265d Characterization of Gel-Filled Porous Membranes Using Moment-Based Interpretation of Transport Measurements

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A method of determining characteristics of the pore size distribution in porous membranes has been developed (Knierim et al, 1984; Baltus, 1997). In this approach, moment theory is used to interpret results from a limited set of transport measurements. These measurements include the hydraulic permeability of the membrane, the diffusive permeability of the membrane to a small solute and at least one transport measurement that depends upon pore size (large solute rejection, large solute diffusivity or small solute transport at Pe ~ 1). The method allows one to place upper and lower bounds on the cumulative pore size distribution without making any a priori assumptions about the nature of the distribution. The same principles can be used to include characteristics of the pore size distribution in predicting the reflection coefficient and the hindered diffusivity of a large solute.

This approach has been applied to transport values reported by Kapur et al. (1997) who measured the diffusive and convective transport of two proteins, ribonuclease A (RNAse) and bovine serum albumin (BSA), through porous membranes with pores filled with polyacrylamide gel. The hydraulic permeability and glucose diffusion rates were also measured. Measurements were repeated with gels with different polyacrylamide concentration. The gel provides the resistance to transport for these systems; therefore, the results yield information about the pore size distribution in the gel material.

The average pore area in each membrane was determined by combining results from the hydraulic permeability and glucose diffusion measurements. A comparison of results obtained in the different gels shows expected trends, with the average pore area decreasing with increasing polyacrylamide concentration. Characteristics of the pore size distribution were captured by including results from one of the protein transport measurements. With the pore area normalized using the average pore area, there is little difference in the bounds predicted for each membrane, indicating that the normalized pore size distribution is generally independent of the polymer concentration in the gel.

This approach also enables one to place upper and lower bounds on the diffusion or reflection coefficient for one protein from the measurement of a different transport characteristic. It will be demonstrated that moment analysis enables one to make reasonable predictions of the transport characteristics in these membranes. Because these predictions incorporate characteristics of the pore size distribution, predicted values are in better agreement with experimental values than are predictions based only on the average pore area.