Adsorption performance and evaluation of activated carbon from coconut shell for the removal of chlorinated phenols in aqueous medium

ABSTRACT

In this study, the removal of 2,4-dichlorophenol (2,4-DCP) from aqueous solutions was performed using coconut shell activated carbon prepared by a two-stage self-generated atmosphere method. Coconut shell was first semi-carbonized at 300 °C for an hour followed by chemical activation with zinc chloride ($ZnCl_2$) as activating agent at 500 °C for 2 h. The effect of impregnation ratio on the physical and chemical properties of activated carbons (ACs) was studied. The morphology and surface chemistry of the prepared carbons were characterized using Scanning Electron Microscope (SEM) and Fourier Transform Infrared spectroscopy (FTIR) respectively. The percentage of yield for the prepared AC was found to be in the range of 26.40-38.82 %. AC registered the highest adsorption capacity and was used in subsequent batch adsorption studies consisting of parameters such as initial concentration, adsorbent dosage and solution pH. The maximum surface area of the best produced AC was recorded as 1482 m^2 g^{-1}. The adsorption capacity was found to increase in proportional to the initial concentration and adsorbent dosage, while acidic solution pH was more favourable for the adsorption of 2,4-DCP by the prepared AC. The equilibrium time for the adsorption of 20 mg L^{-1} of 2,4-DCP on 0.5 g of AC was achieved in 180 min. Adsorption isotherms such as Langmuir, Freundlich and Temkin isotherm models were employed to examine the experimental isotherms while the reaction kinetic data was analysed using pseudo-first-order, pseudo-second-order and intraparticle diffusion model. The 2,4-DCP adsorption results fitted best in the Freundlich isotherm as indicated by the high correlation coefficient value ($R2 > 0.9949$) while the adsorption kinetic fitted to the pseudo second-order model ($R2 > 0.9621$).