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Time-series image analysis for investigating SWRO fouling mechanism

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ABSTRACT

The fouling behavior of seawater reverse osmosis membranes has yet to be definitively investigated due to the complexity of seawater compositions. In this study, a time-series image analysis (TSIA) was performed to investigate the fouling mechanism using scanning electron microscopy (SEM) and atomic force microscopy (AFM). The fouling experiments were conducted with synthetic seawater (SS) and SS mixed with humic acid substances (SHA). The effect of operational time was investigated for 2, 4, 6, 8, 12, and 20 h. According to the TSIA results, different fouling characteristics between SS and SHA experiments were observed. In the SS case, the fouling mechanism is the interaction between inorganic particles and the membrane surface as well as interaction between inorganic particles and the deposited foulants. Then, increased accumulation of deposited foulants was observed with respect to the operational time. However, in the presence of humic acid, the fouling mechanism was significantly influenced by the adsorption of humic acid onto the membrane surface at the initial stage (first 2 h). This organic layer traps inorganic particles and organic substances, and accelerates the fouling formation on the membrane surface, thereby leading to a greater flux decline compared to the SS experiment.

Keywords: Fouling mechanism; Image analysis; Membrane morphology; Reverse osmosis; Surface roughness

1. Introduction

Insufficient water supplies in areas around the world have led to an increased interest in freshwater production via a diverse range of processes. In particular, one promising solution for overcoming the expected water shortage is desalination technology [1]. In recent years, seawater reverse osmosis (SWRO) desalination has become the leading global technology for seawater desalination, because it shows higher economical efficiency compared with multistage flash and multi-effect distillation [2–4]. Furthermore, recent research relating to SWRO processes has focused on energy saving and the cost reduction [5–8]; as such, it is expected that SWRO desalination technology will become more popular and be able to produce freshwater with less energy consumption.

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