Understanding the Transition Flow Region Through Modeling in COMSOL Multiphysics® Software

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Abstract

The pore sizes of many membranes being studied for separating the components in gas mixtures are on the scale of nanometers. Depending on the specific gases and pressures being used, this scale will put the flows in the Transition between Slip Flow and Knudsen regime. The differential flow of the gas components gives the relative diffusion of the gases through the membrane. There are a number of factors that need to be considered in modeling of this process. Some such as solubility can be very important for many situations, but will not be explored in this presentation. This will be focused more on the considerations for modeling the flow and diffusion of the gas components through the membrane in this transition regime where Knudsen Number is between 0.1 and 10.0.

COMSOL Multiphysics® software provides models that handle various aspect of this process. The Molecular Flow Module provides a Lattice Boltzmann/Discrete Velocity method for solving flows in the transition region. Other approaches will be examined. One of these approaches is using incorporating a higher order slip flow model using the CFD Module. Another approach is to modify the flow equations to include a self diffusion term. The last approach that will be examined is a dusty gas model.

This presentation will look at these different implementations for modeling transition flow. Some of the strength and weakness of these different approaches will be examine. Each of these approaches will bring different insights into the membrane separation of gases.

Figures used in the abstract

Figure 1

Figure 2

Figure 3

Figure 4