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Batch and Fixed-Bed Studies of Ammonia Treated Coconut Shell Activated Carbon for Adsorption of Benzene and Toluene

Authors : Jibril Mohammed, Usman Dadum Hamza, Muhammad Idris Misau, Baba Yahya Danjuma, Yusuf Bode Raji, Abdulsalam Surajudeen

Abstract : Volatile organic compounds (VOCs) have been reported to be responsible for many acute and chronic health effects and environmental degradations such as global warming. In this study, a renewable and low-cost coconut shell activated carbon (PHAC) was synthesized and treated with ammonia (PHAC-AM) to improve its hydrophobicity and affinity towards VOCs. Removal efficiencies and adsorption capacities of the ammonia treated activated carbon (PHAC-AM) for benzene and toluene were carried out through batch and fixed-bed studies respectively. Langmuir, Freundlich and Tempkin adsorption isotherms were tested for the adsorption process and the experimental data were best fitted by Langmuir model and least fitted by Tempkin model; the favourability and suitability of fitness were validated by equilibrium parameter (RL) and the root square mean deviation (RSMD). Judging by the deviation of the predicted values from the experimental values, pseudo-second-order kinetic model best described the adsorption kinetics than the pseudo-first-order kinetic model for the two VOCs on PHAC and PHAC-AM. In the fixed-bed study, the effect of initial VOC concentration, bed height and flow rate on benzene and toluene adsorption were studied. The highest bed capacities of 77.30 and 69.40 mg/g were recorded for benzene and toluene respectively; at 250 mg/l initial VOC concentration, 2.5 cm bed height and 4.5 ml/min flow rate. The results of this study revealed that ammonia treated activate carbon (PHAC-AM) is a sustainable adsorbent for treatment of VOCs in polluted waters.

Keywords : volatile organic compounds, equilibrium and kinetics studies, batch and fixed bed study, bio-based activated carbon
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