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Predicting mass fluxes in the pervaporation process of alcohols dehydration using Maxwell-Stefan diffusion coefficients

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Pervaporation is the process that actually in the world industry is applied in majority to dehydration of organic solvents. Most generally, the mass fluxes in the pervaporation process are a function of all mass transport resistances occurring in the mass transport path. The membrane is the heart of pervaporation process and from its permeation properties depends the yield and selectivity of the process. Depending on the construction of pervaporation unit, some other mass transfer resistances can be neglected. The majority of the methods of calculation the mass fluxes in the polymer membranes based on the generalized Fick's equation, while for calculation of mass fluxes in fluid systems the generalized Maxwell-Stefan equations (GMSE) is preferably used. Recently Kubaczka proposed the method that allows prediction Maxwell-Stefan diffusion coefficients (MSD) in the membrane space for multicomponent systems using self-diffusion coefficients and binary diffusion coefficients for infinitely diluted mixtures. The purpose of this study is the test of an accuracy of the prediction of mass fluxes in the pervaporation process based on GMSE where MSD are predicted according to the proposed method. These calculations have been done for the experimental results of pervaporation of the isopropanol-water and ethanol-water mixtures in the poly (vinyl alcohol) membrane. These data were the results of the experiments conducting on the PERVAP 2210 hydrophilic membrane. The self-diffusion coefficients, which are the most important element of analyzed method, were predicted using formulas derived from the free-volume theory by Vrentas and Vrentas. The equilibrium concentrations on both sides of the separating polymer film were computed using UNIFAC-FV method with FV element modified according to the model of Kannan et al. The comparison of calculated and experimental results shows very good agreement between experimental and predicted data. The influences of free volume parameters on the mass fluxes are also analyzed.



Figure1: Comparison of the predicted and experimental mass frictions of water [Kg/Kg] in the permeate

Biography

Andrzej Kubaczka has earned his M.Sc. and Ph.D. degree in Chemical Engineering from Silesian Technical University, Gliwice Poland. He worked as a researcher in the Institute of Chemical Processing of Coal, Poland where he investigated mass transfer in the process of flash coal pyrolysis in the fluidized bed reactor. The subject of his postdoctoral research in the Institute of Chemical Engineering of Polish Academy of Sciences was multicomponent mass transfer in membrane processes. He published over a dozen articles in international and several dozen in national scientific journals, also many articles in the proceedings of national and international conferences. Nowadays, he is an assistant professor in the Department of Process Engineering for the Faculty of Natural Sciences and Technology, Opole University. His present research interest is modelling of mass transport in membrane processes.

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