**Strategies to improve the performance of Membrane Distillation.**

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**Highlights**

* Different Membrane Distillation configurations were integrated.
* Different designs of membrane modules were realized.
* A feed-side heated flat membrane module was designed.

**1. Introduction**

Membrane Distillation (MD) is a thermal membrane separation technique based on the use of microporous hydrophobic membranes. The evaporation of the liquid feed occurs at the liquid-membrane interface, because of the hydrophobic membrane properties that prevent the liquid phase to permeate, and the vapor moves through the membrane micropores thanks to a difference of vapor pressures (driving force) established across the membrane. Depending on the way the driving force is created, different MD configurations can be obtained. The potential of MD as an efficient separation technique has been demonstrated in many fields (seawater and brackish water desalination, wastewater treatment, purification of physiological solutions, etc.). Complete rejection of non-volatile species can be, in fact, obtained working at lower operating temperatures and equipment size than traditional distillation columns. The high specific thermal energy consumption (ratio between the thermal energy supplied and the permeate produced) is, however, one of the main drawbacks of the technique, that is limiting its implementation at large scale. In this respect, this works aims at presenting some possible strategies to improve the performance of MD, in terms of higher permeate flux and lower energy consumption. In particular, the simplest and most investigated MD configuration, the Direct Contact Membrane Distillation (DCMD), was considered in the present study.

**2. Methods**

Three strategies were investigated to improve the performance of DCMD:

1. The coupling of the DCMD unit with an Air Gap Membrane Distillation (AGMD) unit, where the feed exiting from DCMD was heated up in AGMD [1];

2. The realization of new DCMD flat membrane modules presenting baffles at the feed side [2];

3. The design of a feed-side heated DCMD flat membrane module.

For each case, experiments were carried out by varying operating temperatures and flow rates, and the best conditions were identified.

**3. Results and discussion**

The investigated approaches allowed to reach positive results, like:

1. lower specific thermal energy consumption and higher permeate production for the integrated MD system;
2. better heat transport and higher permeate flux for the new DCMD designs.

**4. Conclusions**

The results obtained in this work confirmed the validity of the proposed strategies to improve the efficiency of DCMD. As future research, the combination of the three approaches could be explored to further enhance the performance of this promising separation technology.

**References**

1. A. Criscuoli, Chem. Eng. Res. Des. 111 (2016) 316–322.
2. A. Criscuoli, ICOM2017, July 30-August 4, 2017, San Francisco.