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Adsorption of 2,4-dichlorophenol on paper sludge/wheat husk biochar: process optimization and comparison with biochars prepared from wood chips, sewage sludge and hog fuel/demolition waste

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Abstract

The adsorption of 2,4-dichlorophenol, a toxic by-product of triclosan commonly found in wastewater treatment plant effluents, was studied on paper sludge/wheat husks biochar. By using response surface methodology, the optimum conditions and effects of pH, temperature, initial 2,4-DCP concentration and time were determined. The solution pH was found to be the most influential parameter whereas the optimum adsorption conditions were predicted as: C_0=40.28 mg L^{-1}, T=326 K, pH=2.8, t=143 min, where a 99.95% adsorption could be achieved. Both Langmuir and Freundlich provided a good fit for the experimental data, indicating a surface and multi-layer adsorption. Kinetically, the process primarily followed the pseudo-second order model (chemisorption). By comparing the adsorption capacity at equilibrium of our main biochar (q_e = 9.28 mg g^{-1}) to 3 biochars prepared from different biomasses (q_e values 1.57 - 2.96 mg g^{-1}), it was concluded that pH-dependent electrostatic interactions and non-covalent π-electron donor-acceptor mechanisms play the most important role. Finally, there was indication that high concentrations of Ca and K may promote the adsorbate-adsorbent interactions and enhance adsorption.

Keywords: 2,4-dichlorophenol; ; ; ; , chlorophenols, biochar, adsorption, biomass pyrolysis