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Adsorption equilibrium and kinetic study of removal of nitrate from drinking water supplies by chitosan composite

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Nitrate is one of the most widespread water contaminants in the world, and high nitrate concentrations in drinking water can lead to a potential risk to public health such as methaemoglobinemia and cancer. Therefore, removal of nitrate from drinking water supplies is required in order to protect human health. In this study, cross-linked protonated chitosan/alumina (ChAl) was prepared and utilized for the removal of nitrate from aqueous solutions. The structural information of ChAl composite was examined by Fourier Transform Infrared spectroscopy (FT-IR), and the surface morphology was studied with scanning electron microscope (SEM). The kinetic, equilibrium modeling, thermodynamic parameters, and adsorption characteristics have been studied. The adsorption characteristics and process variables were investigated by examining different parameters such as pH, contact time, initial nitrate concentration, stirring speed, presence of competing ions, and temperature. The maximum adsorption capacity of nitrate on ChAl composite was 92.59 mg/L at 303 K. Adsorption equilibrium models were evaluated using experimental results and the data were well fitted to the linear Freundlich isotherm model. The adsorption kinetics data reveals that the adsorption of nitrate onto the ChAl composite is better described by pseudo-second-order model. Thermodynamic parameters were evaluated in the temperature range of 293-313 K in which the negative values of ΔGo and positive value of ΔHo indicate the spontaneity and the endothermic nature of nitrate adsorption, respectively. The magnitude of heat of adsorption was 24.19 kJ/mol which confirms that adsorption is favored by physical forces. Thermodynamic parameters revealed that adsorption of nitrate was endothermic and spontaneous. The main driving force for the adsorption of nitrate was by electrostatic interaction between the anion and the positive functional groups in the adsorbent. The reusability of adsorbent was evaluated by sequential adsorption-desorption cycles and it was found that 27.89% loss of the actual adsorption capacity of the adsorbent in sixth cycle of adsorption experiments. The results revealed that the ChAl composite was a low-cost, effective, good mechanical integrity, and reusable adsorbent for the nitrate removal from drinking water supplies.

Biography

Wondalem Misganaw Golie is PhD Research Scholar in the Department Chemical Engineering, at Indian Institute of Technology Delhi, India. He has completed his BTech in 2007 in Chemical Engineering from at Defence University, College of Engineering, Ethiopia, and MTech in 2010 in High Energy Materials from Defence Institute of Advanced Technology, India. He was Lecturer and Head of Chemical Engineering Department at Defence University, College of Engineering, Ethiopia from 2010 to 2013.

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