



Reverse osmosis fouling and disinfection byproducts from chloramine in potable reuse treatment trains

Direct potable reuse



Juliana Berglund-Brown, Alex Szczuka, William Mitch

Stanford University

Re-Inventing the Nation's Urban Water Infrastructure (ReNUWIt)

Background

This experiment focuses on the steps taken to ensure clean drinking water from direct potable reuse treatment trains. The Codiga Resource Recovery Center at Stanford is a pilot test bed for the Staged Anaerobic Fluidized Membrane Bed Reactor (SAF-MBR), an anaerobic secondary treatment reactor. Little research, however, has been conducted on how anaerobic effluent will foul Reverse Osmosis membranes when linked to water recycling. The following experiment analyzes how chloramine affects the rate of membrane fouling. This experiment also analyzes the Disinfection Byproducts produced through the disinfection of water via chloramination. Disinfection Byproducts are significant because they prove to be potentially harmful for human consumption. The question this experiment addresses is two fold. First, when chloramines are applied to SAF-MBR effluent, what effect do they have on fouling? Second, when applied, what levels of Nitrosamines—a known class of DBPs— will be produced? If the point at which nitrosamines form are identified, steps can be taken to adjust treatment methods to reduce Nitrosamines in final effluents.

Approach



Figure 1. Potable reuse treatment train

Use different methods of water treatment and to analyze the affect of such disinfectants on membrane fouling. This experiment focuses on the use of chloramine as a disinfectant.

Reason behind use of chloramines is two fold:

1. Chloramine is relatively less expensive than other disinfectants.
2. Chloramine has disinfectant residual, meaning than chloramines will continue to disinfect after treatment is over, say, if additional contaminants were added. This helps prevent, for instance, microbial regrowth.

Determine whether or not foulants were formed during SAF-MBR treatment, or if foulants were already present in the waste water.

- Water disinfecting with chloramine was run through the R.O. and flux was measured by having water effluent amount weighed every five minutes.
- Two different water sets were used. One set of lab reactor water, and one set of Codiga water. Lab reactor water is fed a synthetic feed whereas the Codiga water is waste water from sewage.

DBPs were tested every step in the treatment train. DBPs were only tested in lab reactor water. Figure 1 outlines the treatment train, with the stars representing each stage in which DBPs were tested.

Results

Condition: chloramine: 1.5 mg/L dose Cl --> 1 mg/L residual after 24 hours

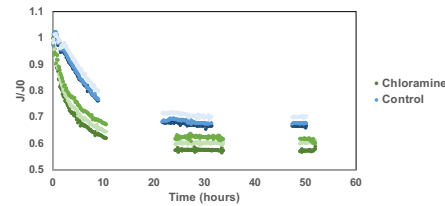


Figure 2. Fouling data for lab reactor water

Condition: chloramine: 1.75 mg/L dose Cl --> 1 mg/L residual after 24 hours

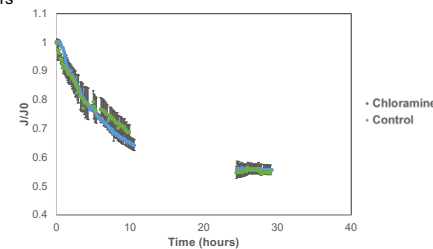


Figure 3. Fouling data for Codiga water

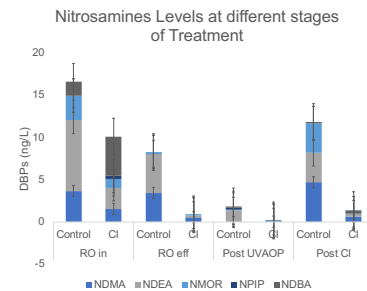
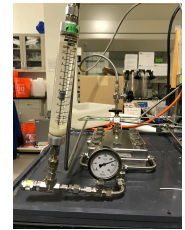


Figure 4. DBPs at different stages in anaerobic water treatment

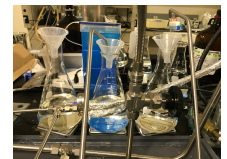
Conclusions

- The data reveals that, for normalized flux, chloramine increases the fouling. This result is not ideal, so potential alternatives, such as ozone, could be used for disinfection. For the Codiga water set, chloramine does nothing to fouling, as both the control and chloramine show relatively similar data. This is most likely due to the Total Organic Carbon content, as there is a different ratio in the lab reactor fed from a synthetic feed versus the Codiga water.



Figures 5&6. Experimental conditions for RO fouling setup (225 psi, 1.6 L/min influent flow)

- In terms of the DBP formation, a higher concentration of Nitrosamines formed after the final chloramination stage in the control. UV based advanced oxidation processes, successfully reduce Nitrosamine concentration. The Nitrosamine levels did not exceed 20 ng/L.



Next Steps

- This experiment only evaluated Disinfection byproduct formation for the lab reactor water, not the Codiga water. The next step will be to continue testing DBPs for Codiga water, in addition to evaluating DBPs other than Nitrosamines, such as regulated halogenated DBPs.
- In addition to testing Halogenated DBPs, we will further evaluate how different DBPs and disinfection methods might affect membrane fouling in wastewater treatment.

Acknowledgements

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