3-1-2013

Effects of Aggregation State on Flux Reduction by Superfine Powdered Activated Carbon on Microfiltration Membranes

Mengfei Li
Clemson University

Jaclyn R. Ellerie
Clemson University

David A. Ladner
Clemson University

Effects of aggregation state on flux reduction by superfine powdered activated carbon on microfiltration membranes

Mengfei Li[1], Jaclyn R. Ellerie[1], David A. Ladner[1]

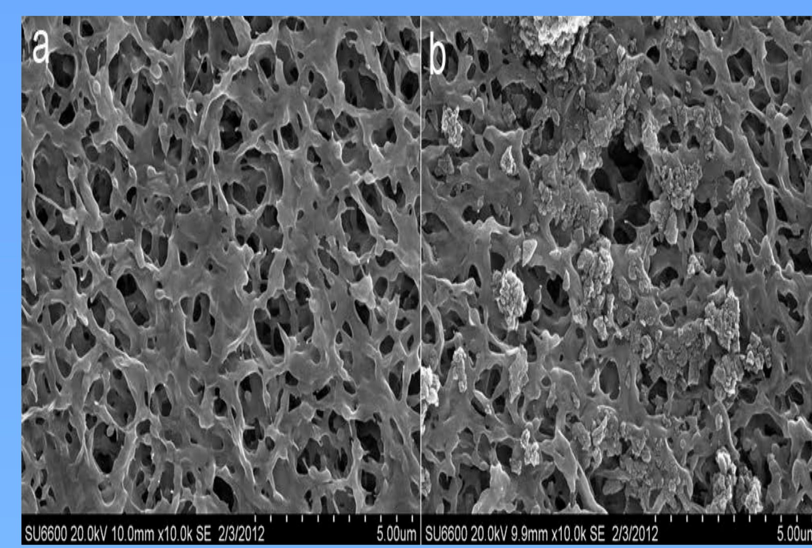
1. Department of Environmental Engineering and Earth Sciences, Clemson University

Abstract

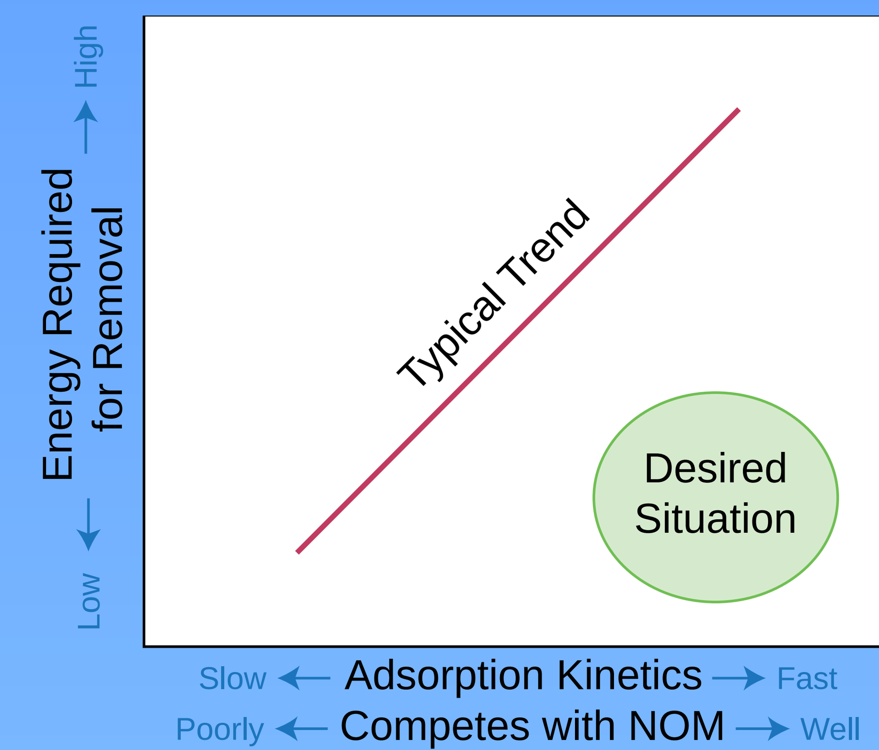
Former data show that superfine powdered activated carbon (S-PAC) removes phenanthrene and atrazine better than adsorbents with larger particle size in the presence of competitive adsorbents like natural organic matter (NOM); however, small-particle adsorbents are much harder to remove from the water stream after adsorption because they are more likely to block membrane pores. In this research we focus on the effect of aggregation on flux reduction when S-PAC as adsorbents are used with microfiltration membranes. Amicon cell experiment with a constant pressure of 10 psi were performed using a 0.1 µm PVDF membrane, which represents the most common type of membrane in drinking water treatment. S-PAC was suspended in ultrapure water as 2 g/L. Bath sonication and probe sonication with various times and power were used to test the degree of disaggregation. It was observed that aggregation state plays a large part in membrane flux decline. Future work will involve understanding new ways to induce aggregation before filtration for low-energy S-PAC removal from water.

