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Removal Efficiency of Pb (II) Metal Ions from Wastewater using Base-Modified Jack Saw Dust

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Abstract

Presence of excess heavy metals such as Pb (II) ions is one of the major causes of water pollution. Lead contaminated effluents can form complexes with ligands in aqueous media and tend to bio-accumulate in the food chains causing acute and chronic diseases. Therefore, efficient and cost-effective methods to remove such heavy metals from water are important. Since activated carbon (AC) based adsorption techniques have their own drawbacks, the use of biomass has been tested as potential candidates due to abundancy, eco-friendliness, and low cost. This research is focused on the removal of Pb (II) ions from polluted aqueous media using jack saw dust and comparison of its efficiency with commercially available AC. After sieving, washing with distilled water and drying under ambient conditions, the saw dust was treated with different concentrations of NaOH (0.25-5.0 M) to yield BMJSD. The highest adsorption capacity and percent removal was obtained with the 0.25 M (NaOH) on BMJSD. Adsorption of Pb (II) onto BMJSD was optimized by adjusting Pb (II) ion concentration, adsorbent dosage, contact time and temperature. From the results, it was revealed that optimum Pb (II) ion adsorption is 700 ppm with a contact time of 30 minutes at room temperature for 20 g L^{-1} of adsorbent. The optimum Pb (II) ion adsorption is 700 ppm with a contact time of 60 minutes at room temperature for 28 g L^{-1} of AC. The collected data were tested with the linear Freundlich, Langmuir and Temkin isotherm models. The rate of adsorption was studied using pseudo-first order (PFO) and pseudo-second-order (PSO) kinetic models. The adsorption processes by both BMJSD and AC follow the PSO kinetics as well as Freundlich, Langmuir and Temkin adsorption isotherms with R^2 values of 1.00, 1.00, 0.99 and 0.99, respectively. The rate constants suggest that adsorption process by BMJSD is more efficient than that by AC. The Gibbs free energy of adsorption by BMJSD and AC were determined to be -8.25 and -6.98 kJ mol^{-1} respectively, revealing both processes to be spontaneous. In conclusion, the adsorbent produced in this study offers high potential for the removal of Pb (II) from aqueous solutions with a percent removal of over 95% and the adsorption process is more feasible, efficient, and economical compared to AC.

***Keywords**:* Adsorption, Biomass, Heavy metals, Jack saw dust, Lead (Pb)