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Adsorption of Metha-nitrophenol onto Alumina and HDTMA Modified Alumina: Kinetic, Isotherm and Mechanism Investigations

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Abstract

In this work, the removal of Metha-nitrophenol (MNP) from aqueous solutions onto γ -Al₂O₃ and hexadecyltrimethyl ammonium bromide modified alumina (HDTMA⁺/Al₂O₃) and its adsorption mechanism were investigated. Kinetics and isotherms experiments were made in batch experiments at pH = 6, versus time, initial concentrations of MNP and adsorption temperature. The results indicated that the MNP adsorption reached equilibrium within 1h, and the removal efficiency of MNP was enhanced by HDTMA⁺/Al₂O₃ adsorbent, compared to alumina alone, and an increase in adsorption temperature, indicating the endothermic process. The experimental data were examined by using linear and nonlinear forms of the kinetics and the isotherms models. Based on the errors calculated values of R² (Coefficient of determination), χ^2 (Chi-square) and standard deviation (Δq (%)), it was found that the nonlinear forms of second order kinetic model and Freundlich isotherm model are best fit the experimental data for both adsorbents. FTIR analysis of both adsorbents, before and after adsorption of MNP, shows that the adsorption mechanism of MNP occurs on heterogeneous sites via the O-H and NO₂⁻ functional groups of MNP, following two different mechanisms.

Keywords: Adsorption; Al₂O₃; HDTMA⁺/Al₂O₃; kinetic; Isotherm; Metha-nitrophenol, nonlinear models.

1. Introduction

Phenol and its derivatives, especially the nitrophenolics (NPs) compounds, are classified as highly toxic for human beings and for all aquatic life. These compounds exist in the petrochemical, olive oil mills, photographic developers, oil refining, plastics, leather, paints, pharmaceuticals, steel and other industrial waste waters [1,2]. In addition, the NPs compounds are used in the synthesis of dyes, explosives, pesticides and drugs and as a reactant model in the conversion of aromatic nitro-compounds to aromatic amines, which has a great importance in pharmaceutical industries [3–5]. As a result, the contamination of the water from industrial

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