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Fouling mitigation of a dead-end microfiltration by mixing-enhanced preoxidation for Fe and Mn removal from groundwater

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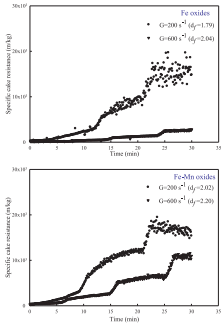
HIGHLIGHTS

- The reduced cake resistance is caused by mixing-enhanced preoxidation.
- A hydrophobic cake aggravates membrane fouling as Fe–Mn oxides form.
- The irreversible fouling induced by Fe–Mn oxide is severer than that by Fe oxide.

GRAPHICAL ABSTRACT



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ABSTRACT

A combination of oxidation and microfiltration (oxidation-MF) is commonly used to remove Fe and Mn from groundwater. The characteristics of Fe and Mn oxides formed by oxidation can be significantly affected by the mixing intensity during oxidation, which subsequently influences the performance of membrane filtration. To optimize oxidation-MF, the critical role of mixing intensity on Fe and Mn oxide formation was investigated. Sufficient oxidant (NaOCl) was added to a prepared ferrous solution with or without Mn ions to oxidize the ions at different mixing intensities, followed by a dead-end MF for 30 min at a constant transmembrane pressure of 1 kg/cm^2. A custom-made module surrounded by a tube membrane was used in microfiltration. The resistance of membrane filtration was calculated by a resistance-in-series model. Cake resistance (R_c) dominated the fouling of the membrane, which depended on the composition of oxides. Oxides formed at high mixing intensity were smaller and more compact, which resulted in reduced R_c and increased permeate flux. The presence of oxidized Mn aggravated membrane fouling. Permeate flux declined rapidly as a result of the cake formed by Fe–Mn oxides with increased hydrophobicity. The irreversible fouling of the dead-end MF was insensitive to mixing intensity during prechlorination, while the irreversible fouling induced by Fe–Mn oxides was more severe than that by Fe oxides as membrane filtration cycle progressed. The results show that membrane flux of a dead-MF can be effectively improved by prechlorination with enhanced mixing due to the formation of a permeable cake layer with low cake compressibility in the membrane filtration.

1. Introduction

Fe and Mn are found in groundwater in their most soluble form, Fe(II) and Mn(II) ions, and in the oxide form, Fe_2O_3 and MnO_2. Conventionally, raw water is first oxidized, and then filtered to remove the oxide solids. Vigorous oxidation is needed to comply with

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