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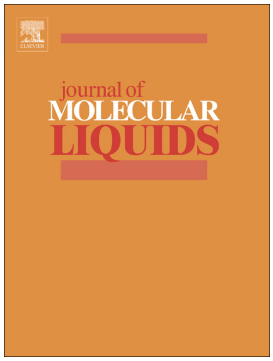

Nano zirconium silicate coated manganese dioxide nanoparticles: Microwave-assisted synthesis, process optimization, adsorption isotherm, kinetic study and thermodynamic parameters for removal of 4-nitrophenol

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Nano Zirconium Silicate Coated Manganese Dioxide Nanoparticles: Microwave-Assisted Synthesis, Process Optimization, Adsorption Isotherm, Kinetic Study and Thermodynamic Parameters for Removal of 4-Nitrophenol

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Abstract

The adsorption behavior and interaction of 4-nitrophenol (4NP) with a novel designed nanoadsorbent were investigated and optimized by the batch technique, using a green chemical process via solvent free microwave-assisted coating of zirconium silicate with manganese dioxide nanoparticles ($ZrSiO_4$–MnO_2-NPs). The assembled nanosorbent was characterized by XRD, FT-IR, TGA and SEM techniques. The high resolution transmission electron microscopic analysis (HR-TEM) has confirmed the nanosize range (3.15 – 8.59 nm) of $ZrSiO_4$–MnO_2-NPs. The adsorption reactions were optimized in presence of different experimental parameters such as pH, contact time, nanosorbent dose, initial concentration of 4NP, other coexisting species and reaction temperature. The presence of coexisting NaCl, KCl, $CaCl_2$, NH_4Cl and $MgSO_4$ with 4NP was found to strongly influence the adsorptive removal process. The adsorption mechanism of 4NP onto $ZrSiO_4$–MnO_2-NPs was found to fit well with the *pseudo*-second order model (R^2 = 0.999-1.000) compared to *pseudo*-first order, intraparticle diffusion, Elovich and fractional power models. The adsorption processes were found to obey the Langmuir, Freundlich, Temkin and Sips models, also the characterized values of ΔG°, ΔH° and ΔS° confirmed the spontaneity and endothermic behaviors. Excellent recovery values for removal of 4NP (4.0-6.0 and 8.0 mgL^{-1}) were established for real water samples such as tap water (93.068-98.54%), industrial wastewater (88.86-92.27%) and sea water (82.72-88.31%).

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