Improving the Performance of TFN Membranes by Incorporating UiO-66 and MIL-125 MOFs Nanoparticles Used for Water Desalination

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Summary

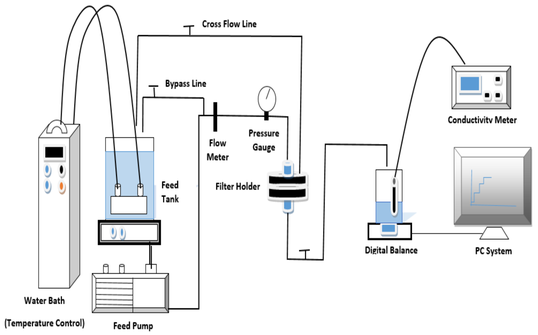
Knowing that the world is facing a shortage of fresh water, desalination, in its different forms, including reverse osmosis, represents a practical method to produce potable water from a saline source. In this project, UiO-66 and MIL-125 (~ 100 nm) metal-organic frameworks (MOFs) nanoparticles (NPs) were embedded into thin-film composite membranes in different weight ratios, 0, 0.05, 0.1, 0.15, 0.2, and 0.3 %. The membranes were synthesized by the interfacial polymerization (IP) of *m*-phenylenediamine (MPD) in aqueous solution and trimesoyl chloride (TMC) in an organic solution. The membranes were characterized by the scanning electron microscopy (SEM), contact angle measurement, Permeability test, transmission electron microscopy (TEM), and salt rejection and water flux assessments. Results showed that the NPs could improve the membranes' performance depending on the NPs loading. At the optimum NPs loadings, 0.15% UiO-66 and 0.3% MIL-125, the water flux increased from 62.5 to 74.9 and 85.0 L/m^2 h, respectively; while NaCl rejection was slightly improved, always >98.5%. The experiments were tested at 2000 ppm salt concentration, 25 °C, and 300 psi transmembrane pressure.

Materials and Methods

PSU Support Sheets : Made by dissolving 15 wt.% of PSU in DMF solvent and casting the solution then.

MPD Solution	TMC Solution
a- 2% MPD, b- 1% CAS/TEA salt, c- 0.01 % $CaCl_2$, d- 96.99 % Water.	a- 0.15% TMC, b- 99.85 % 2,2,4-trimethyl pentane.

Operation Conditions : 300 psi, 25 °C, 2000 ppm NaCl and 8 hours.



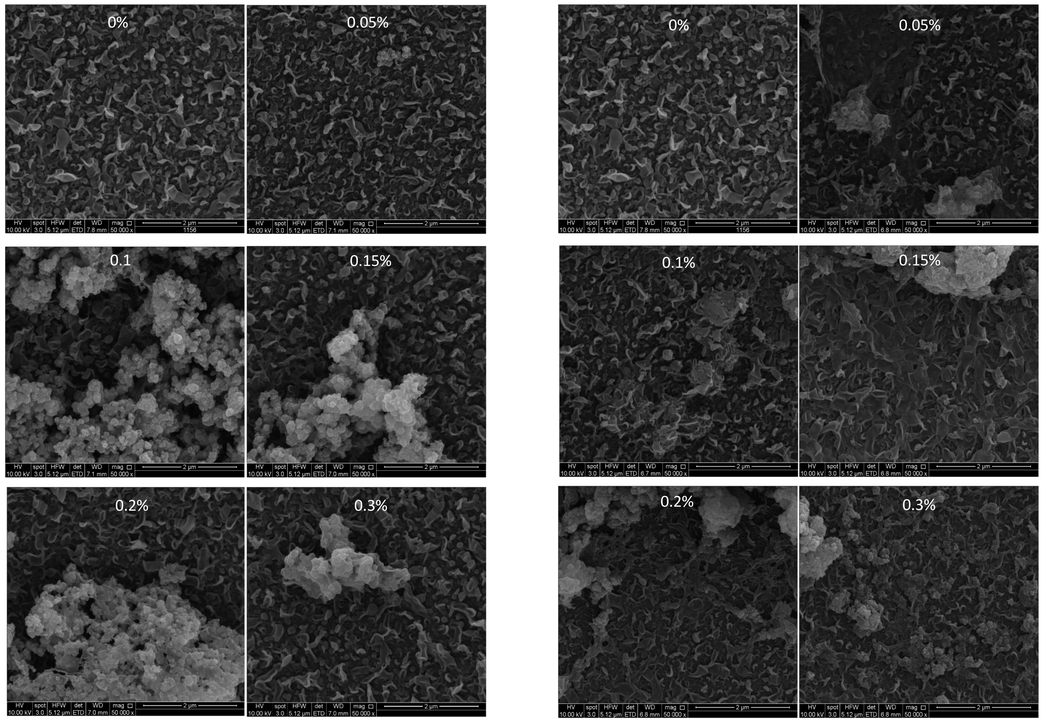
Schematic diagram of the experimental system

