Conditioning Films Formed by Algal Biopolymers in Seawater Reverse Osmosis Desalination

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Overview
Fouling of reverse osmosis membranes in desalination facilities is heavily exacerbated by marine algal blooms (like “Red Tides”). The algae themselves are not the fouling culprits because they are large enough (roughly 10 to 50 µm) to be removed by pretreatment systems. Biopolymers released from the algal cells, however, can pass through pretreatment and adsorb to the reverse osmosis (RO) membranes. These biopolymers form a conditioning film that changes the surface properties of the membranes and can enhance biofilm development. This project seeks to characterize algal biopolymers and their interactions with RO membranes.

Materials and Methods

Heterocapsa pygmaea algae were cultured in the laboratory (Fig. 1). Bench-scale RO experiments were performed with commercial membranes (Fig. 2). Analytical tools included visual imaging, laser scanning cytometry (LSC), scanning electron microscopy (SEM), attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR), wet-chemical protein and carbohydrate determination, and polyacrylamide gel electrophoresis (SDS-PAGE).

Results and Discussion

When algae were spiked directly to the RO system some flux decline occurred; however, little if any change in performance was seen when the particles were removed and only organic matter remained (Fig. 3). Visual imaging could not detect the organic matter, though fluorescence imaging using LSC gave some detection (Fig. 4). With SEM it is clear that not much organic matter accumulated even after a significant time period (Fig. 5). The concentration shown is the amount of protein in the feed water that was collectable by that membrane. Circles give actual measurements (2 repetitions per sample). Bars show averages. The concentration data can be used to determine release of algicidal biopolymers in seawater desalination plants such as a release could be caused by shear in intake structures, pumps, and valves.

Conclusions

Algal biopolymers do not show a very strong affinity for RO membranes, nor do they decrease RO water flux in and of themselves. But they do accumulate and form a conditioning film. Proteins are more prominent in this film than carbohydrates. Work continues to determine which proteins have the greatest adsorption affinity.

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References


