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Valorization of heat lost by refrigeration equipment for desalination by membrane distillation

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Abstract

The objective of this project is the coupling of a refrigerating machine to a membrane distillation unit. This sea water desalination technique is based on the creation of a temperature gradient between a hot channel and a cold channel. The seawater is heated by the condenser of a refrigerating machine.

Presentation of the study

Fig. 1 shows the design of a coupling approach of a MD unit and a refrigeration machine for cooling and desalination.

Principle: this system allows the recovery of waste heat in the environment by refrigeration or air conditioning equipment to produce fresh water

Mass transfer through the membrane: It depends on the difference in partial pressure of vapour between the feed water in the hot channel and the air gap and on the permeability B of the membrane

$$J_v = B\Delta P \quad (1) \qquad\qquad B = \frac{\varepsilon\, M_w P\, D_{ia}}{RT_m(\delta_m \tau + \delta_g)|P_a|_{ln,a}} \quad (2)$$

Validation of the numerical model: The theoretical model was developed and validated using experimental data obtained at the scale of an air gap membrane distillation pilot. The maximum difference between simulated and experimental results was 6% (Fig.4).

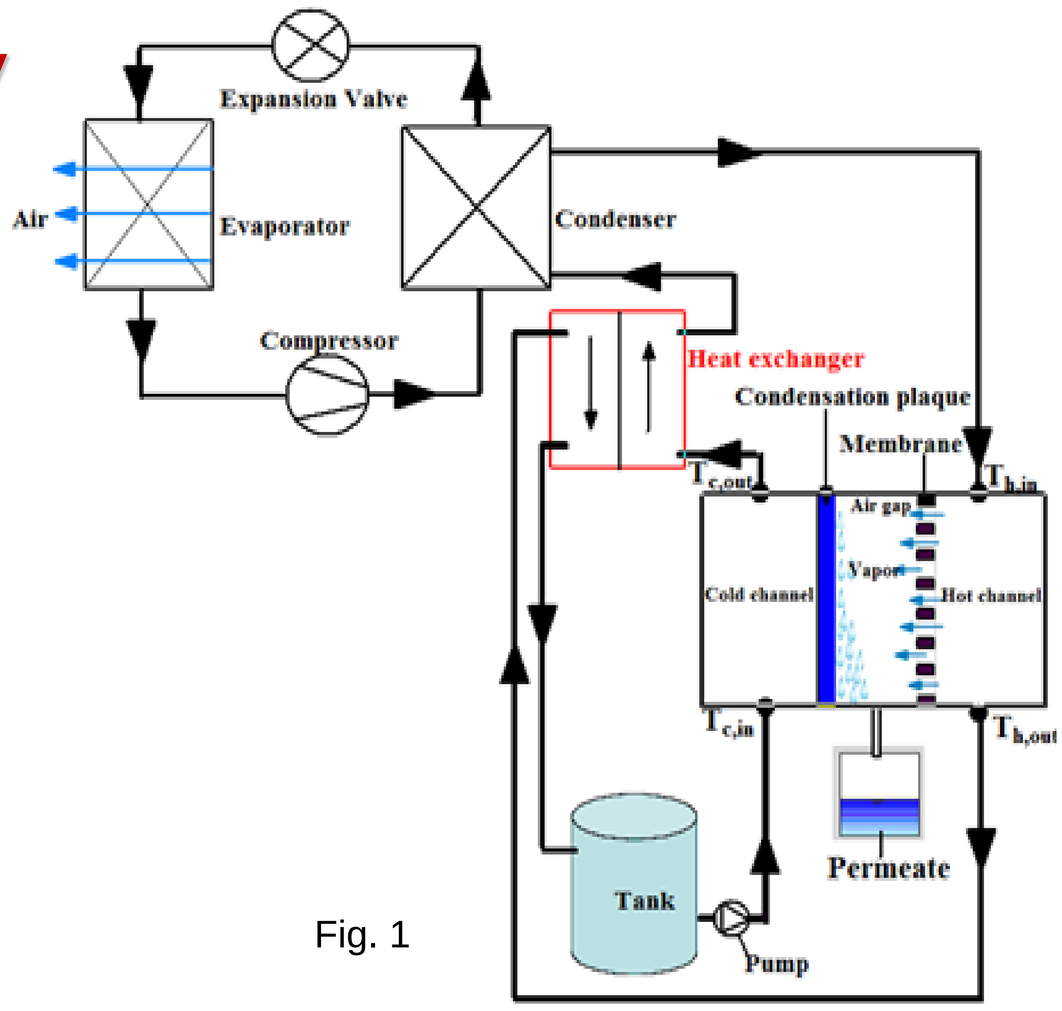


Fig. 1

Results

Fig. 2

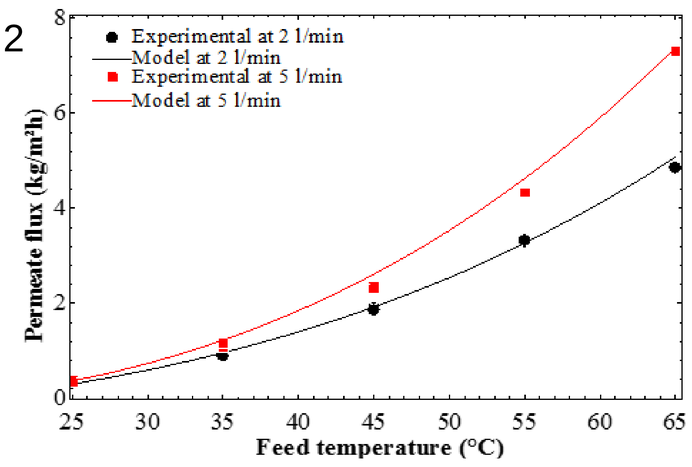


Fig. 3

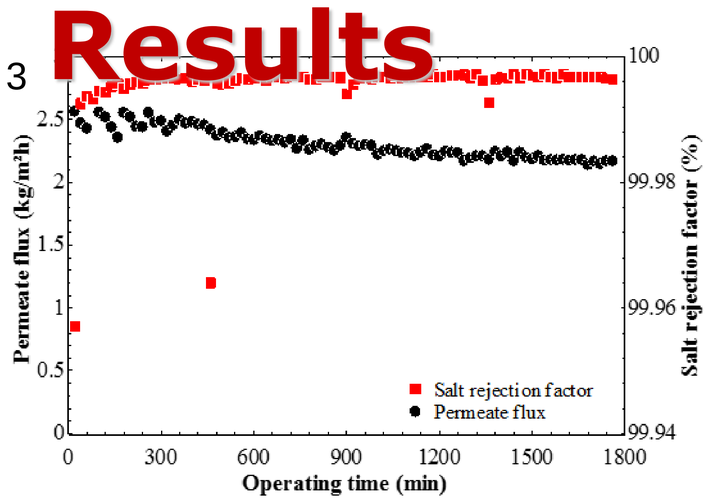