References

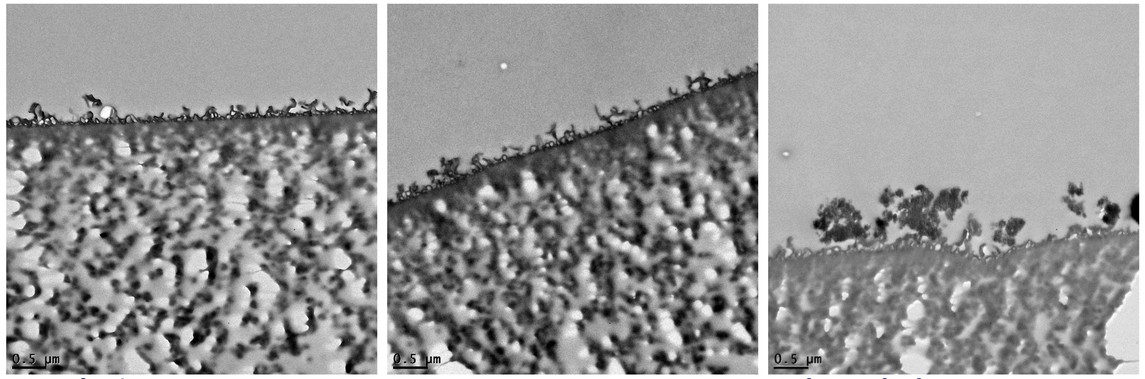
1- Menachem Elimelech and William A. Phillip, Science, 333, 2011.
2- John Cadotte, U. S. Patent 4277344, 1981.
3- Mohammed Kadhom, Jun Yin,, Baolin Deng, Membranes, 6 (50) 1-12, 2016.

Results and Discussion

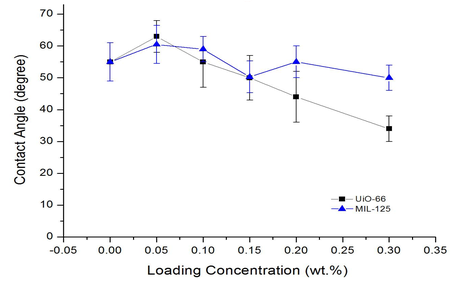
SEM Images of the Membranes After Filling UiO-66 (Right) and MIL-125 (Left)



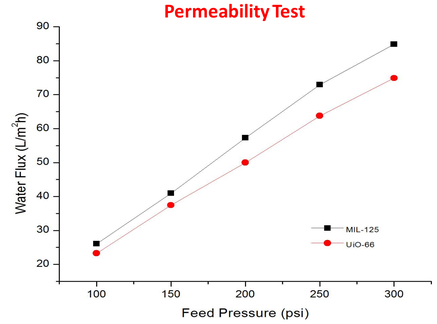
TEM Images of Membranes, Plane (Left), Filled with 0.15% UiO-66 (Center), and Filled with 0.3% MIL-125 NPs (Right)



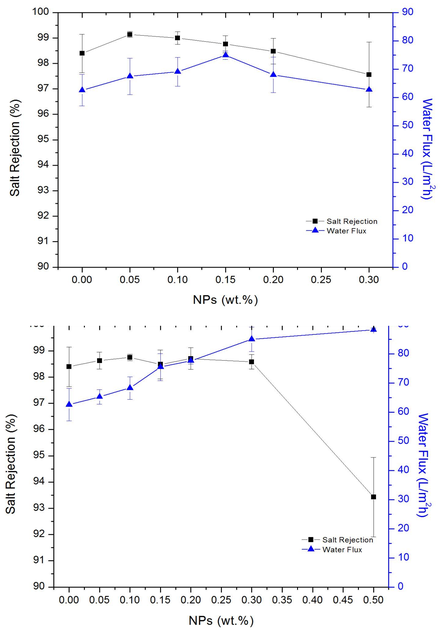
Contact Angle Test



Permeability Test



Performance Test of TFN membranes filled with UiO-66 (Upper) and MIL-125 (Lower) NPs



Conclusions

1- TFN membranes filled with MOFs and supported by a plastic sheet layer were synthesized by the IP process and applied in reverse osmosis.
2- UiO-66 and MIL-125 MOFs NPs (~100 nm) were prepared by the solvothermal method
3- The NPs and membranes were examined using different techniques.
4- MOFs NPs improved the membranes' water flux and salt rejection in a high ratio comparing with the conventional materials due to their special structure.

Acknowledgments

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