Heat-Responsive Microgel Anti-Foulant Coatings for Water Purification Membranes

Andrea Kraetz, Chemical Engineering

Mentor: Dr. Mary Laura Lind Thomas, Associate Professor, Chemical Engineering

School for Engineering of Matter, Transport, and Energy, ASU

Reverse Osmosis Membrane

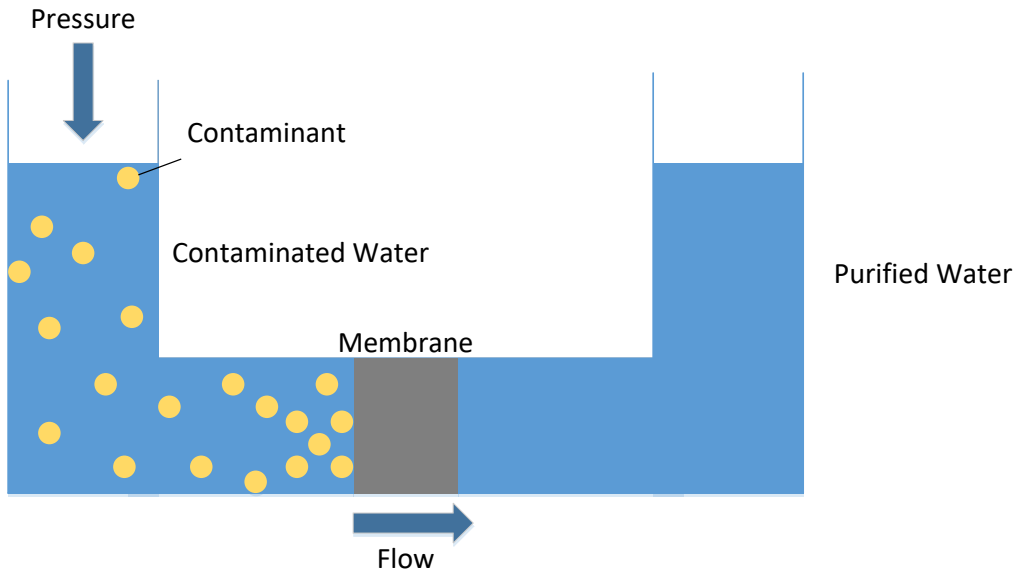


Figure 1. Typical reverse osmosis system

- Applied pressure forces contaminated water through membrane.
- Membrane structure allows water through, but prevents the flow of contaminants.
- Structure of the membrane determines selectivity.
- Flux of the membrane is the amount of water through the membrane per area per time.

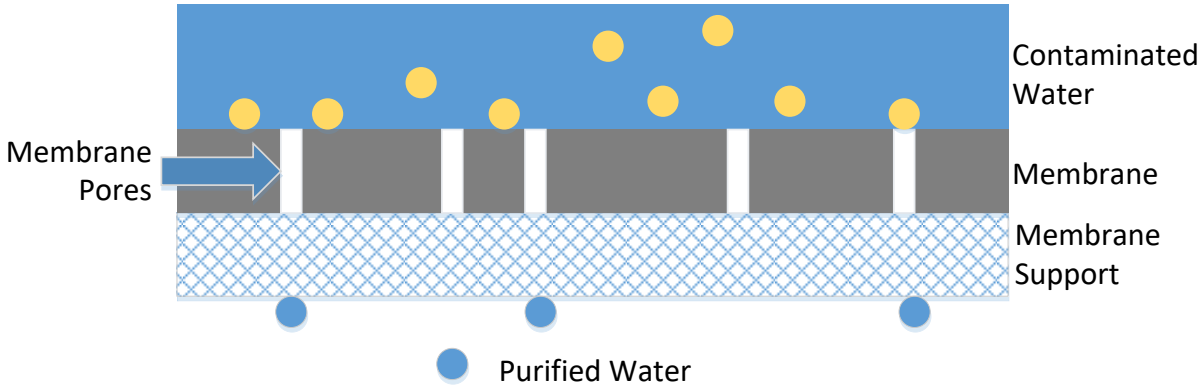


Figure 2. Typical structure of a reverse osmosis membrane.