Fig. 4

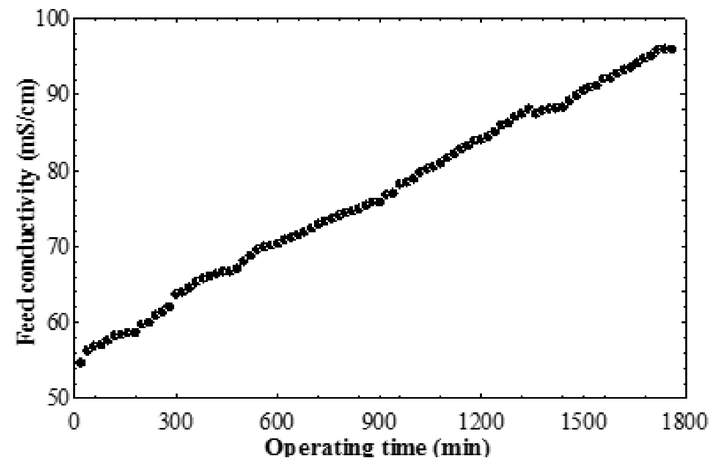


Fig. 5

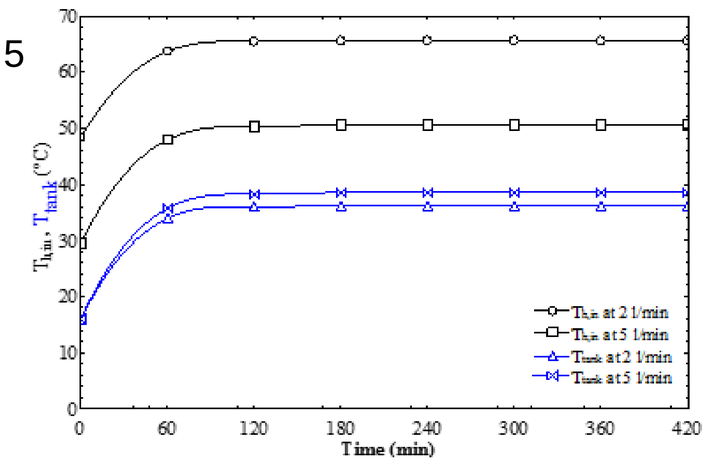


Fig. 6

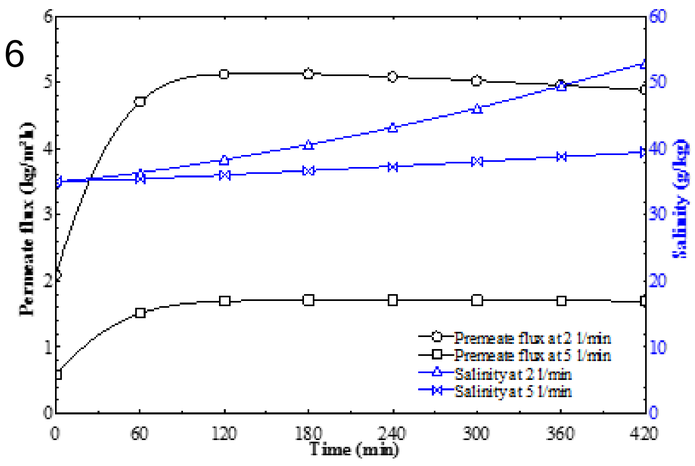
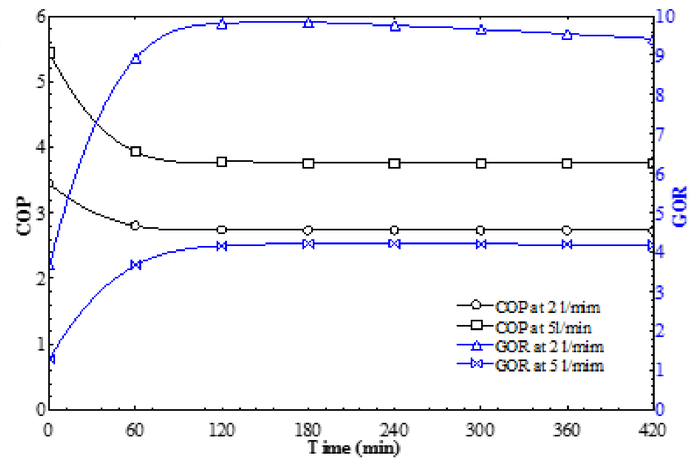


Fig. 7



Conclusions

- Fig. 3 shows that the permeate flux of the AGMD slightly decreases with time while the salt rejection rate remains greater than 99.9%.
- Fig. 4 shows that salinity increases during the same test as in Fig. 3.
- A low flow rate increases the $T_{h,in}$ while a high flow increases the T_{tank} (Fig. 5).
- The coupling shows that the permeate flux decreases despite the $T_{h,in}$ and T_{tank}, which results in an increase in the salt concentration (Fig. 6).
- GOR increases with a decrease in water flow and the effect of this decreases the COP (Fig. 7).