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Adsorption of Lead (II) and Copper (II) Ions onto Marula Nuts Activated Carbon

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Abstract : Heavy metal contamination in waste water is a very serious issue affecting a lot of industrialized countries due to the health and environmental impact of these heavy metals on human life and the ecosystem. Adsorption using activated carbon is the most promising method for the removal of heavy metals from waste water but commercial activated carbon is expensive which gives rise to the need for alternatively activated carbon derived from cheap precursors, agricultural wastes, or byproducts from other processes. In this study activated bio-carbon derived from the carbonaceous material obtained from the pyrolysis of Marula nut shells was chemically activated and used as an adsorbent for the removal of lead (II) and copper (II) ions from aqueous solution. The surface morphology and chemistry of the adsorbent before and after chemical activation with zinc chloride impregnation were studied using SEM and FTIR analysis respectively and the results obtained indicate that chemical activation with zinc chloride improves the surface morphology of the adsorbent and enhances the intensity of the surface oxygen complexes on the surface of the adsorbent. The effect of process parameters such as adsorbent dosage, pH value of the solution, initial metal concentration, contact time, and temperature on the adsorption of lead (II) and copper (II) ions onto Marula nut activated carbon were investigated, and their optimum operating conditions were also determined. The experimental data was fitted to both the Langmuir and Freundlich isotherm models, and the data fitted best on the Freundlich isotherm model for both metal ions. The adsorption kinetics were also evaluated, and the experimental data fitted the pseudo-first order kinetic model better than the pseudo second-order kinetic model. The adsorption thermodynamics were also studied and the results indicate that the adsorption of lead and copper ions is spontaneous and exothermic in nature, feasible, and also involves a dissociative mechanism in the temperature range of 25-45 °C.

Keywords : adsorption, isotherms, kinetics, marula nut shells activated carbon, thermodynamics
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