries, petrochemical, phenolic resin, pharmaceutical, chemical and dye industries, etc. (Zumriye and Yener, 2001; Banat *et al.*, 2004). The discharge of phenolic waste into waterways may adversely affect human health as well as that of flora and fauna. Considerable quantities of agricultural by-products result from the annual harvesting and processing of various agricultural crops grown worldwide. These by-products were observed to have potential materials in the manufacture of activated carbons (Kadirvelu *et al.*, 2000; Namasivayan and Kadirvelu, 1999). Malaysia is the largest oil palm producer in the world. Empty fruit bunches are one of the most abundant residues regularly discharged from the palm oil refineries. Small amount is used for steam generation for the processing of the palm oil production while the larger portion is left unused and disposed to sanitary landfills. Hence, converting of empty fruit bunch into activated carbon would provide safe disposal to empty fruit bunch as well as produce useful adsorbent that has wide applications special in water and wastewater treatment. The aim of this study was to evaluate the adsorption properties and characterizations of the activated carbon prepared form empty fruit bunch.

MATERIALS AND METHODS

Empty fruit bunche samples were obtained from a Seri Ulu Langat Oil Palm Mill in Dengkil, Selangor, Malaysia. The samples were washed and dried in the oven at 105°C for 24 hours for dehydration.

Activated carbon production

2-level full factorial design using two central points was selected for the optimization of activated carbon production runs by statistical software Design Expert 6.0.8. The prepared EFB were carbonized and activated in a horizontal furnace of CARBOLITE brand. Physical activation consisted of carbonization using nitrogen gas at flow rate of 2.5 L/min (Phan *et al.*, 2006) for 30 min, followed by activation with CO_2 gas at different temperatures (600, 750, and 900°C), gas flow rates (0.1, 0.175, 0.25 L/min) and times (15, 30, 45 minutes) was adopted to prepare activated carbon samples. The preparation variables levels were selected based on the previous experimental works done by other researchers (Alam *et al.*, 2006a; Phan *et al.*, 2006). The activated carbon samples produced were ground and sieved to size fractions less than 250 μm as shown in Figure 1(a), (b).

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