2015

Low-Cost Desalination Unit: Direct Contact Membrane Distillation

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MECHANICAL AND NUCLEAR

Low-Cost Desalination Unit

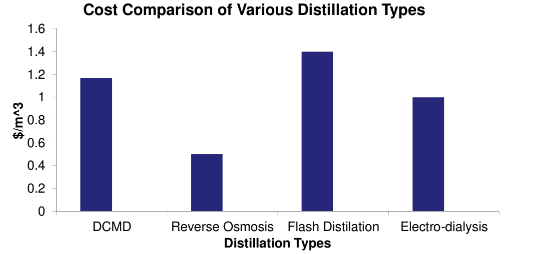
Direct Contact Membrane Distillation

CAPSTONE DESIGN EXPO 2015

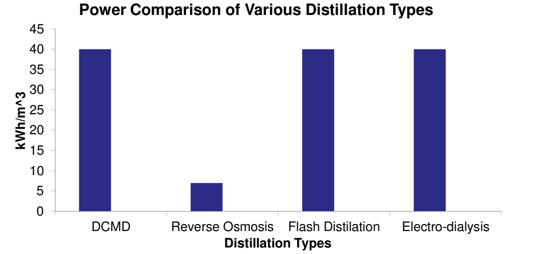
Introduction

•Overpopulation and pollution have diminished the world's fresh water sources leaving 783 million people without access to clean water.
•There are three leading desalination techniques: Reverse Osmosis, Flash Distillation, Electro-dialysis.
•Direct Contact Membrane Distillation (DCMD) is a newer promising method with potential for lower cost and energy use.

The goal of the project was to design and build a low-cost and low-energy DCMD unit



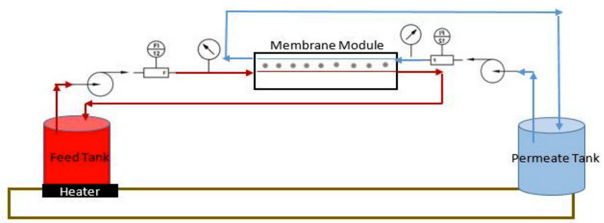
Al-Obaidani, et al. "Potential of Membrane Distillation in Seawater Desalination: Thermal Efficiency, Sensitivity Study and Cost Estimation." *Science Direct*. Journal of Membrane Science, 1 Oct. 2008.



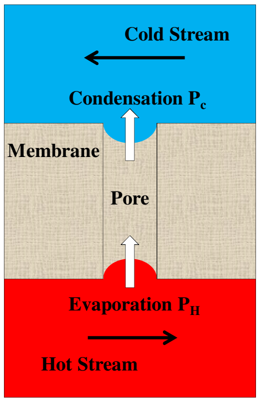
Zuo, Guangzhi, et al. "Energy Efficiency Evaluation and Economic Analyses of Direct Contact Membrane Distillation System." *Science Direct*. 1 Dec. 2011.

DCMD Design

System Schematic

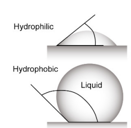


Inside the Membrane Housing

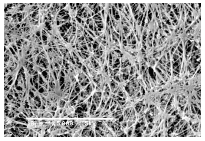


DCMD water flow through membrane diagram

- A portion of the contaminated hot water evaporates up to the cold stream.
- Once through the hydrophobic membrane, the water condenses.
- The properties of the Teflon membrane allows for only steam to pass through.



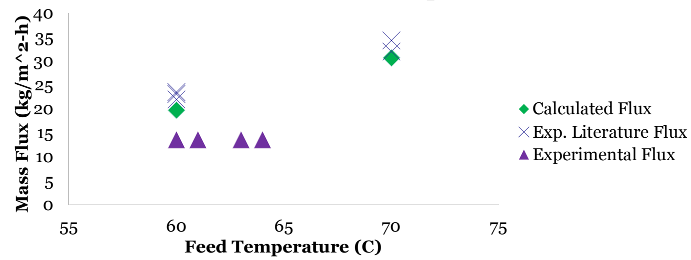
Hydrophilic vs Hydrophobic contact angles photo credit: Adhesion Bonding



Electron microscope image of PTFE membrane
Photo Credit: Sterlitech

Results

Avg. Flux: 13.624 (kg/m²-h)
Avg. ΔVolume: 16.39 (cm³/h)
Avg. ΔSalinity (Permeate): -0.014 ppt
Avg. ΔSalinity (Feed): 0.356 ppt



$$N = \frac{kmDp(Th - Tc)}{3600}$$

- N, the mass flux, determines the expected mass transport through the membrane.

$$K_m = \frac{eD_v M_v P_t}{\tau d P_{aavg} R T_{avg}}$$

- K_m, the membrane coefficient, is based on material properties.

Conclusion:

•Final Cost: $624.93
•Achieved goal of successfully producing drinkable water.

Future Research and Applications:

•Super hydrophobic membrane
•Alternative energy sources
•Larger scale for higher production rate

Acknowledgments:

•VCU School of Engineering

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Make it real.

VIRGINIA COMMONWEALTH UNIVERSITY