Materials

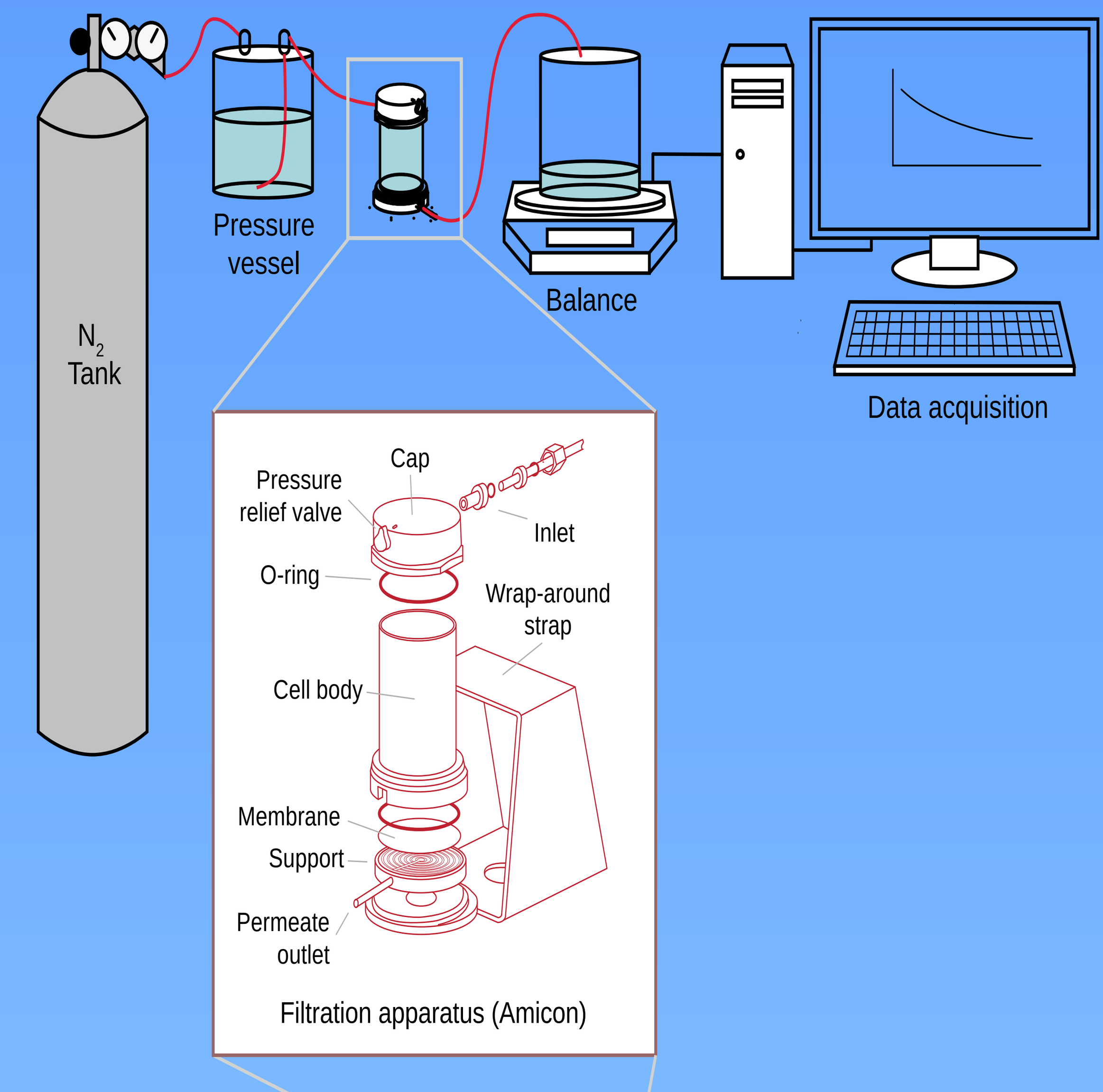
WPH S-PAC (Calgon Carbon Corp.)
WPH PAC (Calgon Carbon Corp.)
PVDF membrane (0.1 µm)
Ultrapure water



