

# Development of a Novel and High Performance WO<sub>3</sub>/Al<sub>2</sub>O<sub>3</sub> Ceramic Composite Membrane for Oil-Water Separation

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The process of oil extraction makes large amounts of a toxic and oil-contaminated byproduct known as produced water, with the US generating over 30 billion barrels in 2022. Oil-water (O/W) separation through membrane technology is a favorable solution, but membranes are susceptible to oil fouling, which reduces water filtration flux. While tungsten trioxide (WO<sub>3</sub>) based membranes are promising, they were not yet tested for their photocatalytic self-cleaning (i.e., anti-fouling ability). Thus, this project aimed to study the self-cleaning and O/W emulsion separation performance of novel WO<sub>3</sub>/Al<sub>2</sub>O<sub>3</sub> composite membranes with different WO<sub>3</sub> particle shapes (spherical nanoparticles, hexagonal nanoparticles, and nanoflakes). The three membranes were fabricated by covalently crosslinking WO<sub>3</sub> nanomaterial to an Al<sub>2</sub>O<sub>3</sub> support by interfacial polymerization. The super-hydrophilic and underwater super-oleophobic surface properties were confirmed through contact angle measurements. Characterized by FTIR, SEM, EDS, and XRD, the membranes were tested in O/W emulsion separation with oil concentrations ranging from 50 to 200 ppm and at pressures between 2 and 8 bar. Long-term filtration tests showed a 97% flux recovery after UV irradiation every 2 hours, which proved the membranes' self-cleaning and anti-fouling ability. Further, all membranes showed more than 99% O/W emulsion separation efficiency, which was stable for 8 hours. The nanoflake WO<sub>3</sub>-based membrane achieved the highest efficiency (99.8%), while the hexagonal WO<sub>3</sub>-based membrane exhibited the highest flux (751 LMH). The developed WO<sub>3</sub>/PA@Al<sub>2</sub>O<sub>3</sub> membranes showed great potential for effective O/W emulsion separation with anti-fouling properties, promoting its application in oily wastewater treatment, specifically for produced water.

## Awards Won:

Fourth Award of \$500