PROJECT TITLE: Low-cost ceramic membranes for ultra/nanofiltration of produced water

START DATE: March 1, 2019

END DATE: February 29, 2020

PRODUCTS:

MS Thesis:

- "Studies on the use of metakaolin geopolymer for produced water treatment", School of Materials Science and Engineering, Oklahoma State University (December 2019)

Proposal:

- *Title* – "Low Cost Ceramic Membrane Based Modular System for Residual Oil Recovery and Radionuclide Separation from Produced Water"; *Source* – Department of Energy, EPSCoR; *PI* – R. P. Singh (OSU); Co-PIs – P. Sarin and K. Wagner (OSU), and L. Biedermann (Sandia National Laboratories, Albuquerque, NM) *Amount* – $1,562,494; *Duration* – 12/1/2019-11/30/2021. *STATUS:* Declined.

STUDENT SUPPORT

Student Status	Number	Disciplines
Undergraduate	1	Mechanical & Aerospace Engineering
M.S.	2	Materials Science & Engineering
Ph.D.	0	
Post Doc	0	
Total	3	

NOTABLE ACHIEVEMENTS AND AWARDS:

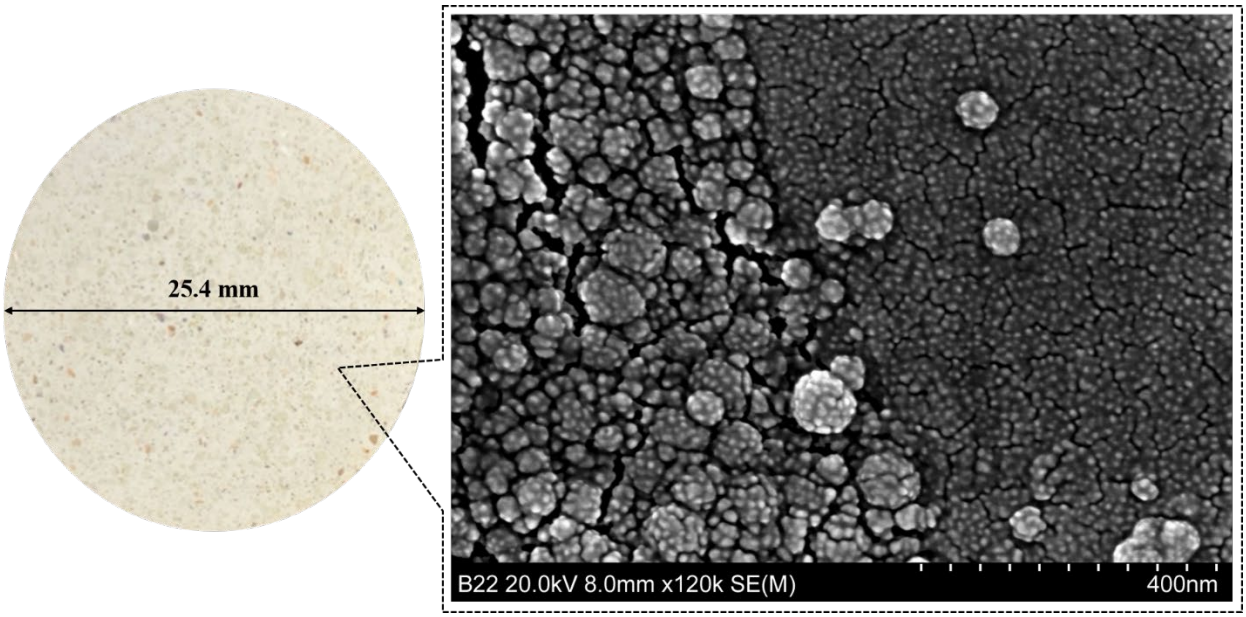
1. 3rd Place in OSU 3Minute Thesis Competition, 2020

SYNOPSIS: *(250 words)*

Low cost ceramic membranes were successfully developed in this project. Stand-alone disc-shaped membranes were processed as ceramic composites using geopolymers as the matrix phase and natural zeolites or biochar as the filler phase at low temperatures. A range of compositions, which varied in both the concentration and type of the filler phase, were evaluated. The properties and performance of the developed membranes were analyzed for their microstructure, compressive strength, and filtration performance. Our studies showed that geopolymer + zeolite composites were very promising. Geopolymer composites with fine or medium size particles of clinoptilolite (zeolite) could be processed as membranes with up to 40 percentage by volume zeolite phase addition. Zeolite particles bonded well with the geopolymer matrix phase. Addition of zeolite phase improved both the compressive strength and the filtration performance of the membranes. The most remarkable water quality effect observed from using these membranes for filtration was on turbidity, which was decreased up to 95%. Additionally, significant reduction in the concentrations of Ca, Zn, Fe, Mg, Sr, P, S, Br, and Si were observed. However, unremarkable change was observed in the total dissolved solids concentrations

upon filtration through the membranes, confirming that these membranes were unable to separate out the chloride or sodium ions. Overall, filtration performance of geopolymer composite membranes with fine zeolite was better than with medium zeolite, and was found to be invariant under different pressures. Some promising directions identified in this work that are being pursued further include optimization of composition and development of 3D ceramic membranes on porous scaffolds.

FIGURE/PHOTOGRAPH:



Ceramic composite membrane with 80% geopolymer and 20% fine zeolite composition (left) decreased produced water turbidity by 95%, from 74.7 NTU to 4.4 NTU at 2 bar pressure. The SEM image (right) of the composite membrane at 120,000 X magnification confirmed that zeolite particles were seamlessly integrated in the geopolymer matrix.