MEMODEV

Membrane Testing for Permeation Model Validation and Development.

THE CONTEXT

With the growth of the membrane market in Europe due to the continued development of this technology and the drive towards sustainability, there is a rising need for modelling and consultancy services. Implementation of novel technologies in conservative markets remains a risky venture. Modelta aims to reduce this risk and bridge the gap between research and industry with modelling of membrane- and membrane reactor technology. Our analyses are based on in-house developed membrane- and membrane reactor models in software such as Aspen Custom Modeler, which can be exported to process simulators such as Aspen Plus. Blocks within existing process simulators currently do not have dedicated membrane blocks. To provide accurate and reliable calculations to this upcoming membrane market for a wide variety of sectors (e.g. water treatment, hydrogen, CCU/CCS, chemical reactions) is an important need to be solved.

The added societal- and economic impact of these services is tightly correlated to the societal- and economic impact of the membrane market on Europe and the world. Already in the energy transition, hydrogen infrastructure and carbon capture are two very crucial eco-systems which benefit greatly from membrane technology. The total addressable market for membrane modelling and consultancy services is €2B+.

To provide optimal support to this growing membrane market, dedicated modelling methods and expertise is crucial. To ensure that these models represent real operational conditions, they need to be validated with real membrane performance data. We therefore need reliable experimental data at a range of temperatures, pressures, flowrates, and compositions for multiple applications which will be used to improve and validate our models. The INNOMEM consortium will be needed to perform permeation tests with their (or commercially available) membranes and provide us with the data needed to validate our corresponding membrane models. Furthermore, a market validation will help identify actual markets where these validated models will have the most urgent need.

In this project several membranes have been produced or acquired such that a database of membrane testing has been produced to be used by MODELTA for their commercial modelling tool validation.

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THE CHALLENGE

Membrane models are available at different scales but used especially in academia. These models are generally *ad-hoc* models and are not available in commercial tools. MODELTA, has created commercial tools that are integrated in simulation software like ASPEN. However, these models need a large array of experimental data to be able to validate the models in different conditions and for different membranes.

This requires production (or in general acquisition) of different membranes and testing is several conditions and a great knowledge of all the parameters used in the testing along with physico-chemical characterization of these membranes. This is why it is often difficult to validate models with literature data, as those are generally not complete or critical info are missing. MEMODEV project has helped MODELTA acquiring the experimental data needed for their model validation using dedicated experimental setups available at TUE.

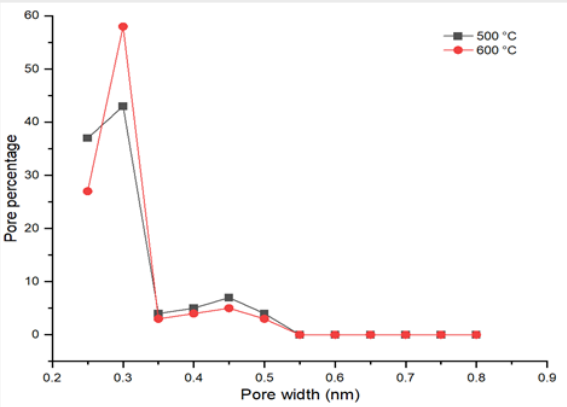
Typical experimental setup used for membrane testing with gases containing impurities.

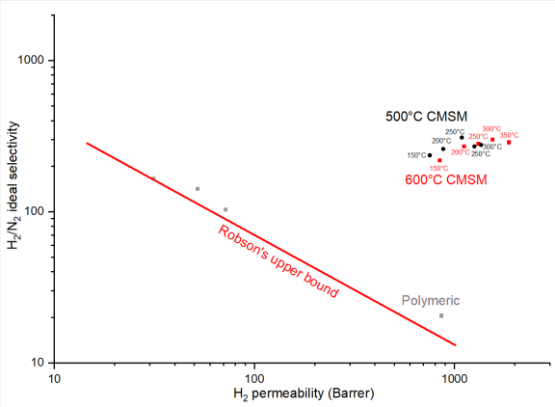
THE RESULTS

Several membranes, carbon and Pd based, have been produced and tested for permeation. The results have been obtained for several conditions including pure gases, mixtures of binary gases and more complex mixtures and created in tables that can be used by MODELTA for their model validation.

Membranes have been tested at high pressure and in the conditions required by the company.

Also commercial membranes have been tested, especially polymeric membranes.





Typical pore size distribution and membrane results for C-based membranes.

CONCLUSION

Compared with the situation before the project, MODELTA has now access to a large array of experimental data on different types of membranes.

While data are available, characterization of the membrane also help MODELTA to validate their model, thus TUE will continue support the validation also beyond the project.

Membranes have been tested in the conditions required for validation

TECHNIQUES USED

Membrane preparation for Pd-based and C-based membranes

Testing facilities for membrane permeation

Membrane characterization for pore size and pore size distribution

Chemical and physical characterization of membranes

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