Removal of Foulant-Repelling Dendrimer Layer on Reverse Osmosis Membranes

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Introduction

❖Membrane fouling hinders the efficiency of reverse osmosis (RO) membranes in water treatment processes

❖Fouling accounts for decreased flux

❖ Membranes must go through a time consuming cleaning process regularly

❖Coating membranes in polyamidoamine (PAMAM) dendrimer has proven to improve effluent flux.
Sarkar et al. *J. Membrane Sci. 349.* (2010). 421-428

Objectives

❖PAMAM layer needs to be removed from the membrane then replaced when it becomes saturated with foulant

❖ Determine if simply exposing the SWC5 RO membrane will coat it with PAMAM

❖ Release G4 and G5 PAMAM be changing the RO feed conditions (i.e. pH and salinity)

Experimental Methods

SWC5 membranes were coated in a 9.87 µM G4 PAMAM solution and a 3.34 µM G5 PAMAM solution for approximately 24 hours.

The coated membranes were rinsed in solutions of pH 2, pH 13, 0.5 M NaCl, and 0.1 M sodium dodecyl sulfate (SDS) for 2 minutes

The zeta potential (ZP) across each membrane surface was measured over a full titration (pH 3 to pH 9) using the Anton Paar SurPASS Electrokinetic Analyzer. The zeta potential allowed for the analysis of the extent of PAMAM coating and removal from the SWC5 membrane.

Scanning electron microscopy (SEM) was also done on the virgin SWC5, G4 coated, pH 2 rinsed, and 0.1 M SDS rinsed membranes using the Hitachi SU6600 Scanning Electron Microscope.

