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Pre-oxidation coupled with ceramic membrane filtration for natural organic matter removal and membrane fouling mitigation during surface water treatment

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ABSTRACT

Catalytic ozonation coupled with membrane filtration has been widely used in water treatment to improve effluent quality as well as control membrane fouling. In this study, the removal of natural organic matter (NOM) from surface water and the mitigation of membrane fouling by $O_3/H_2O_2/TiO_2$ pre-oxidation coupled with ceramic membrane in static cycling model were investigated. The results showed that the pre-oxidation of O_3, O_3/H_2O_2 and O_3/TiO_2 significantly improved the removal rate of NOM, with the sequence of $O_3/TiO_2 > O_3/H_2O_2 > O_3$. Under the O_3/TiO_2 pre-oxidation, the macromolecular substances such as aromatic proteins, fulvic acid-like and humic-like substances were completely removed, which may be due to the accelerated ozonolysis and •OH formation by TiO_2. Meanwhile, three-dimensional fluorescence spectra and molecular weight distribution showed that humic acids and biopolymers were the main pollutants, and also the main causes for membrane fouling. The pre-oxidation of O_3, O_3/H_2O_2 and O_3/TiO_2 significantly mitigated the membrane fouling via the degradation of humic acids and biopolymers with the order of $O_3/TiO_2 > O_3/H_2O_2 > O_3$. Under the optimal pretreatment, the resistance of membrane fouling was significantly reduced, and the transmembrane pressure (TMP) decreased by 62.2%. Redundancy analysis showed that the molecular weight was the most important factor for total fouling resistance, while turbidity was negatively correlated with the fouling resistance. In addition, the $O_3/H_2O_2/TiO_2$ pretreatment can also enhance NOM removal and membrane fouling mitigation under long-term (48 h) cycle model.

Keywords: Pre-oxidation; Ceramic membrane; Surface water; Natural organic matter; Membrane fouling

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