Fixed-bed Column Study for Adsorption of Cadmium on Oil Palm Shell-derived Activated Carbon

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Abstract

The spread of heavy metal pollution in the environment can lead to the contamination of crops and water for consumption. An approach to control the spread of groundwater pollution is by using a permeable reactive barrier with granular activated carbon. In this study, the adsorption of Cd(II) ions was conducted in a continuous flow fixed-bed column by using oil palm shell-derived activated carbon. The activated carbon column performance was evaluated by manipulating the activated carbon bed height, cadmium solution flow rate and influent concentration. The increase in bed height increased the amount of adsorbent used, thus increasing the total removal of Cd(II) and prolonged the lifespan of the activated carbon column. However, the increase in flow rate and influent concentration resulted in the shortened lifespan of the column. The column system with a bed height of 5.5 cm, flow rate of 2.0 mL/min and 200 mg/L influent concentration showed the best Cd(II) uptake performance in this study. The column performance were best fitted to the Thomas model and Yoon-Nelson model for the longest bed depth of 5.5 cm, all flow rates studied and highest influent concentration of 200 mg/L, with correlation coefficient greater than 0.95.

Keywords: *Adsorption, agriculture waste-derived adsorbent, breakthrough curve, continuous flow .*

1. Introduction

Most environmental pollution occurs due to the negligence of the operator in controlling their effluent discharge at source despite the known impact and discharge regulation – a pollutant of global concern is heavy metal. The spread of heavy metal in the environment, especially groundwater, can lead to the contamination of crops and water for consumption. Heavy metal spreads faster in acidic ground due to its solubility and this requires longer duration and more tedious effort for the cleanup. Passive approach such as permeable reactive barrier with adsorbent [1, 2] has been applied to control the spread of pollutants in the ground by adsorbing the pollutants from migrating further. Activated carbon has been proven to be a flexible wastewater treatment technique due to the high adsorptive capacity and versatility. Currently, the production of activated carbon from renewable and low cost materials especially from agricultural wastes has become the focus of attention of numerous researchers because the conventional raw materials for producing activated carbons are costly. Therefore, the production of activated carbon from agricultural wastes is more economical and friendly to the environment. Malaysia has around 4.7 million hectares of oil palm plantation [3]. As one of the world's largest producers of palm oil, Malaysia palm oil industry generates a vast amount of palm oil wastes, such as empty fruit bunch, fiber, wet shell, palm kernel, fronds and trunks. Oil palm shell is a highly carbonaceous material and thus the conversion of oil palm shell into activated carbon

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