

ADSORPTION OF LEAD (II) IONS ON MAGNETITE/MAGNESIUM OXIDE NANOCOMPOSITES

V. Gurunathanan^{1*}, M.I. Ishra¹, K.B. Wijayarathne^{1, 2}, B.S. Dassanayake^{1,2} and H.C.S. Perera^{1, 2}

¹Postgraduate Institute of Science, University of Peradeniya, Peradeniya, Sri Lanka

²Department of Physics, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka

*guru201666@gmail.com

The effective removal of heavy metal ions, particularly lead(II) [Pb(II)], from contaminated water sources remains a pressing environmental concern. This study explores the potential of magnetite/magnesium oxide (Fe₃O₄/MgO) nanocomposites as an efficient adsorbent for selective Pb(II) removal. The Fe₃O₄/MgO nanocomposites were synthesised using a controlled sol-gel method and characterised using various techniques. XRD analysis confirmed the presence of cubic MgO and cubic Fe₃O₄. Pb(II) adsorption induced a crystallographic transformation, forming hexagonal Mg(OH)₂ crystals, indicating interaction with the adsorbent. SEM analysis revealed rod-like and spongy spherical morphologies. Rod-like structures provided a larger surface area and active sites for effective Pb(II) interaction, while spongy spherical particles, representing magnetic Fe₃O₄, contributed to stability and dispersibility. EDS analysis showed Fe, O, and Mg presence with weight percentages of 28.97%, 25.55%, and 30.0%, respectively. VSM results confirmed superparamagnetic behavior with a saturation magnetisation of 32.02 emu g⁻¹, indicating potential for magnetic separation and recovery in various wastewater treatment applications. Adsorption experiments utilised optimised conditions: initial concentration of 600 mg L⁻¹, adsorbent dosage of 0.25 g L⁻¹, pH of 7, and 120 minutes reaction time. Fe₃O₄/MgO nanocomposites exhibited exceptional performance with a remarkable 99.98% removal efficiency and a high adsorption capacity of 2399.44 mg g⁻¹. These impressive results underscore the outstanding adsorption potential of the nanocomposites. Adsorption kinetics followed the pseudo-second-order model (R² = 0.99), confirming suitability for Pb(II) removal. The Freundlich model indicated a heterogeneous surface with different adsorption sites. These comprehensive findings support efficient Pb(II) removal using Fe₃O₄/MgO nanocomposites, paving the way for advanced adsorption strategies in water treatment. Overall, Fe₃O₄/MgO nanocomposites exhibit potential as a cost-effective, environmentally friendly adsorbent for removing Pb(II) ions, providing a promising water purification and environmental remediation solution.

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Keywords: Adsorption capacity, Environmental remediation, Heterogeneous surface, Superparamagnetic behavior, Sol-gel method