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Effective removal of heavy metals from aqueous solutions by cost-effective adsorbents

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Heavy metals are detrimental to human health and the environment with, negative consequences. Such as kidney and nervous system disorders, and for plants; inhibition of photosynthesis. Thus, efficient strategies must be applied to eliminate heavy metal cations from contaminated water. Normally, bricks and activated charcoal (AC) are well-known adsorbents in wastewater treatment. In this study, naturally available brick material from the Deegawapi area and commercially available AC were used to remove lead (Pb^{2+}) and cadmium (Cd^{2+}) ions from an aqueous solution. To the best of our knowledge, this is the first attempt at, a comparison of AC and bricks in the heavy metal adsorption process and herein, the best adsorbent among these two was determined. The Langmuir and Freundlich adsorption models were used to analyse the equilibrium adsorption data. As a measure of the fit, the coefficient correlation (R_2) was used. The equilibrium data of Pb^{2+} treated with both adsorbents, better fitted to the Langmuir isotherm exhibited higher correlation coefficients ($R_2 \geq 0.90$). The maximum adsorption capacity of Pb^{2+} on AC was remarkably higher as compared to Pb^{2+} on brick samples, with the 303.03 mg g^{-1} maximum adsorption value. Equilibrium data of Cd^{2+} on both adsorbents were fitted to the Freundlich model with the correlation coefficient (R_2) less than or equal to 0.97 ($R_2 \geq 0.97$). From fitted data, Cd^{2+} on AC showed larger K_F values over Cd^{2+} on brick, indicating AC's higher adsorption capacity and affinity towards Cd^{2+} ions. The adsorption of both metal ions on AC followed the pseudo-second-order kinetic model with a correlation coefficient over 0.97 ($R_2 \geq 0.99$) than the pseudo-first-order kinetic model. The Pb^{2+} and Cd^{2+} treated with AC show the maximum concentration adsorption rate (h) of 1.896 mg g^{-1} min and 1.179 mg g^{-1} min, respectively. According to data, AC was determined as the best adsorbent owing to its higher adsorption capacity, better chemical stability, excellent mechanical properties and well-developed mesopores than bricks. Future researchers must focus on the synthesis of AC, containing functional groups and develop this technique for water purification systems.

Keywords: *Activated charcoal, bricks, cadmium ion, lead ion*