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Activated Alumina for the Removal of Fluoride Ions from High Alkalinity Groundwater: New Insights from Equilibrium and Column Studies with Multi-component Solutions

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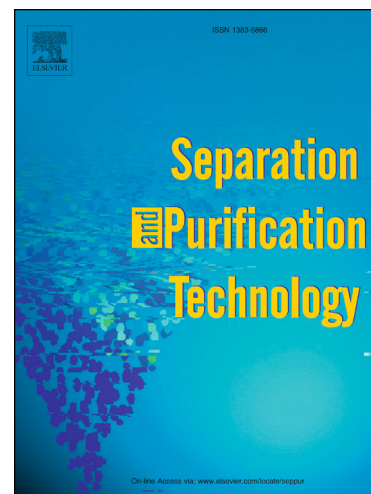
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**Activated Alumina for the Removal of Fluoride Ions from High Alkalinity Groundwater:
New Insights from Equilibrium and Column Studies with Multicomponent Solutions**

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This study focussed on the differences in sorption behaviour of fluoride on activated alumina, between simple sodium fluoride solutions and multicomponent groundwater samples with high alkalinity. It was our hypothesis that: fluoride uptake may be inhibited by the presence of bicarbonate ions: the separation mechanism may involve multiple pathways which have not been identified previously due to inappropriate bottle-point approaches; groundwater pH is critical; and methods of pH modification are important. Equilibrium studies of alkaline UOP-A201 alumina with sodium fluoride solutions showed that the isotherm was unfavourable in character (due to competition with hydroxyl species) in contrast to existing literature which suggested it was favourable. The monolayer capacities of the alumina depended upon pH, with fluoride uptakes of 6.63, 29.8, and 23.78 g F/kg alumina predicted at pH values of 8, 6, and 4, respectively. Evidence for multilayer sorption was apparent at pH 8 and 4, and as such the Aranovich Donohue model successfully simulated isotherm behaviour. Column studies of sodium fluoride solutions resulted in diminished operational fluoride loadings (1.05 to 1.29 g F/kg alumina) due possibly to high pH of the exchange environment. Adjustment of solution pH using sulphuric acid was detrimental to fluoride uptake due to competitive interactions between fluoride and sulphate ions for adsorption sites. In a column study, fluoride was effectively removed from an acid dosed groundwater sample from the Surat Basin in Queensland, with almost 800 bed volumes of water treated prior to break through of the 2 mg/L discharge limit. The groundwater was pre-treated with hydrochloric acid (ca. pH 5.2) to decompose high concentrations of bicarbonate ions which reduce fluoride uptake. Operating capacity of the alumina was 2.94 g F/kg alumina which was substantially less

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