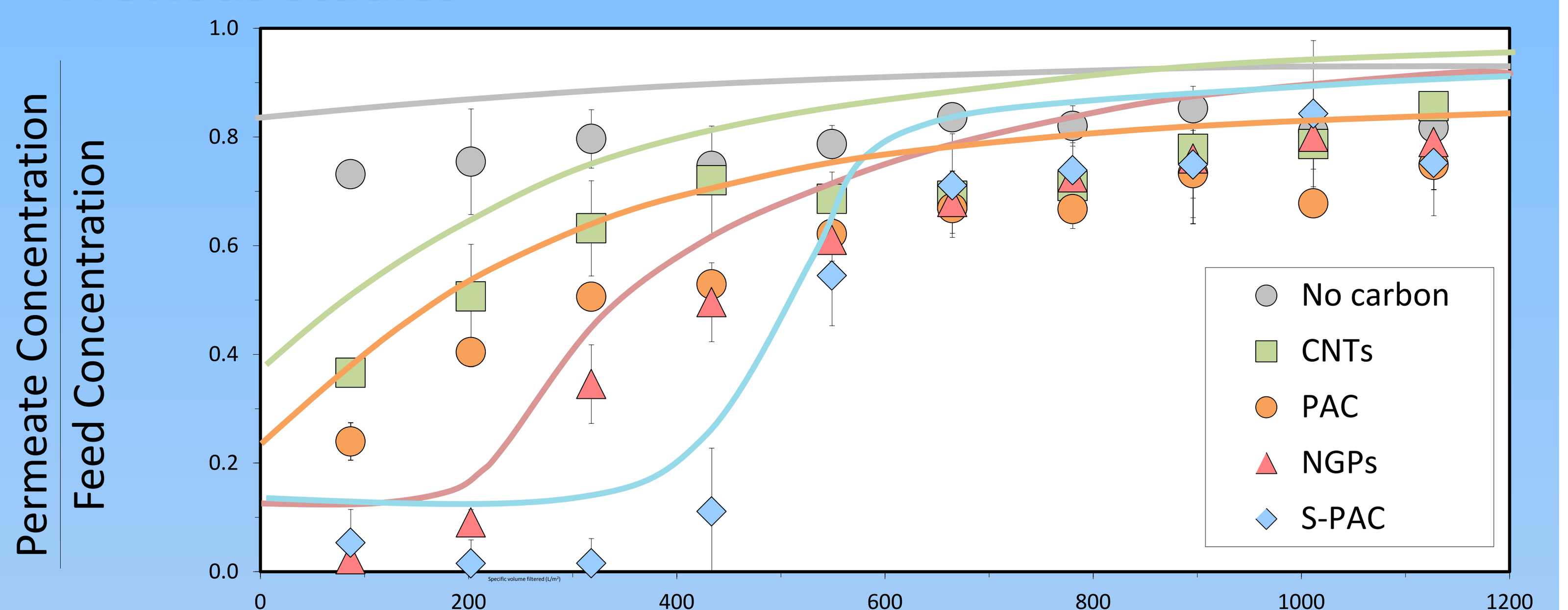
SEM images of (a) a virgin 0.1 µm PVDF membrane, (b) S-PAC particles on the membrane.