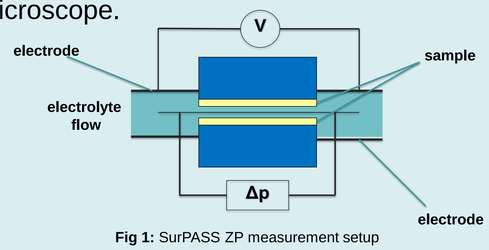

Fig 1: SurPASS ZP measurement setup

Results

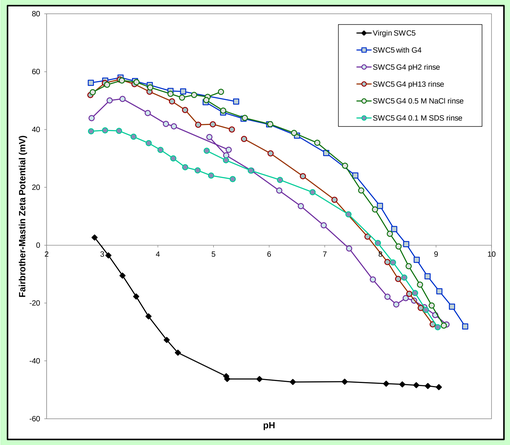

Fig 2: Zeta potential measurements of SWC5 membrane with G4 PAMAM coating

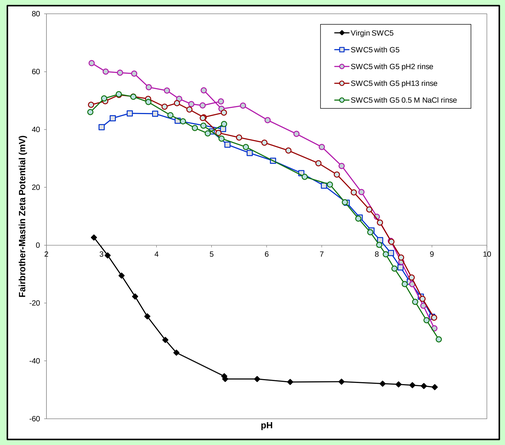

Fig 3: Zeta potential measurements of SWC5 membrane with G5 PAMAM coating

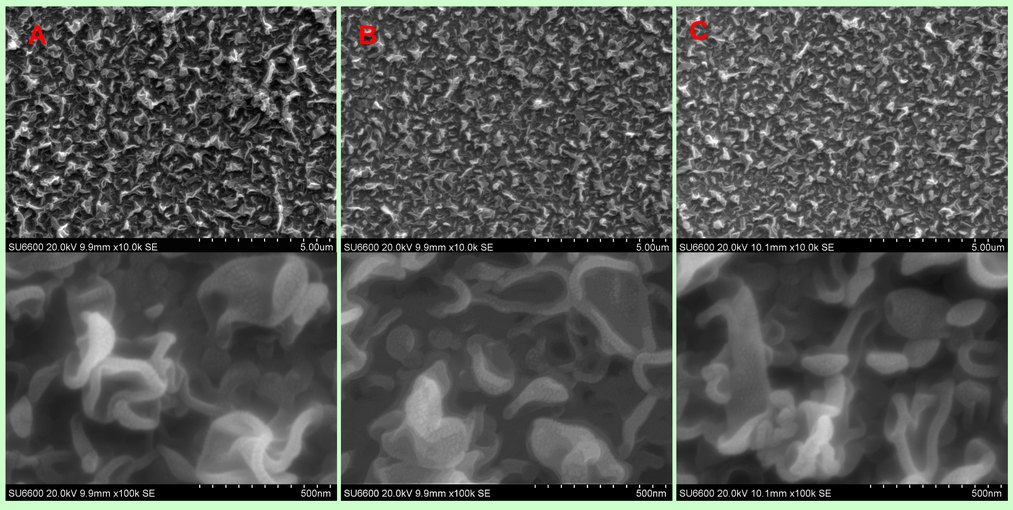

Fig. 4: SEM images of SWC5 membrane. **A)** Virgin SWC5. **B)** G4 PAMAM coated SWC5. **C)** G4 coated SWC5 after 0.1 M SDS rinse.

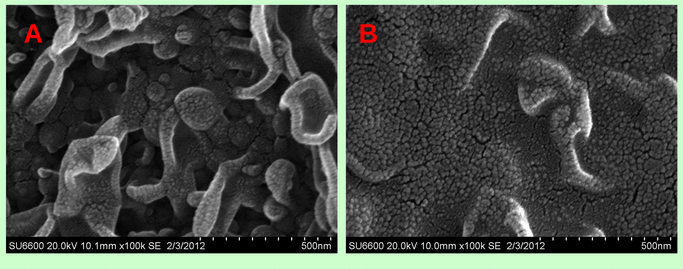

Fig. 5: SEM images of SW30HR membrane. **A)** Virgin SW30HR. **B)** PolyDADMAC coated SW30HR

Discussion

❖ Measured zeta potentials show that the G4 and G5 PAMAM dendrimer has been coated onto the SWC5 RO membrane

- PAMAM is a positively charged dendrimer

❖ None of the removal methods performed were able to remove all of the dendrimer

- Most effective is the pH 2 rinse
- 0.5 M KCl rinse is the least effective, indicates PAMAM will not be removed in desalination processes

❖ SDS likely binds to the dendrimer

- Negative charge on SDS lowered ZPAs the titration proceeded
- SDS was washed off the dendrimer coating

❖ SEM images indicate the G4 PAMAM coating is very thin while increasing the surface charge

- Impressive compared to the polyDADMAC coated SW30HR membrane, where the coating is clearly visible on the surface

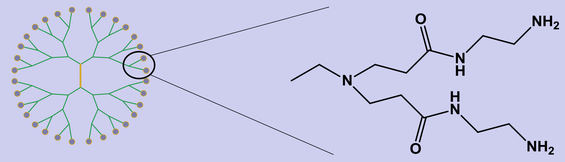

Fig 6: PAMAM dendrimer with magnified surface groups

Conclusions

❖ G4 and G5 PAMAM dendritic polymers adhere well to SWC5 membranes

❖Changes in pH and salinity do not show significant removal of the G4 PAMAM dendrimer from the SWC5 membrane

❖SDS appears to bind with the dendrimer, but not permanently

Future Work

❖ Consider using different surfactants that will bind better with the PAMAM

❖Test the removal in a simulation where actual fouling has occurred

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