

Adsorptive removal of cadmium in aqueous solutions using coconut dregs residue as the adsorbent

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Rapid industrialization has contributed to the release of toxic heavy metals into natural water bodies giving rise to water pollution which has become a serious concern all over the world due to the non-biodegradable nature of heavy metals. Removal of heavy metals by utilizing the technique of adsorption using biological waste is an effective alternative.

The present study is focused on the potential use of coconut dregs residue, a by-product of coconut milk production, as an effective low cost biosorbent for adsorbing Cd(II) from aqueous solutions. Batch adsorption studies were carried out to investigate the percentage removal and adsorption capacity of coconut dregs residue as a function of contact time, initial pH, initial Cd(II) concentration, adsorbent dose and temperature.¹ The data were analysed using different kinetic and isotherm models. The equilibrium data satisfactorily fitted all three isotherms of Langmuir, Freundlich and Dubinin-Radushkevich (D-R) models with correlation coefficients (R²) greater than 0.98. Boehm titration and Fourier Transform Infrared spectroscopy (FT-IR) were conducted to analyse the surface functional groups on coconut dregs residue while surface structure was analysed by Scanning Electron Microscopy (SEM). Further characterization was done by determining the pH and pHPzc (pH at point zero charge).

A percentage removal of 87.65% and an equilibrium adsorption capacity of 4.408 mg/g were observed at the optimum pH of 7.0 for an initial metal concentration of 25 ppm, 0.5 g/100.00 cm³ adsorbent dosage with 250-500 µm particle size, within the contact time of 120 minutes at 303 K. The Freundlich isotherm model best explained the adsorption of Cd(II) on to the coconut dregs residue while among the kinetic models studied, pseudo-second order model provided a better explanation for the adsorption process with an adsorption capacity of 4.327 mg/g which is approximately equal to the experimental value at 303 K. The calculated thermodynamic parameters showed a favourable and a spontaneous exothermic process. The Gibbs free energy change in Cd(II) adsorption process was -5.41 kJ mol⁻¹ while the enthalpy change was

calculated as -50.40 kJ mol⁻¹. The negative entropy change of -150.00 J mol⁻¹ indicates the decrease in randomness of metal ions at the solid-liquid interface. FT-IR analysis indicated the presence of hydroxyl carbonyl and amide functional groups on the adsorbent. SEM analysis confirmed the presence of uneven surface structure with tubular voids important for adsorption. The pH of coconut dregs residue was determined as 6.13 while the pHPzc was determined as 5.6. As the pH was greater than pHPzc, it could be confirmed that the adsorption of positively charged Cd(II) species was favoured. Chemical Oxygen Demand (COD) measurement indicated that the use of coconut dregs residue in aqueous medium for the removal of heavy metals is within safe limits. The comparison study conducted with activated carbon prepared from coconut dregs residue showed a higher adsorption capacity of 4.685 mg/g and a percentage removal of 95.64% for Cd(II) when compared with raw coconut dregs residue.

References

1. Kamari, A.; Yusoff, S. N. M.; Abdullah, F.; Putra, W. P., 2014, *Journal of Environmental Chemical Engineering*, 2(4), 1912-1919.