Desalination and Water Treatment
www.deswater.com
1944-3994 / 1944-3986
doi: 10.5004/dwt.2009.116

2 (2009) 203–222
February

Natural organic matter removal and enhanced coagulation as a link between coagulation and electrocoagulation

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Received 17 June 2007; Accepted 28 July 2008

ABSTRACT

Although coagulation has historically been used for turbidity removal, drinking water regulations have emerged in recent years expanding the use of this process beyond its traditional role to include disinfection by-products (DBP) precursors removal. Effective removal of DBP precursors is the one of the major challenges in modern drinking water treatment. DBP precursors are present in all surface water supplies existing as natural organic matter (NOM), and this type of precursors can be characterised by the following measurements of dissolved organic carbon (DOC), ultraviolet absorbance at 254 nm (UV_{254}), specific ultraviolet absorbance (SUVA), and disinfection by-products formation potential (DBPFP). The effort to remove DBP precursors results in reduction of DBP formation in potable water. However, scientists discovered that chlorination of organic matter in raw water resulted in formation of DBPs. Because of concerns over the health effects of these organic by-products, several industrial countries have established limits for DBP in drinking water. The most known chlorination by-products are trihalomethanes (THM) and haloacetic acids (HAA). The US Environmental Protection Agency (USEPA) regulated THM and HAA in drinking water at the limit of 80 and 60 $\mu g\ L^{-1}$, respectively, while recently, the European Union countries regulated THM in their water at the limit of 100 $\mu g\ L^{-1}$. The USEPA has identified enhanced coagulation (EnC) as a best available technology (BAT) for reducing DBP precursors in conventional water treatment plants. Their removal by EnC depends on a variety of factors, including but not limited to, pH, alkalinity, coagulant type and dosage, and the type and concentration of NOM. Finally, electrocoagulation (EC) presents a robust novel and innovative alternative in which a sacrificial metal anode doses water electrochemically. This has the major advantage of providing active cations required for coagulation, without increasing the salinity of the water. EC is a complex process with a multitude of mechanisms operating synergistically to remove pollutants from the water. EC has the potential to remove efficiently DBP precursors which are essentially negative dissolved species by cationic charge neutralisation/electrical field oxidation/metal hydroxides adsorption. This paper tries briefly to describe NOM removal by coagulation, EnC and EC and shows that EC seems a priori to be the next future process step from coagulation passage via EnC process. However, the application of EnC to maximise removal of organics may not necessarily result in attainment of stringent levels of THMs in drinking water where chlorine is used as disinfectant. This is due to the concentration of residual DOM that is recalcitrant to removal by coagulation. This problem does not occur when the EC process is used, since disinfection is assured by EC itself. Consequently, more studies on application of EC as a substitute of chemical coagulation/disinfection at an industrial level must be done with NOM characterisation to optimise this process.

Keywords: Natural organic matter; Water treatment; Coagulation; Enhanced coagulation; Electrocoagulation

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