

Adsorptive removal of various phenols from water by South African coal fly ash

JH Potgieter¹, SO Bada² and SS Potgieter-Vermaak^{1,3*}

¹ Chemistry and Materials Division, School of Biology, Chemistry and Health Sciences, Manchester Metropolitan University, All Saints Campus, Oxford Street, Manchester, M15 6GD, UK

² School of Chemical and Metallurgical Engineering, University of the Witwatersrand, Private Bag X3, Wits, 2050, South Africa

³ Molecular Science Institute, School of Chemistry, University of the Witwatersrand, Private Bag X3, Wits, 2050, South Africa

Abstract

South African coal fly ash (SACFA) was used to effectively remove phenol, 2-nitrophenol and 4-nitrophenol from wastewater. The rate of adsorption follows first-order kinetics before attaining equilibrium with the sorption rate (K_{ad}) obtained being the highest for 4-nitrophenol (*p*-nitrophenol) ($7.0 \times 10^{-3}/h$), followed by phenol ($1.2 \times 10^{-3}/h$) and 2-nitrophenol (*o*-nitrophenol) ($1.0 \times 10^{-3}/h$). Batch studies were performed to evaluate the adsorption process, and it was found that the Freundlich isotherm effectively fits the experimental data for the adsorbates better than the Langmuir model, with the fly ash having the highest adsorption capacity of 6.51×10^{-2} mg/g for 4-nitrophenol, 6.00×10^{-2} mg/g for 2-nitrophenol and 6.31×10^{-2} mg/g for phenol. The fly ash was found to adsorb 90.2% of phenol, 88.9% of 2-nitrophenol and 92.6% of 4-nitrophenol at an initial concentration of 20 mg/l. The desorption studies suggested that the desorption of 4-nitrophenol was the most difficult of the three adsorbates to be desorbed. The desorption efficiency was 17.9% for phenol, 18.8% for 2-nitrophenol and 10.2% for 4-nitrophenol. This work proved that SACFA can be used as an efficient adsorbent material for removal of phenol from water and wastewater.

Keywords: fly ash, phenol, nitrophenols, adsorption-desorption, batch study