Preparation of Activated Carbon by Reduction of SO_2 Adsorbed on Palm Oil with Microwave Energy

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Abstract

The preparation of activated carbon from palm oil shell by activation with microwave energy was divided into three steps: carbonization, sulfur dioxide adsorption, and microwave activation. The first step - carbonization - was carried out at 400^oC for 60 min. The characteristics of char were: yield 31.72%, volatile matter 18.87$\pm$0.06%, fixed carbon 69.41$\pm$ 0.09%, and BET surface area 152$\pm$4 m^2g^{-1}.

Sulfur dioxide, 2,000 ppm, was adsorbed for 420 min by the prepared char until reaching the equilibrium at room temperature in the reactor, diameter of 5 cm, and height of 30 cm.

The activation with microwave energy was carried out in Pyrex tube (U-shaped) reactor, diameter of 28 mm, length of 150 mm, and height of 100 mm. The reactor was set up in a microwave oven. The variables studied were: activation time (range of 30-180 min), activation energy (range of 225-500 watt), and number of cycles of adsorption and activation from 1 to 4 times. The optimum conditions from experimental results were: activation time of 90 min, activation energy of 450 watt, and second cycle of adsorption and activation. The characteristics of activated carbon produced at the optimum condition were: iodine adsorption number 1385$\pm$ mg g^{-1}, methylene blue adsorption number 235$\pm$6 mg g^{-1}, bulk density 0.659 g cm^{-3}, pH 8.11, surface area 1172$\pm$49 m^2 g^{-1}.

Keywords: *Activated carbon, palm oil shell, microwave energy, carbonization, sulfur dioxide adsorption, microwave activation, reactor, carbonizer.*

Introduction

Physical activation used oxidizing gases such as H_2O, CO_2, NO_2, O_2, and SO_2 gases with applied energy. The effective activation factors were oxidizing concentration, temperature, time, type, and quantity of the raw material (Hassler 1974). The influence of oxidizing gas such as steam by gasification produces low adsorption surface area on charcoal because many macropores were formed (Rodriguez-Reinoso and Lanires-Solano 1965). The reaction is shown in Equation (1):

$$C + H_2O \longrightarrow H_2 + CO \quad \text{.....(1)}$$

The activation of carbon dioxide on charcoal was studied while temperature was set within 800-900^{o}C. The endothermic reaction which illustrates the reaction between C on charcoal and carbon dioxide (Ergun and Mentser 1965) is shown in Equation (2):

$$C + CO_2 \longrightarrow 2CO \quad \text{.....(2)}$$

The exothermic activation of oxygen formed pores easier on the surface area of charcoal rather than using steam and carbon dioxide. This is shown in Equations (3) and (4):

$$C + O_2 \longrightarrow CO_2 \quad \text{.....(3)}$$
$$2C + O_2 \longrightarrow 2CO \quad \text{.....(4)}$$