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Model-dependent analysis of gas flow/pore dewetting data for microfiltration membranes

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Abstract

A reliable methodology for the treatment of gas/liquid displacement (GLD) permporometry data and the determination of pore-number distribution of microfiltration membranes was developed in this work. Models according to Poiseuille, Klinkenberg and Forchheimer were initially chosen to describe the gas flux through the dry and the wet membrane. The gas viscosity was considered to be constant, but unknown. Thereafter, it was shown that by the introduction of the concept of "variable viscous resistance", the GLD porometry data could be treated more easily to determine the pore-number distribution. For that, two new models were established, the variable viscosity Poiseuille model for gas flow and the unified Poiseuille model for gas and liquid flow. Three levels of validity test, namely, 'prediction of dry flux', 'simultaneous reproduction of dry and wet flow curve' and 'prediction of integral relative flow' had been applied to rank the model-adequacy. Consistent results in terms of differently defined averaged pore diameters (Weber-type, flow-averaged and mean flow) had been obtained with all the developed models. The predictability of liquid flow through microfiltration membranes based on GLD porometry data had been discussed and it was found that for satisfactory prediction, the gas viscosity should be considered a model-dependent parameter. Finally, experimentally obtained permeability data of a reference liquid were correlated with GLD porometry data in order to find the absolute pore-number distribution and to estimate the membrane porosity. For a membrane with straight non-intersecting pore channels, the porosity was found to be in the same range as that determined experimentally. Hence, this work provides a significant progress for the detailed analysis of barrier properties of microfiltration membranes.

Graphical abstract