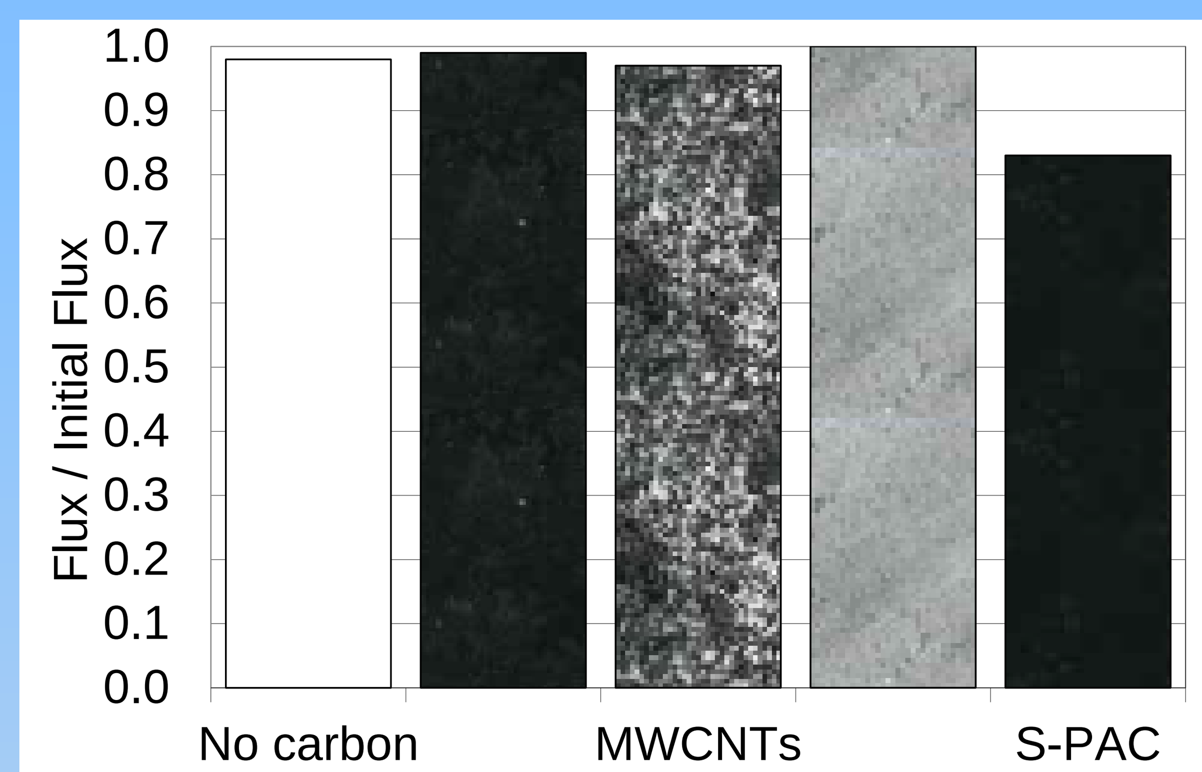
Adsorbents with fast kinetics and that compete well with NOM tend to be smaller particles that require high energy inputs to remove from the water stream (as manifest by flux decrease in our preliminary data).



