특별강연 I

Pervaporation Separation of Binary Organic-Aqueous Liquid Mixtures

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A novel membrane separation process for the separation of liquid mixture is Pervaporation. The term, 'pervaporation', is a combination of permeation and evaporation, and was first introduced by Kober[1] in 1917. In this technique, the liquid mixture in feed is in contact with one side of a dense non-porous membrane and after diffusing through the membrane is removed from the downstream side in the vapor phase, but is usually condensed afterwards to obtain a permeate in liquid form. Since Binning et al.[2,3] in 1955 first proposed pervaporation as an industrial separation process, the total installed capacity of pervaporation plants in the world is now growing rapidly, for example, 10 plants with capacity of 20 kL/day in 1985 and 3 plants with capacity of 200 kL/day in 1987 have been built. At present, most pervaporation researchers are concerning on the separation of alcohol -water mixtures. It is expected that in the near future membrane development will aim at more difficult separation systems, such as, the separation of non-aqueous liquids, e.g., aliphatic/aromatic and isomeric mixtures, and the dehydration of aliphatic organic acids, such as acetic acid, formic acid etc[4].

This research concerns pervaporation studies for dehydration of ethanol and acetic acid aqueous mixtures using several membrane

materials and the development of models to predict the separtion characteristics for various mixture systems[5].

Pervaporation models were developed to predict the separation characteristics for various mixture systems, such as n-hexane - benzene - polyethylene membrane (nonpolar - nonpolar mixture), methanol - pentane - Nylon 6/PAA blended membrane (polar - nonpolar mixture), and ethanol - water - Nylon 4 membrane (polar - polar mixture). These models were based on the Fujita's free volume theory and Flory-Huggins thermodynamics. The predicted pure liquid permeabilities were quite close to the experimental permeabilities, and the individual permeabilities of binary mixture were reasonably close to the experimental values.

A model calculating the diffusion coefficients of liquid in polymeric membranes from the diffusion coefficients at zero concnentration was developed. The calculated diffusion coefficients of several liquids were simulated by calculating the pure liquid permeabilities in a pervaporation system. These calculated values were found to be in fairly good agreement when compared with the experimental permeabilities.

Since Nylon 4 polymer is not commercially available, Nylon 4 was synthesized through the use of the carbon dioxide/potassium pyrrolidonate catalyst system with and without added 18-crown-6 ether activator.

For the separation of aqueous mixtures, Nylon 4-Nylon 6, Nylon

4-Poly(acrylic acid) (PAA), Nylon 4-poly(vinyl alcohol) (PVA) and Nylon 6-PVA blended membranes, and Nylon 4 and PVA homopolymer membranes were investigated. A PVA modification method with maleic acid in aqueous solution using tertiary amine and water catalyst system is presented. The modified PVA membrane showed the highest separation factor of 128 at 10 wt.% water in feed at 45 ℃ with the permeation rate of 0.016 kg/m^{2}hr. Nylon 4-PAA and Nylon 4-PVA blended membranes gave fairly high separation factors of 9.4 and 10.6 at 50 wt.% ethanol in feed at 25 ℃, respectively. At azeotropic composition, Nylon 4 homopolymer membrane gave higher separation factor than other homopolymer membranes.

Refernces

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[3] R.C. Binning, R.J. Lee, J.F. Jennings and E.C. Martin, Ind. Eng. Chem., 53 (1961) 45.

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