Fouling

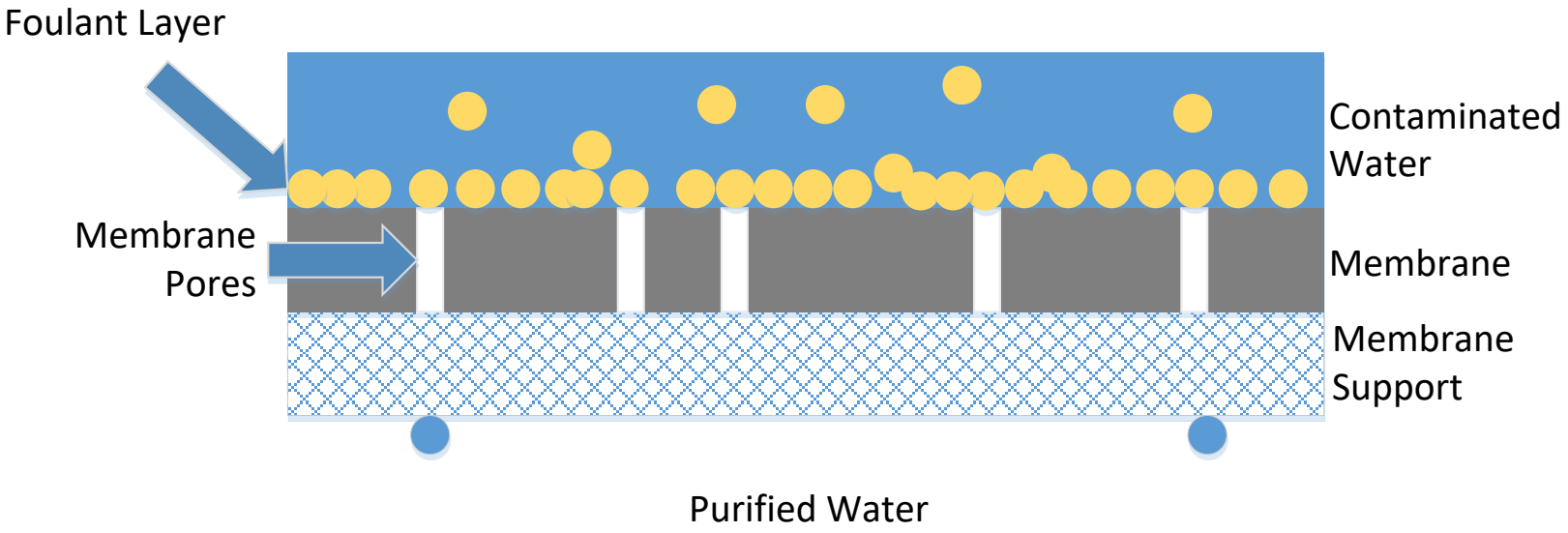


Figure 3. Fouled membrane surface

- As contaminants build up on one side of the membrane, it produces a layer on the membrane surface.
- Fouling layer prevents water from traveling through membrane.
- Reduces the flux of the membrane and requires additional pressure to push water through, reducing efficiency.
- Anti-fouling coatings are being developed to prevent this.

