World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:10, No:07, 2016

Modeling Sorption and Permeation in the Separation of Benzene/ Cyclohexane Mixtures through Styrene-Butadiene Rubber Crosslinked Membranes

Authors : Hassiba Benguergoura, Kamal Chanane, Sâad Moulay

Abstract : Pervaporation (PV), a membrane-based separation technology, has gained much attention because of its energy saving capability and low-cost, especially for separation of azeotropic or close-boiling liquid mixtures. There are two crucial issues for industrial application of pervaporation process. The first is developing membrane material and tailoring membrane structure to obtain high pervaporation performances. The second is modeling pervaporation transport to better understand of the above-mentioned structure–pervaporation relationship. Many models were proposed to predict the mass transfer process, among them, solution-diffusion model is most widely used in describing pervaporation transport including preferential sorption, diffusion and evaporation steps. For modeling pervaporation transport, the permeation flux, which depends on the solubility and diffusivity of components in the membrane, should be obtained first. Traditionally, the solubility was calculated according to the Flory–Huggins theory. Separation of the benzene (Bz)/cyclohexane (Cx) mixture is industrially significant. Numerous papers have been focused on the Bz/Cx system to assess the PV properties of membrane materials. Membranes with both high permeability and selectivity are desirable for practical application. Several new polymers have been prepared to get both high permeability and selectivity. Styrene-butadiene rubbers (SBR), dense membranes cross-linked by chloromethylation were used in the separation of benzene/cyclohexane mixtures. The impact of chloromethylation reaction as a new method of cross-linking SBR on the pervaporation performance have been reported. In contrast to the vulcanization with sulfur, the cross-linking takes places on styrene units of polymeric chains via a methylene bridge. The partial pervaporative (PV) fluxes of benzene/cyclohexane mixtures in styrene-butadiene rubber (SBR) were predicted using Fick's first law. The predicted partial fluxes and the PV separation factor agreed well with the experimental data by integrating Fick's law over the benzene concentration. The effects of feed concentration and operating temperature on the predicted permeation flux by this proposed model are investigated. The predicted permeation fluxes are in good agreement with experimental data at lower benzene concentration in feed, but at higher benzene concentration, the model overestimated permeation flux. The predicted and experimental permeation fluxes all increase with operating temperature increasing. Solvent sorption levels for benzene/cyclohexane mixtures in a SBR membrane were determined experimentally. The results showed that the solvent sorption levels were strongly affected by the feed composition. The Flory- Huggins equation generates higher R-square coefficient for the sorption selectivity.

Keywords : benzene, cyclohexane, pervaporation, permeation, sorption modeling, SBR
Conference Title : ICCE 2016 : International Conference on Chemical Engineering
Conference Location : Montreal, Canada
Conference Dates : July 14-15, 2016