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Model study on the adsorptive removal of nickel and cobalt ions from waste water using clay soil as a natural adsorbent

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Requirement for developing strategies for employing cost effective and efficient adsorbents for the removal of heavy metals from waste streams has been steadily increasing over the past years. Naturally occurring clay is a cost effective and efficient adsorbent due to its natural abundance, high surface area, porosity and high cation exchange capacity. In Sri Lanka, untreated laboratory waste water which contains toxic heavy metals is released to the environment continuously due to the absence of proper laboratory waste water management strategies.

An effective heavy metal adsorption into a particular adsorbent is governed by the factors such as initial metal ion concentration, ionic strength, pH and contact time etc. The present study mainly focused on optimizing pH and contact time to achieve maximum adsorption of Nickel and Cobalt on to clay soil. In this regard, clay soil sampling was carried out at a clay mining site of a brick making facility at Malwana area, followed by the standard soil characterization. The highest cation exchange capacity bearing clay soil was used to prepare the Na^+ homoionic clay soil adsorbent. During this study, heavy metals under six different initial concentrations (i.e., 900 mg L^{-1}, 1200 mg L^{-1}, 1500 mg L^{-1}, 1800 mg L^{-1}, 2400 mg L^{-1} and 3000 mg L^{-1}) were used. Adsorptive removals of Ni^{2+} and Co^{2+} by Na^+ homoionic clay soil under different pH values (pH 3, pH 7 and pH 11) were studied by conducting single element batch experiments under each initial metal ion concentration in order to determine the effect of pH for the adsorption capacities of Nickel and Cobalt. Similarly, contact time of 1 day, 3 days and 5 days were used to determine the effect of the contact time. Flame atomic absorption spectrophotometry was used for the analysis of metal concentrations.

The present study revealed that the nickel and cobalt ion adsorption capacities increase for each initial metal ion concentration upon increasing the pH and the contact time. Ni^{2+} at initial metal ion concentration of 3000 mg L^{-1} had the maximum adsorption of 64.09 ± 0.51 mg g^{-1} at pH 11 for the contact time of 3 days. Co^{2+} adsorption capacity nearly attained constant after 3 days. The maximum adsorption value of 63.88 ± 0.25 mg g^{-1} at pH 11 after 3 days was observed for Co^{2+} at the initial concentration of 3000 mg L^{-1}. Further, for both metal ions, even though there was a significant increment with the increase of pH values, there was no significant difference in the adsorption capacities for the contact time after 3 days. This trend is in good agreement with previous studies carried out on removing of Cu, Pb, Cd and Cr ions using clay soil adsorbents.

Keywords: Adsorbent, Clay soil, Cobalt, Nickel