Adsorption of Heavy Metals on Na-Montmorillonite: Effect of pH and Adsorbent Dosage

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The rapid increment in world population, urbanization, industrialization, agricultural and household activities have caused water contamination by heavy metals, which is a significant threat to the well-being of life forms and environmental stability. To resolve this matter, cost-effective adsorbents have been studied including, Na-montmorillonite, to remove heavy metal contaminants from wastewater. Na-montmorillonite [$(Na,Ca)_{0.33}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot nH_2O$] is a porous 2:1 layered smectite clay bearing permanent negative charges caused by isomorphic substitution. Adsorption is an effective technique of wastewater remediation involving cation exchange and surface complexation mechanisms. In this study, the structure of the commercial Na-montmorillonite sample was confirmed by Powder X-Ray Diffraction analysis. Subsequently, the adsorption of Cu^{2+}, Ni^{2+}, Cd^{2+}, Cr^{3+}, Pb^{2+} heavy metal ions on Na-montmorillonite (the adsorbent) were studied in triplicate using single-element solutions in trace concentrations (100 mg L^{-1}), under ambient conditions. In addition, the adsorption behaviour of the most efficient heavy metal cation was evaluated as a function of the initial p^H (1-5) and adsorbent dosage (0.025-0.300) g. The results reveal that the adsorption efficiency on Na-montmorillonite increases as: Pb^{2+} (21.90%) $<$ Cd^{2+} (35.47%) $<$ Ni^{2+} (41.44%) $<$ Cu^{2+} (46.69%) $<$ Cr^{3+} (59.12%). This observation is in accordance with the characteristics of heavy metal cations (such as valency, size/ ionic radius). This study found that the adsorption efficiency of Cr^{3+} increased with rising pH and adsorbent dosage, whereas the adsorption capacity reduced with the increase of dosage. Optimum p^H and adsorbent dosage for Cr^{3+} adsorption were obtained as p^H 5 and 5 g L^{-1}, respectively. The remaining optimizations of the initial Cr^{3+} concentration and shaking time will be completed in the future, along with isotherm and kinetic studies. Eventually, an industrial wastewater sample is expected to be analyzed. Based on the results obtained and economic aspects, Na-montmorillonite can potentially be used as an efficient adsorbent for Cr^{3+} in aqueous wastewater systems.

Keywords: *Na-montmorillonite, Cr^{3+} ion, Heavy Metal Removal, Smectite Clay, Wastewater Treatment*