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Exploration on new model of selectively preferential sorption—facilitated transport with fixed site carriers

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Abstract

A new model of selectively preferential sorption—facilitated transport with fixed site carriers was advanced in this paper. A number of experiments were arranged to demonstrate the ideal above. Preliminary results were obtained from the experiments, and shown the model was applicable for many membrane processes, such as RO, ED, gas separation and liquid membranes etc.

Keywords: Membrane separation; Selectively preferential sorption; Facilitated transport

1. Introduction

Transport phenomenon is the base of chemical industry. How to increase transport ratio is one of the important goals in the area of chemical industry.

About 40 years ago, Dr. S.Sourirajan put forward the mechanism of preferential sorption-capillary flow for RO membrane desalination based on Gibbs absorption equation and negative absorption of NaCl solution on the interface between membrane and air. At the nearly same time, Dr. N. N. Li introduced the conception of facilitated transport into emulsion liquid membranes.

The model of selectively preferential sorption—facilitated transport with fixed site carriers combines selectively preferential sorption and facilitated transport with membrane separation. The purpose of advanced the model is to deepen the research of transport phenomenon and to raise the efficiency of membrane separation. Based on the model, the concentration of separated components in feed on the surface of the membrane may be much greater than that in the bulk. And the transfer velocity of the separated components in the membrane may be much quicker than that in the membrane with no carriers.

This model is suitable for the main membrane processes, such as pressure driven membrane processes, electrically driven membrane processes and processes with concentration as driving force, etc..

2 Preliminary results of the model

2.1 Gas (CO_2) separation

The membrane made out copolymer of acrylamide and maleic anhydride was used for this experiment. CO_2 and CH_4 sorption characteristics of the membrane was tested. The result showed that the polymerization ratio changing from 5 to 30, the CO_2 saturated sorption capacity of copolymer membrane was 45-70mg(CO_2)/g(dry membrane), however, the CH_4

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saturated sorption capacity of copolymer membrane was only 4mg(CH_4)/g(dry membrane) as shown as in Fig.1. The selectively preferential sorption of the polymer toward CO_2 over CH_4 may be the reverse reaction between CO_2 and amino-group in the copolymer.

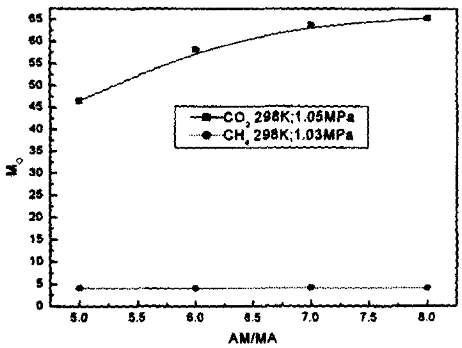

Fig 1 Effect of monomer ratio on CO_2 and CH_4 sorption quantity of copolymer membrane

2.2 Pervaporation

A PVA membrane comprising fixed-site carrier Co^{2+} was prepared for olefin/paraffin(cyclohexene/cyclohexane) separation. It was shown the membrane had both high olefin flux and high olefin/paraffin selectivity. The effects of carrier content and anion species on the membrane performance were investigated, and optimum content of the carrier and selection principle for the carrier were also determined as shown below.

2.2.1 The effects of carrier content on the membrane performance

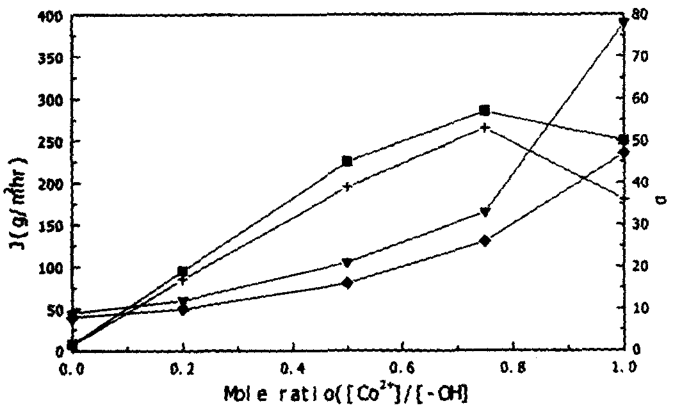

Figure 2 Effect of carrier content on membrane performance

-▼-: Flux (J) of fixed-site carrier membrane for $Co(CH_3COO)_2$

-◆-: Flux (J) of fixed-site carrier membrane for $Co(NO_3)_2$

-■-: Separation factor (ô) of fixed-site carrier membrane for $Co(CH_3COO)_2$

- + -: Separation factor (ô) of fixed-site carrier membrane for $Co(NO_3)_2$

It was shown from Fig.2 that the membrane performance of the two membranes with fixed site carries was much better than that of pure PVA membrane, and with increase of the relative content of the carrier the membrane performance was become better and better. In Fig.3 also showed anions corresponding to the carriers had their influence on membrane performance. The carrier $Co(CH_3COO)_2$ is better than $Co(NO_3)_2$.

2.2.2 Effect of feed concentration on membrane performance

In Fig.3 showed the effect of feed concentration on membrane performance. It can see from Fig.3 that fluxes of the two membranes are increased with the increase of the concentration, and the separation factors of the two membranes are decreased.

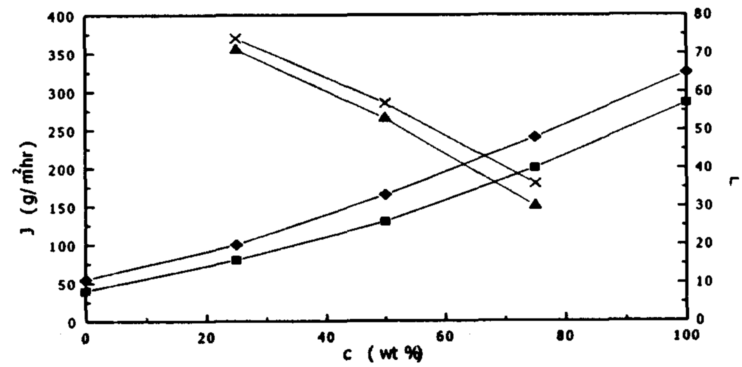

Figure 3 Effect of feed concentration on separation performance of membrane

-◆-: Flux (J) of fixed-site carrier membrane for $Co(CH_3COO)_2$

- ■ -: Flux (J) of fixed-site carrier membrane for $Co(NO_3)_2$

-×-: Separation factor (ὰ) of fixed-site carrier membrane for $Co(CH_3COO)_2$

-▲-: Separation factor (ὰ) of fixed-site carrier membrane for $Co(NO_3)_2$

Conclusion

From preliminary research of the model , It was shown that this model is suitable for the many membrane processes such as gas separation, pervaporation, and so on. It is worth to study the model further both in theoretical and practical, to get the deep understanding of the model.

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