Functionalised natural zeolite and its potential for treating drinking water containing excess amount of nitrate

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Abstract

An excess level of nitrate in drinking water is responsible for methemoglobinemia, or 'blue baby' disease. Consequently, management of nitrate in drinking water is universally of public health interest. In this study, clinoptilolite functionalised with cationic surfactant hexadecyltrimethyl ammonium (HDTMA) was used for the removal of nitrate from drinking water. The effects of surfactant loading, adsorbent dosage, pH, coexisting ions, temperature and environmental water quality on the adsorption of nitrate were investigated. It was found that adsorption was optimum when the initial concentration of the functionalising surfactant was 3 000 $mg \cdot \ell^{-1}$. An increase in adsorbent dosage raised the percentage removal of nitrate. The valency of the coexisting anion had a major effect on nitrate removal, with the presence of phosphate (a trivalent anion) leading to the lowest removal ability. Temperature and pH had negligible effects on adsorbent performance. Environmental water samples (natural groundwater samples from Limpopo Province, South Africa) were tested and it was found that the World Health Organisation (WHO) regulatory compliance can be achieved even when the initial concentration of nitrate exceeds 300 $mg \cdot \ell^{-1}$. Equilibrium data was modelled using the Freundlich and Langmuir isotherms and the data conformed well to the Freundlich isotherm, indicating the heterogeneous nature of the active sites. Kinetically, nitrate adsorption was best described by the pseudo-second rate equation.

Keywords: adsorption, zeolite, nitrate, kinetics, equilibrium