TECH OFFER

# Membrane Distillation: Hydrophilic & Fouling Resistant

## KEY INFORMATION

TECHNOLOGY CATEGORY:
Environment, Clean Air & Water - Filter Membrane & Absorption Material

TECHNOLOGY READINESS LEVEL (TRL): TRL4
COUNTRY: SINGAPORE
ID NUMBER: TO174528

## OVERVIEW

Compared to other desalination technologies, membrane distillation (MD) possesses several advantages, including the tolerance to high salinity, the capability to leverage low-grade heat sources, and the low capital expenditure.

However, MD faces the problems of membrane wetting and fouling when desalinating wastewater and seawater with complex compositions. Membrane wetting is a prominent challenge to MD because it allows direct permeation of the salty feed across membrane pores, resulting in salt passage and process failure. The inherent hydrophobicity of conventional MD membranes increases the fouling propensity of organic foulants (e.g., proteins and oil). This blocks the membrane pores, which leads to a lower water productivity. Oil-induced fouling is particularly relevant to MD because MD has been extensively explored and shown promising to desalinate the produced water from hypersaline shale oil/gas streams.

This technology relates to a novel NF/MD membrane to combat the issue of surfactant-induced wetting in MD. A dense top layer, which mimics the selective layer of NF membranes, is constructed on top of a polyvinylidene fluoride (PVDF) MD

membrane.

The technology owner is currently seeking interested commercial entities to license the technology and develop it into a product.

## TECHNOLOGY FEATURES & SPECIFICATIONS

This technology relates to the addition of a hydrophilic layer as well as an anti-fouling and anti-wetting layer onto a polyvinylidene fluoride (PVDF) membrane. The vapour flux data have confirmed that the hydrophilic layer does not add extra resistance to water vapour transport. The said membrane exhibits excellent resistance toward both surfactant-induced wetting and oil-induced fouling in direct contact MD (DCMD) experiments.

**Performance**

This membrane has enhanced hydrophilicity and oil-fouling resistance, leading to higher productivity.

**Fouling Resistance of Membranes**

An oil-containing saline solution was employed as the feed to test the fouling resistance of the three membranes.

After 4 hours of direct contact MD operation with an oil-in-water emulsion (1 g/L oil, 0.03 g/L SDS, and 0.6 M NaCl)

- **Pristine PVDF membrane**
- Initial vapour flux: 25.5 LMH
- Vapour flux decreases by ~70%
- Salt rejection also declines
- **This membrane incorporated with selected additive**
- Initial vapour flux: 21.5 LMH
- Vapour flux remains constant for at least 12 hours
- Salt rejection remains constant for at least 12 hours

**Hydrophilicity of Membranes**

- **Water Contact Angle in Air**
- Pristine PVDF membrane: 115.93 ± 4.99°
- This membrane: 35.99 ± 4.97° (easily wetted ~ hydrophilic)
- This membrane incorporated with selected additive: 8.42 ± 1.29°
- **Oil Contact Angle in Water**
- Pristine PVDF membrane: 65.20 ± 4.07°
- This membrane: 127.16 ± 2.88° (not easily wetted ~ resistant to fouling by oil)
- This membrane incorporated with selected additive: 142.80 ± 3.01°

## POTENTIAL APPLICATIONS

- Desalinate produced water from hypersaline shale oil and/or gas streams.
- Treatment of oil field produced water
- Concentration of aqueous solutions
- Wastewater treatment

The global membrane separation technology market size was estimated at USD 17.9 billion in 2019 and is expected to register a CAGR of 11.7 % from 2020 to 2027.

## UNIQUE VALUE PROPOSITION

- Resistant towards both surfactant-induced wetting as well as oil-induced fouling.
- For surfactant induced fouling, our membrane incorporated with a selected additive also has a constant vapour flux over 12 hours compared to a large decline in flux for the pristine PVDF membrane.
- Longer interval between cleaning
- High productivity of membrane