Microgel

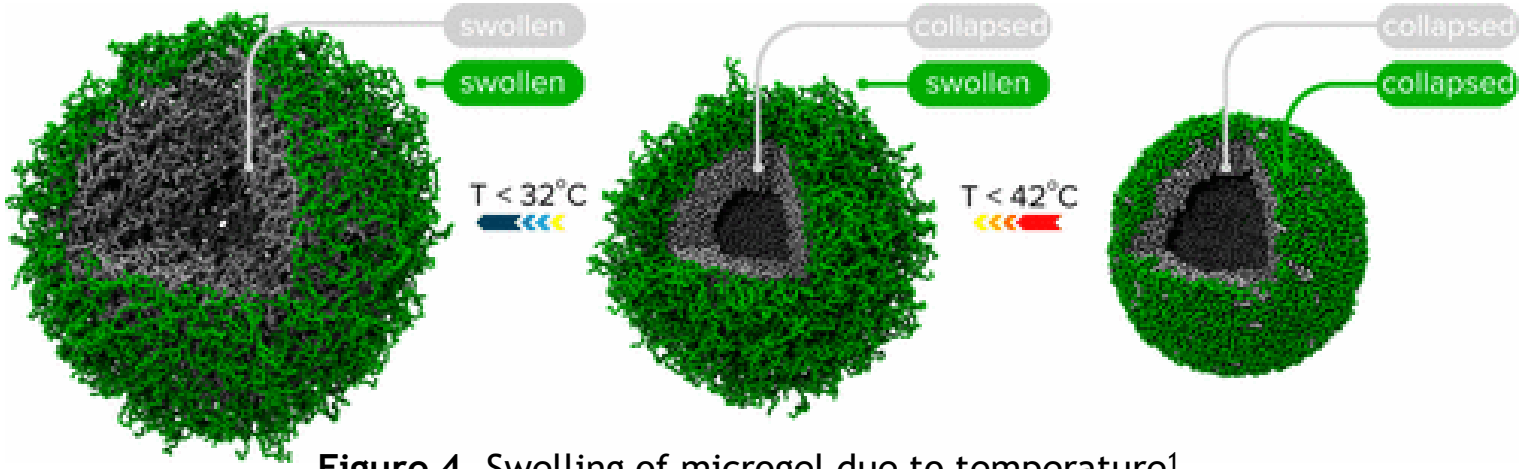


Figure 4. Swelling of microgel due to temperature[1]

- Colloidal substance that is highly responsive to outside stimuli.
- Shrinks at higher temperature.
- Microgel can be used as an anti-foulant coating through functional group binding to foulant and as a physical barrier between the foulants and the membrane surface.
- When it shrinks in higher temperatures, foulants on the microgel will be removed.

[1]F. A. Plamper and W. Richtering, "Functional Microgels and Microgel Systems," Accounts of Chemical Research, vol. 50, no. 2, pp. 131-140, 2017.

Experiment

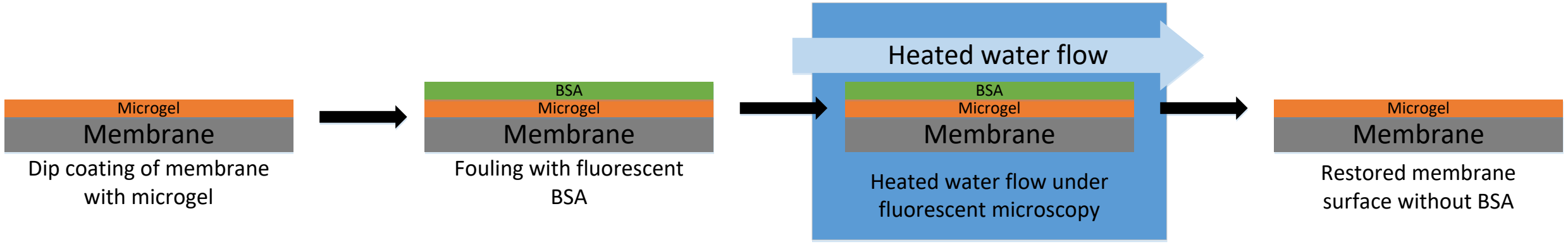


Figure 5. Experimental process for testing microgel as an anti-foulant

- Membrane dip coated with microgel
- Coated membrane with fluorescent bovine serum albumin (BSA)
- Exposed membrane surface to heated water in cross flow (60°C) at low flow rate (0.4L/h) under fluorescent microscopy

Results

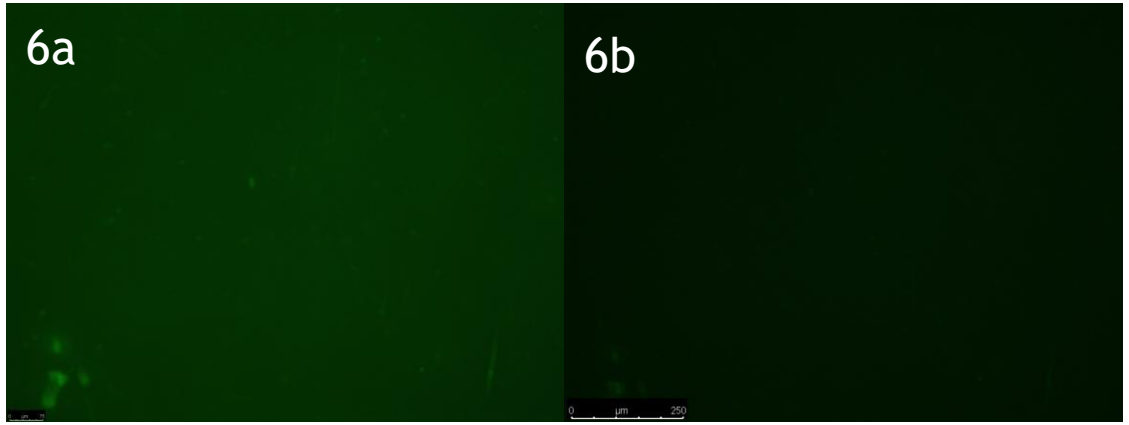


Figure 6. Image of microgel coated membrane with fluorescent BSA with a) the initial amount of fluorescence and b) the amount after 20 minutes of hot water

