MemPy v1.0 - Simulation software for gas separation using spiral-wound membrane modules

A simulation software tool to evaluate performance of spiral-wound membrane modules.

Applications

- Spiral-wound membrane modules
- Gas or chemical separation

Key Benefits & Differentiators

- **Accurate depiction of modules** with transport phenomena modeled in two-dimensions
- **Bench-to-industrial scale simulation**: software can accurately model different scales
- **Ideal for research and teaching**: user-friendly and built in open-source software

Mathematical models for spiral-wound membrane modules (SWMs)

Spiral-wound membrane modules are widely used for applications such as reverse osmosis (RO), nanofiltration (NF), ultrafiltration (UF) and gas separation applications. A typical spiral-wound membrane system consists of a flat sheet membrane and a permeate spacer wound around a permeate collection tube to produce flow channels for permeate and feed solution. This design maximizes flow while minimizing the membrane module size. However, the geometrical arrangement and material properties of SWMs are relatively complex, involving multiple domains per leaf where variables depend on at least two-dimensions and heterogeneous solid spacer materials. Mathematical models implemented in conventional software tools for the simulation of chemical processes involve over-simplifications and assumptions that can lead to significant errors when a large fraction of the fluid is recovered by the membrane. In these cases, existing software tools do not accurately and comprehensively depict the system.

An accurate simulation software for SWMs

Researchers at the University of Minnesota have developed **a simulation software tool based on a new mathematical model to accurately describe the mass and momentum balances for gas separations in a spiral-wound membrane module**. Specifically, this model accounts for variations and uncertainties in feed parameters, and permeate-side variables in two-dimensions without neglecting effects of flow channel bending. The researchers have validated the model by directly comparing it to an experimental N_2/O_2 separation system. This validated model is implemented in Pyomo and is user-friendly and customizable. This simulation software tool can be used to simulate and predict the performance of membranes from the bench-scale to the industrial-scale, gain deeper, clearer understanding of the transport phenomena, quickly design a simple system or the most complex gas separation system, select optimal design and flow pattern configurations, and conduct post-implementation performance review of spiral-

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wound membrane modules.

System Requirements

- OS: Mac, Windows or Linux
- Pyomo/Python 3.7.0 version or newer

Phase of Development

- The model is validated using experimental data.
- Alpha version of simulation software (MemPy v1.0) is built in an open-source package.

Acknowledgment

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