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Pervaporation Separation of Water-Acetic Acid Mixtures Through Poly(vinyl alcohol) Membranes Crosslinked with Glutaraldehyde

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Poly(vinyl alcohol)(PVA) membranes crosslinked with Glutaraldehyde (GA) were prepared for the separation of acetic acid-water mixtures. For the preparation of the crosslinked membranes, dry PVA films were immersed for 2 days at 40 °C in reaction solutions which contain different content of GA solution(25 % GA in water), aceton and a catalyst, HCl.

IR spectroscopy was employed to characterize the crosslinking reaction between hydroxyl groups in PVA and aldehyde groups in GA. Swelling measurements of the crosslinked membranes were carried out in both water and acetic acid to investigate the crosslinking density and swelling behaviour of the membranes.

Membranes fabricated with low GA content in the reaction solution were found from the IR spectrum to have few aldehyde groups. As the GA content increases, unreacted aldehyde groups pending on PVA chains as well as crosslinking density were observed increased in the resulting membrane and the increase in unreacted aldehyde groups was more significant. They affected the swelling behaviour of the resulting membrane in an opposite way; more crosslinks makes the membrane less swollen and more aldehyde groups makes the membrane more swollen in both water and acetic acid. The result of the swelling measurement showed that the aldehyde group has an affinity to both water and acetic acid, and the affinity to acetic acid is more remarkable.

Therefore, the swelling ratio curve of a membrane with GA content in the reaction solution was of parabolic shape having minimum value at about 10 wt.% of GA solution.

The pervaporation separation of acetic acid-water mixtures was performed over the range of 70-90 wt.% acetic acid in feed at temperature varying from 35 to 50 °C. The best pervaporation performance was obtained from the membrane prepared at 5 wt.% GA solution which gives separation factors of 120-420 and permeation rates of 29-263 $g/(m^2.h)$ depending on the operating temperature and the feed mixture composition. The temperature dependence of the permeation rate for the binary mixtures was expressed by Arrhenius-type relation and permeation activation energies of 11.38-14.53 kcal/mol were calculated for the acetic acid-water mixtures. The permeation activation energies were used to analyze permeation behaviour through the membranes.