A Fouling comparison study of algal, bacterial, and humic organic matters in seawater desalination pretreatment using UF ceramic membranes

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Abstract

This paper investigates three types of organic matters, namely algal organic matter (AOM), bacterial organic matter (BOM), and humic organic matter (HOM). These organics are different in properties and chemical composition. Therefore, they were systematically studied to understand whether they behave differently or similarly in reference to organic fouling of ceramic ultrafiltration (UF) membranes. (AOM), (BOM) and (HOM) were compared in terms of organic content, fouling behavior, and removal efficiency. UF experiments have been conducted at constant flux mode using (5 KDa) and (50)kDa ceramic membranes. Six filtration cycles were tested in duplicates, with a cycle consisting of thirty minutes operation followed by hydraulic backwashing for one minute. AOM and BOM were extracted from marine algae, *Chaetoceros affins* (*CA*) and marine bacteria, *Pseudidiomarina atlantica* (*P. atlantica*) respectively in the lab, while commonly used (Suwannee River) humic acid was used as HOM. These organics have been spiked separately into synthetic seawater feed with a total TOC of (0.5 mg/L). Results showed that more TEP/organics were removed by the 5 kDa membranes compared to the 50 kDa membrane, which is accounted for by lower MWCO. The UF 5 kDa membrane also showed low fouling formation than 50 kDa membrane for all of three types of organic matter tested. Analysis of the fouled membranes by SEM images showed that fouling was dominated by cake layer formation for the 5 kDa membrane while pore blockage followed by cake layer formation is apparent for the 50 kDa membrane. The SEM images clearly show that a cake layer is formed for all types of organics tested; the flux was stable over the filtration periods for AOM and BOM, most probably due to the high porosity of the cake layer. On the other hand, HOM showed more fouling due to the combination of pore blockage and cake layer formation. AOM and BOM organics exhibited a similar fouling behavior and mechanism. However, AOM was higher than BOM in terms of TEP concentrations. This is probably attributed to high polysaccharides concentration in AOM whereas BOM was higher in protein content than AOM. HOM exhibited a different organic content, fouling behavior and mechanism compared to AOM and BOM. This is most likely due to the difference in size of HOM compared to the other organics. Furthermore, the divalent cations such as calcium and magnesium showed a significant impact on membrane fouling. That's probably because of the presence of calcium and magnesium ions made the membranes and organic matter less negatively charged and easier to deposit on membranes, thus, enhancing the membrane fouling significantly.

Keywords: SWRO pretreatment; UF Ceramic membranes; Fouling, AOM, TEP.