Previous Studies



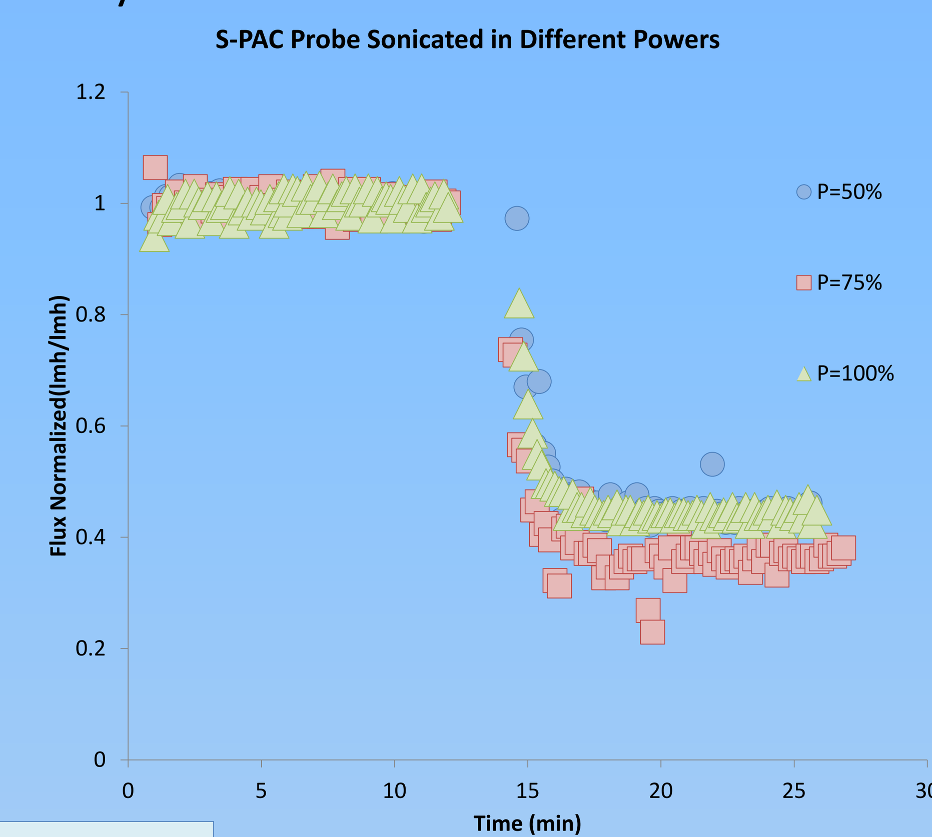
Atrazine removal by 0.1 µm PVDF membranes coated with CNTs, PAC, NGPs, and S-PAC. A non-coated membrane is also shown, for comparison. The feed atrazine concentration was 15 ppb. S-PAC shows greatest removal at lower filtered volume and has no big difference when the volume is up to 600L/m^2.



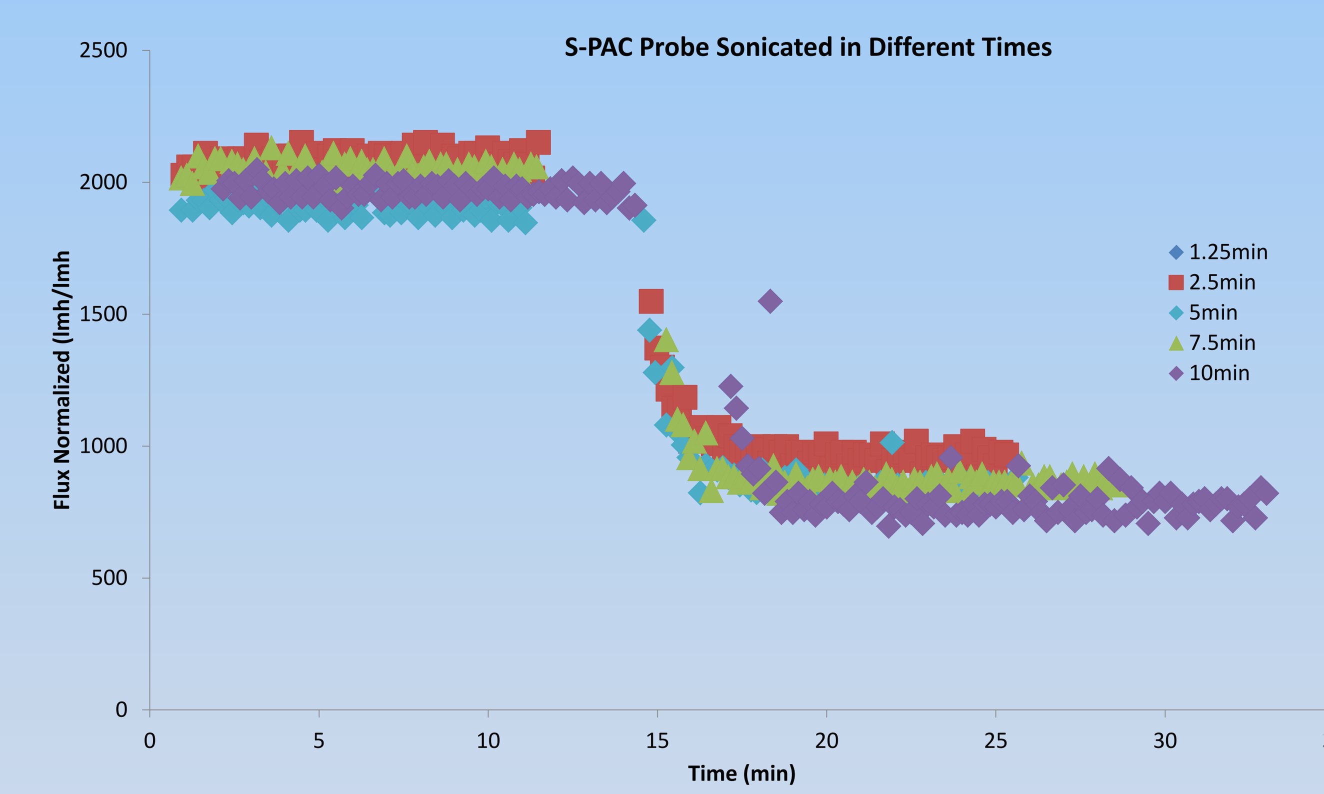
The S-PAC can block the pores of membrane which leads to flux decline, other types of carbon will aggregate to larger particles and not influence the flux largely.

