

Factors affecting the coagulation of seawater by ferric chloride

J. Duan^{a,b}, A. Niu^b, D. Shi^a, F. Wilson^b, N.J.D. Graham^{c*}

^a*School of Environmental and Municipal Engineering, Xian University of Architecture and Technology, 13 Yanta Road, Xi'an, China*

^b*School of Civil and Environmental Engineering, Nanyang Technological University, Singapore*

^c*Department of Civil and Environmental Engineering, Imperial College London, UK*

Tel. +44 20 7594 6121; Fax +44 20 7594 6124; email: n.graham@imperial.ac.uk

Received 16 September 2008; Accepted 24 August 2009

ABSTRACT

The combination of chemical coagulation and membrane filtration (e.g. micro- or ultrafiltration) represents an effective pretreatment for seawater desalination by reverse osmosis (RO). The removal of dissolved organic substances requires optimization in order to enhance treatment performance and minimize the risk of membrane fouling. For this reason a detailed understanding of the performance of hydrolyzing metal salts during coagulation is essential. In this study, coagulation experiments with ferric chloride were carried out using a standard jar test technique, and microfiltration (MF) was simulated using a 0.45- μm membrane filter. Factors affecting the coagulation behaviour in terms of the removal of humic acids (HA) in seawater were investigated, namely the pH, coagulant dose, saline strength, HA concentration and presence of oil. Experimental evidence concerning the chemical bonding of high valence metal ions (Fe^{3+} , Ca^{2+} , Mg^{2+}) were provided by fluorescence spectroscopy and its theoretical relevance to the coagulation processes has been discussed. Laboratory experiments were carried out over a wide range of iron dosage (16–2,500 $\mu\text{mol/L}$) and pH (4–9) and a coagulation diagram (iron dosage vs. pH) defining domains of HA removal has been established with corresponding values for the electrical surface potential of aggregates. The maximum removal of HA (~95%) in samples of Singapore seawater was found to occur at pH 5 and at a coagulant dose $\geq 150 \mu\text{mol Fe/L}$. For water quality comparable to that of offshore seawater the coagulation performance in terms of HA removal was not strongly influenced by seawater strength, the presence of oil or the initial HA concentration within practical ranges of these parameters.

Keywords: Coagulation; Seawater; Water treatment; Ferric chloride; Humic acid; Oil

* Corresponding author.