Mass Transport Study of Combined Gas Phase and Surface Diffusion in Porous Glass Membranes

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Increasing efforts are currently focused on the development and application of membrane technology. The understanding of mass transfer rates is essential for the optimized production and application of a specific membrane. There is a great interest in applying a membrane not only for separation but also in combination with chemical reactions.

The goal of the present work is, therefore, to quantitatively study the mass transfer of binary mixtures of inert or adsorbable gases through tubular porous Vycor glass using transient diffusion experiments as illustrated schematically in Fig. (a) [1]. Before the experiment an opened inner volume is rinsed with a gas (1). At the beginning of the measurement a gas (1) is substituted by a gas (2). The developments of pressure difference between an inner volume and a closed outer volume are observed for the systems inert-inert, inert-adsorbable and adsorbable-adsorbable gases.

Typical results are shown in Figs. (b) and (c). In the case of (c) there is obviously a strong asymmetry between two reverse exchange experiments which is not found for inert gases, Fig. (b). Also the amplitudes are quite different. Based on the dusty gas model [2] for the expression of gas phase diffusion and the generalized Stefan-Maxwell theory [3] for the description of surface diffusion, a combined transfer model is used for the analysis of observed data. The work is focused on a quantitative explanation of the observed transients and the underlying transport mechanisms. The results could be important for the design and optimization of membrane reactors.
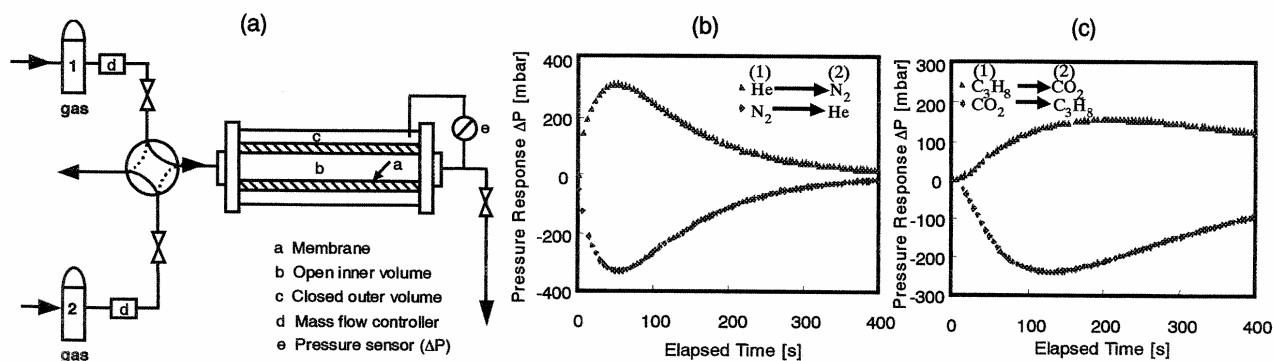
Schematic diagram of experimental setup and typical observations.

References
[1] A. Tuchlenski, P. Uchytil and A. Seidel-Morgenstern, An Experimental Study of Combined Gas Phase and Surface Diffusion in Porous Glass, Journal of Membrane Science, 140 (1998) 165-184.
[2] E. A. Mason, A. P. Malinauskas, Gas Transport in Porous Media: The Dusty Gas Model, Elsevier, Amsterdam, 1983.
[3] R. Krishna, Problems and Pitfalls in the Use of the Fick Formulation for Intraparticle Diffusion, Chemical Engineering Science, 48 (5) (1993) 845-861.