The first 10 minutes data in all the graphs show the value of ultrapure water flux.

WPH S-PAC results

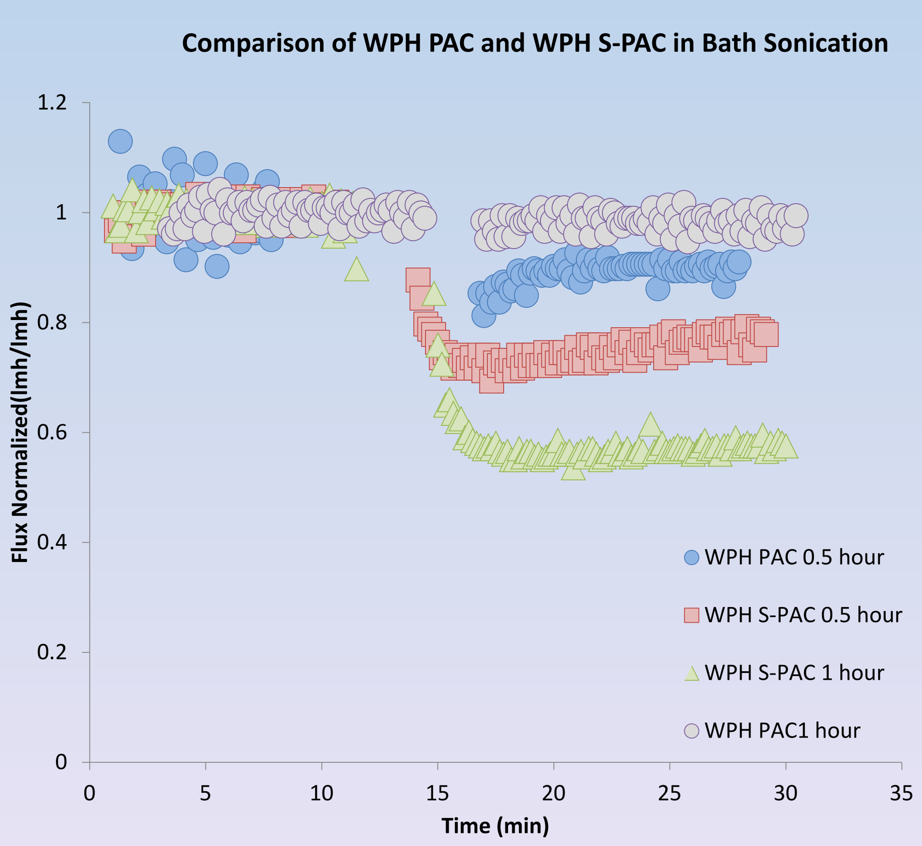


Different powers of probe sonication do not have big influence on the flux decline, even though 75 percent power has greater effect on flux decline than other two. The probe sonication breaks the particles of S-PAC completely in lower power.