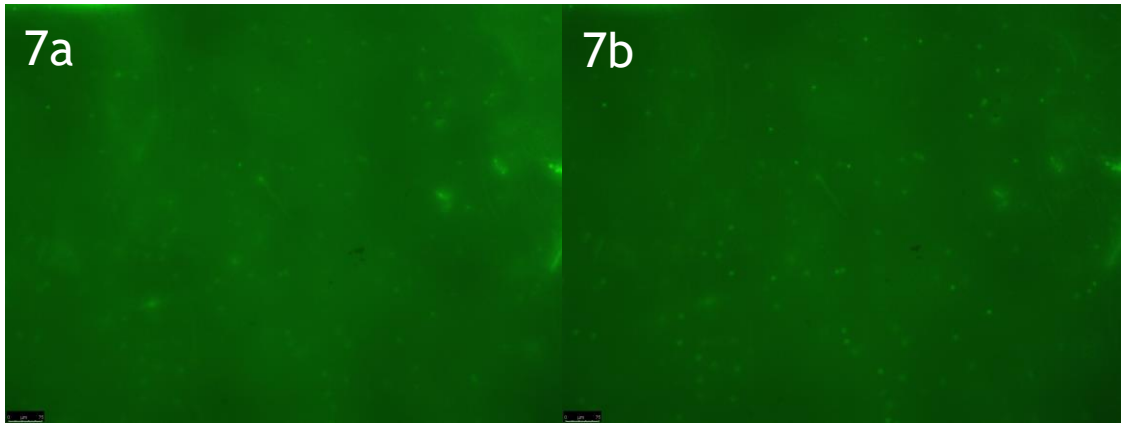
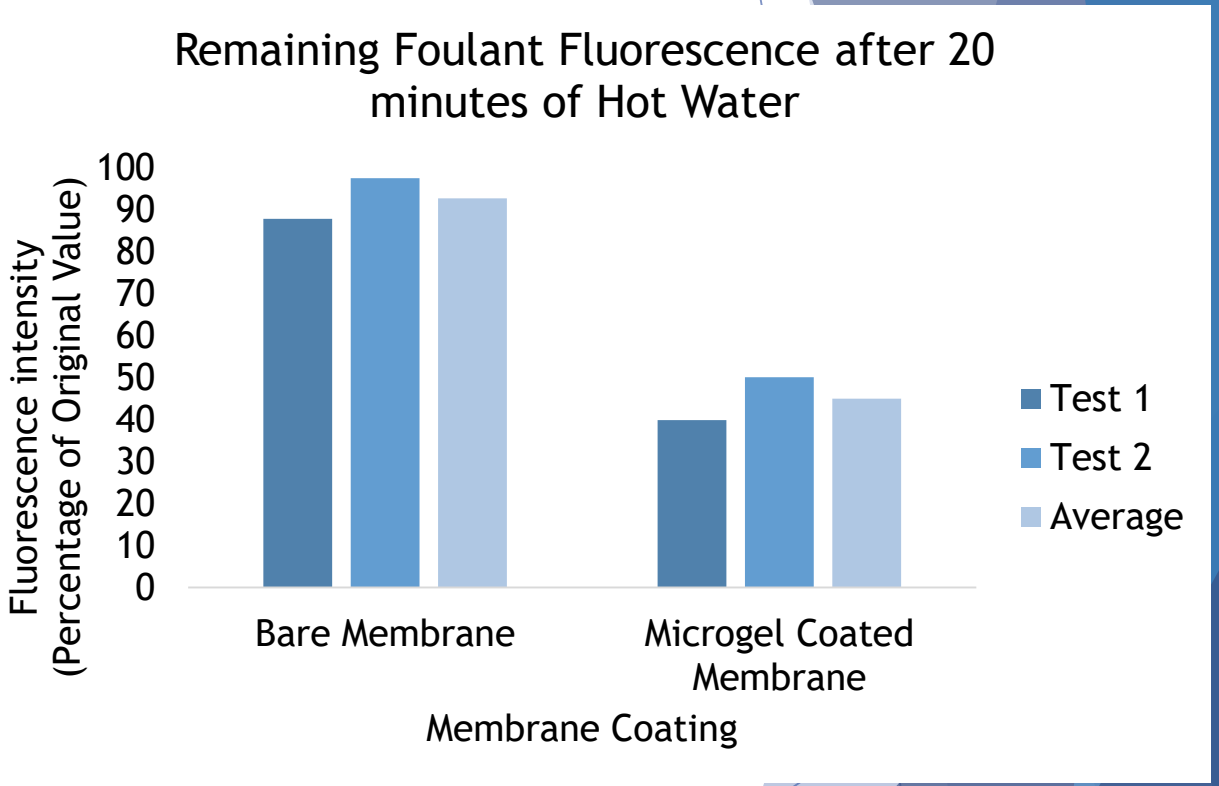


