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Characterization of adsorption properties of naturally occurring clay deposits in Mannar District to remove lead and cadmium from aquatic systems

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Water is a fundamental resource for life on earth. Water pollution by heavy metal contamination has a major negative impact on human health due to its toxicity. To remove heavy metals from aquatic environments several methods have been implemented. From these methods, use of natural clays for adsorption of heavy metals is considered to be environmentally friendly and cost-effective method. Montmorillonite is one major type of natural clays which is well known for its adsorption ability. Therefore, this study was basically focused on assessing the potential of lead and cadmium adsorption by MMT-rich clay in different places in Sri Lanka. Three soil samples from selected places of Mannar District were collected and conditions were optimised for Pb²⁺ and Cd²⁺ adsorption. Then the adsorption was assessed using Atomic Adsorption Spectrophotometer. 100 mg/L initial concentration, 0.10 g adsorbent dosage, and pH 4 as optimum conditions for Pb²⁺ adsorption, whereas 100 mg/L initial concentration, 0.10 g adsorbent dosage, and pH 6 as optimum conditions for Cd²⁺ adsorption were observed. Langmuir constants obtained for Pb²⁺ and Cd²⁺ were -1.233 L/mg and 0.0477 L/mg. Freundlich constants obtained for Pb²⁺ and Cd²⁺ were 2.489 mg/g and 0.764 mg/g respectively. Based on the values obtained for the constants, $1/n$, q_{max} , and R_L , it was assumed that both metal ions show multilayer adsorption on a heterogeneous surface, which favours Freundlich isotherm. Optimized conditions were applied to the soil samples collected from Giant's tank, Marvelankeni, and Allavankai areas areas of Northern province. Reduction percentages obtained for adsorption of Cd²⁺ by soil samples from Giant's tank, Marvelankeni, and Allavankai areas were 91.385%, 98.381%, 68.152% respectively and adsorption capacities were 111.239 mg/g, 119.755 mg/g, 82.969 mg/g respectively. Reduction percentages obtained for adsorption of Pb²⁺ by soil samples from Giant's tank, Marvelankeni, and Allavankai were 48.472%, 30.561%, 58.481% respectively and adsorption capacities were 211.807 mg/g, 133.561 mg/g, 255.286 mg/g respectively. The values obtained were compared with the control sample (reduction percentages 75.633%, 83.751% respectively for Cd²⁺ and Pb²⁺). adsorption capacities 92.076 mg/g and 365.986 mg/g respectively for Cd²⁺ and Pb²⁺. Based on these results, there might be a potential of using Montmorillonite rich soil in Mannar district to remove Pb²⁺ and Cd²⁺ from aquatic systems.

Keywords: Cadmium, Lead, Montmorillonite, Water pollution