Air gap membrane distillation: optimal use of residual heat

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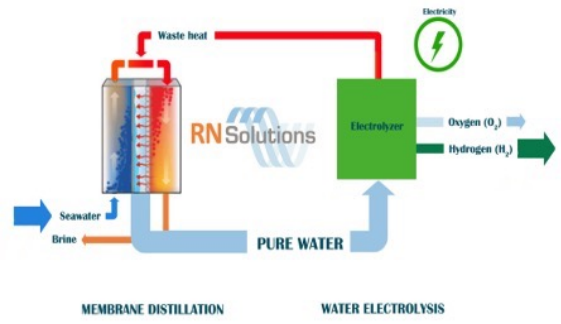
Introduction

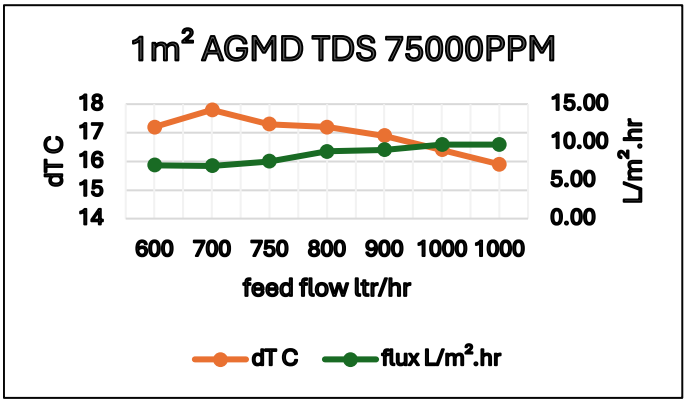
Membrane distillation (MD) was patented already in 1963 (Bodell, 1963), only shortly after the first reverse osmosis (RO) desalination membrane (Loeb, 1960). MD however, is not widely applied for desalination, despite a substantial amount of research into design and optimization of MD membranes and modules, which is continuing. MD provides a unique opportunity to use residual heat from processes like hydrogen generation, power generation and other exothermal processes, or to use solar power. Scale up was limited by both Temperature and Concentration Polarization. A new air gap MD module has been developed (Nidhansing, 2018) that has unique thermal and hydrodynamic properties, maximizing the net water flux. The bespoke membranes are strongly hydrophobic, and the spacer can be adapted to the application.

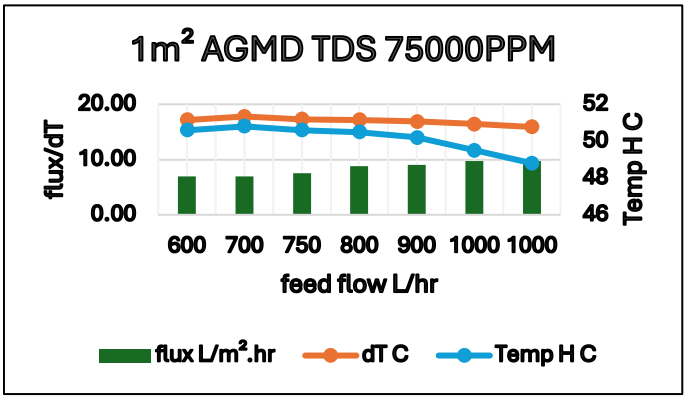
Membrane Distillation in Green Hydrogen



- Sufficient waste heat
- Reduction of cooling costs
- Unmanned operation
- One step process, or:
- EDI as post treatment

Membrane Distillation Performance

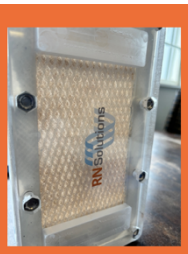




Advantages RN Solutions Module Design

- Diamond 2.5 mm spacer prevents both Temperature Polarization and Concentration Polarization
- Optimised heat transfer through rectangular design
- High flux (10 L/m^2.hr) at low feed temperature (50°C) and low ΔT (17°C)
- Proprietary gluing process for leak free operation
- Competition spiralwound design: flux 2 L/m^2.hr at high feed temperature (80°C) and high ΔT (30°C)

Membrane Distillation Modules



Lab scale (250 cm²)

Pilot-small scale (1 m²)

Full scale (15-30 m²)

Sustainability

- Waste heat contributes strongly to global warming (Bian, 2020)
- Reverse Osmosis power consumption 3-5 kWh/m^3, MD 0.1-0.5 kWh/m^3
- Low pressure operation, no need for chlorine tolerant stainless steel (Duplex, Hasteloy, SMO 254)
- No chemicals needed (reverse flow cleaning)