Permeation of a Solvent Mixture through an Elastomeric Membrane—The Case of Pervaporation

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ABSTRACT: This article presents a model for the permeation of solvent mixtures through an elastomer in the particular case of pervaporation. An analytical expression for each solvent permeation rate is derived, in the limited case of a membrane that undergoes small swelling, without making any assumptions on the solvent diffusion coefficients and their dependence on solvent concentrations. Applying this analytical expression to different situations, we fitted most of the curves previously published on pervaporation experiments. In particular, we correlated the synergy developed by a mixture of two solvents in the permeation process with the sign of their Flory–Huggins interaction parameter χ_{AB}. This explains why, in most cases ($\chi_{AB} > 0$), a molecule permeating easily through a membrane is mixed with a molecule permeating much less easily; the latter can see its permeation flux increase by a factor 10 or 100 because the swelling of the polymer induced by the more permeable molecule "opens the meshes of the network" allowing the less permeable molecule to pass through more easily. Within our analysis, the efficiency of the pervaporation process, expressed through the separation factor, is derived very simply as a function of the interaction coefficients and the viscosities of solvents and exhibits an exponential dependence on the volume fraction of either component as seen in most experiments. J Polym Sci Part B: Polym Phys 41: 183–193, 2003

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