Full-scale Air Gap Membrane Distillation (AGMD) model, opportunities for module design improvement

[1,2]I. Hitsov, [2]K. De Sitter, [2]C. Dotremont, [1]I. Nopens

[1]BIOMATH, Department of Mathematical Modelling, Statistics and Bioinformatics, Faculty of Bioscience Engineering,
Ghent University, Coupure Links 653, 9000 Ghent, Belgium
[2]VITO - Flemish Institute for Technological Research, Boeretang 200, 2400 Mol, Belgium
Ivaylo.Hitsov@ugent.be; Kristien.DeSitter@vito.be; Chris.Dotremont@vito.be; Ingmar.Nopens@ugent.be

Air gap membrane distillation (AGMD) is one of the most widely discussed membrane distillation configuration. It has been regarded as more thermally efficient than direct contact membrane distillation (DCMD), due to the insulation properties of the air gap. However, most of the models developed to date are either missing validation or are validated only on lab-scale.

A major hurdle in modelling membrane distillation is the lack of information about the condensation that is occurring inside the gap. Often times major parameters such as the average condensate thickness are taken from semi-empirical formulas or are simply estimated based on educated guesses. Moreover, some studies had shown that at certain conditions the gap can be completely flooded with condensate, which raises the question if the module can be modelled as air gap altogether.

In this study previously developed and thoroughly validated DCMD model is expanded by adding the air gap compartment. In this way calibration is only needed for the gap-related parameters. A simple technique is demonstrated for observing the condensation in real time, which also allows to experimentally obtain the value of the average condensate thickness parameter. The model is then thoroughly validated with experimental data from two commercially available modules with areas of 7.2 and 24 m^2, showing excellent. Moreover, this work shows a direct comparison between AGMD and DCMD in terms of flux and thermal efficiency on full-scale using modules with identical geometries and manufacturer.

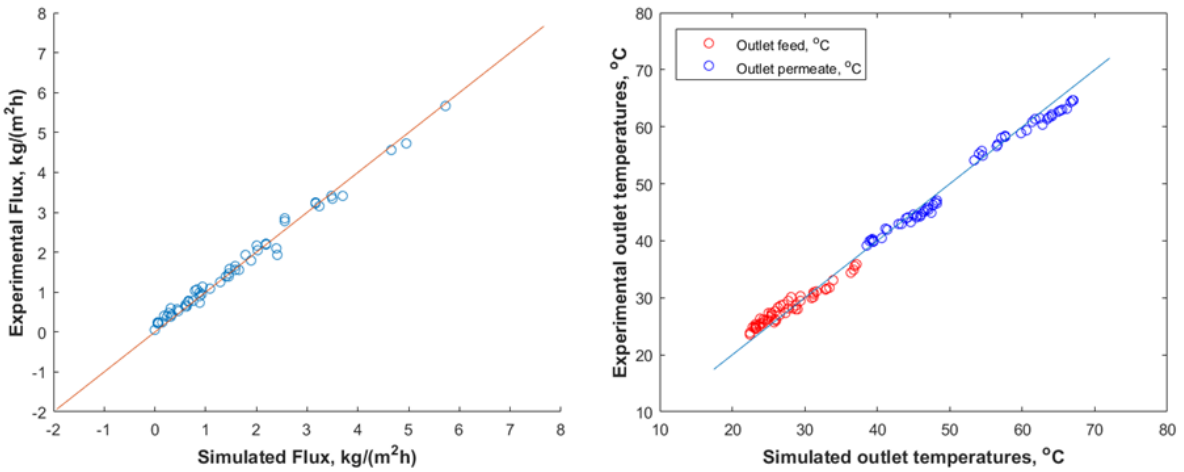

Figure 1 Validation for two AGMD modules 7.2 and 24m^2. Design of experiments is used for the conditions: T_{feed}=50 or 70 °C, $T_{coolant}$=20 °C, Q=300, 600, 900 l/hr.