

Optimization of inline coagulation in integrated membrane systems: A study of FeCl₃

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ABSTRACT

This research investigated the effect of different process conditions (pH, G , Gt and coagulant dose) on inline coagulation pre-treatment of ultrafiltration (UF) with FeCl₃. Delft canal water was coagulated with FeCl₃ and filtered through a 0.1 μm PVDF filter in an Amicon unstirred cell. Filtration was performed in dead-end mode at a constant pressure of 0.1 MPa and at 20°C. Membrane fouling was quantified by calculating the modified fouling index (MFI) of the coagulated solutions. For coagulation with FeCl₃, results showed that at higher coagulant dose (>10 mg Fe³⁺/L), the effect of flocculation time on MFI becomes negligible such that MFI is almost constant for 15 mg Fe³⁺/L for flocculation times ranging from 0 to 60 min. It was also observed that a relatively high dose (5 mg Fe³⁺/l) and long flocculation time (60 min) can compensate for the adverse effect of low pH on MFI. While proper flocculation can be designed and achieved prior to membrane filtration, Gt and retention times within the pipes and membrane modules can affect floc size and structure. Calculations for a treatment plant revealed G values of approximately 4000 s⁻¹ in the pipes (Ø 0.075 m) at a flow rate of 33 m³/h and more than 500 s⁻¹ in the UF hollow fibres (Ø 0.0008 m) at a flux of 80 l/m².h. From the results it may be concluded that process conditions are inter-related, such that careful selection of one parameter could compensate for the inadequacy of the others. Consequently, an important consideration for maintaining low coagulant doses for in-line coagulation is proper optimization of pH and flocculation time.

Keywords: Inline coagulation; Modified fouling index; Process conditions

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