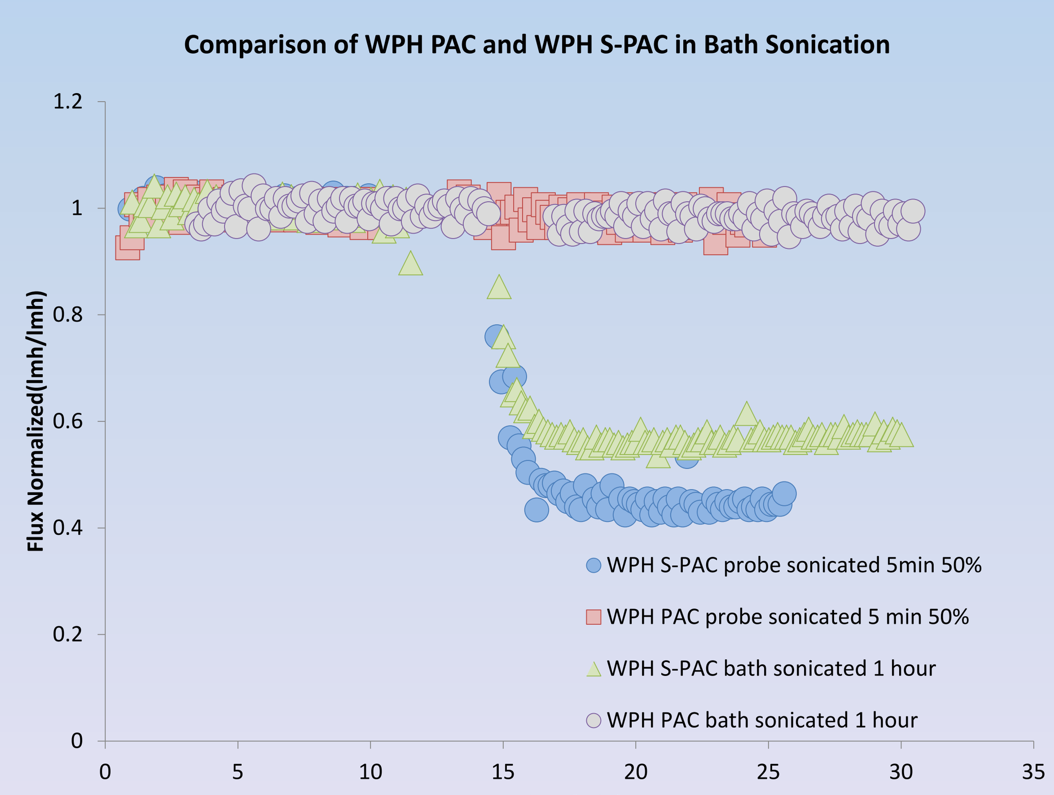


Different times of probe sonication do not have big influence on the flux decline. The probe sonication breaks the particles of S-PAC completely in short period.

Comparison of WPH PAC and WPH S-PAC



WPH PAC have larger particle sizes, which aggregate after sonication and have rarely influence on flux decline. However, instead of aggregation, WPH S-PAC block the membrane pores and leads to flux decline. The longer time of bath sonication is, the more decrease on flux.



WPH PAC still have rarely influence on flux decline even when the time of bath sonication is longer or change the sonication method to probe sonication. WPH S-PAC have prominent results in flux decline by probe and bath sonication. The probe sonication shows greater effect than bath sonication with parameters on the graph.

Conclusions:

- WPH PAC have larger particle size and will aggregate to greater size of particles than the size of membrane pores, which do not affect the flux.
- WPH S-PAC have smaller particle size and will block the pores of membrane, leading the decreasing of the flux, especially after sonication.
- The influences of the sonication are various according to type of sonicator, time, and power.

Future Works:

- Effects of other membranes
- Different instruments like crossflow cell
- Reaggregation

View a PDF with clickable links
http://www.clemson.edu/ces/ladnergroup/posters/

CLEMSON UNIVERSITY