Figure 7. Image of bare membrane with fluorescent BSA with a) the initial amount of fluorescence and b) the amount after 20 minutes of hot water



Graph 1. Indicates the amount of fluorescence remaining after 20 minutes of crossflow with hot water

Membrane Functionalization

- Under reverse osmosis, microgel came off the membrane surface due to high pressures.
- Creates the need to functionalize membrane surface in order to chemically bond the microgel to the membrane surface.
- Functionalization could effect the performance of the membrane.

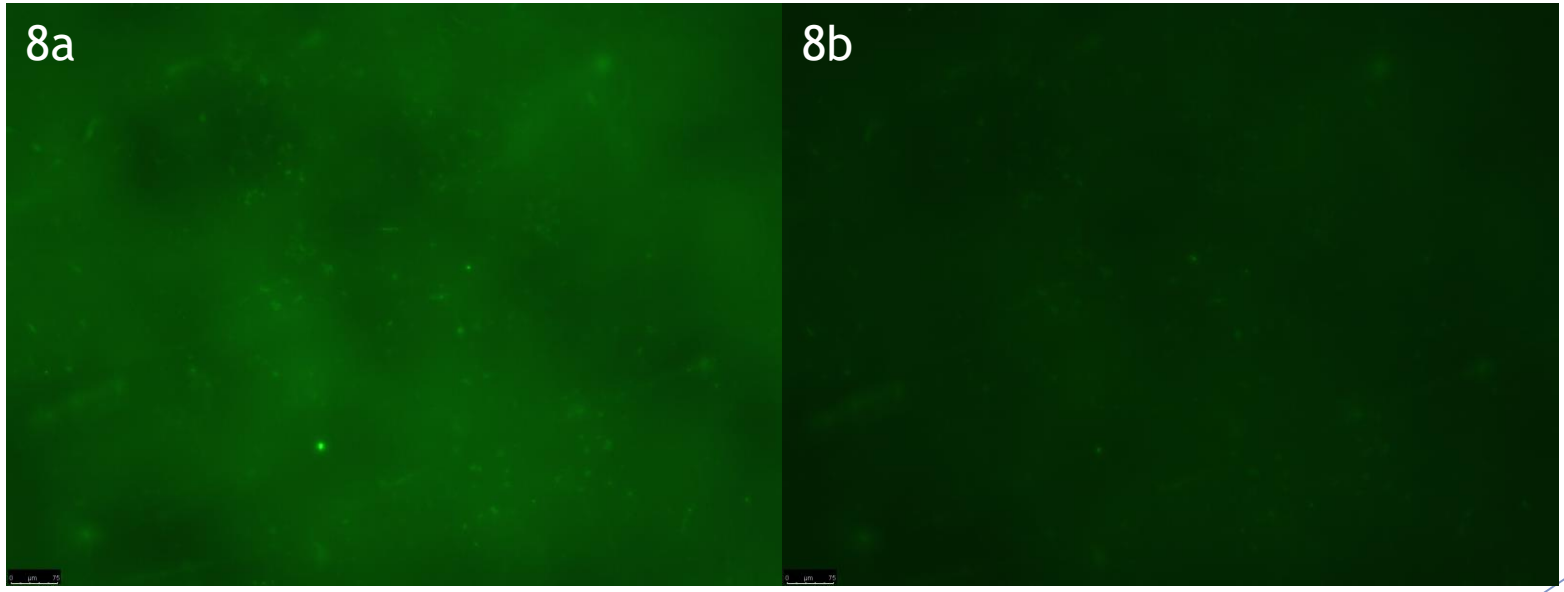


Figure 8. Image of functionalized microgel membrane with fluorescent BSA with a) the initial amount of fluorescence and b) the amount after 20 minutes of hot water

Future Work

- Conduct reverse osmosis tests on the functionalized membranes to determine if the microgel remains in the surface under these conditions.
- Test microgel performance with various foulants.
- Develop additional methods for the uniform coating of microgel on membrane.

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Thank you!

Questions?