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DIAGNOSTICS OF GAS SEPARATION MEMBRANES USING INERT GAS PROBE TECHNIQUE

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Principles of the inert gas probe technique

The inert gas probe technique suggested in this paper is based on the measurement of ra dioactive inert gases which have been inserted at the input of the membrane. Various inert gases, e.g. radionuclides of Xe-133, Kr-85 and Rn-222 were advantageously used by the authors. The application of this technique consists in inserting trace amounts of r dioactive inert gas at the input membrane placed in a standard equipment for gas separa tion. Several methods of the application of inert gas probe technique have been applied for the diagnostics of polymer membranes.

Methods and their application

I. Gas permeability method with autoradiographic detection /1,2/. The trace amount of t inert radioactive gas is inserted at the membrane input and after establishing the stea state of the inert gas flow the diffusion process is stopped by freezing, the membrane put in between two photographic plates to obtain autoradiographs. A map of the inert ga distribution obtained in this way at the output of the polypropylene membrane is shown Fig. 1a. From the differences of the map obtained at the membrane input and output, res the spectra of local diffusion coefficients and solubility constants of the inert gas i the membrane material can be determined (see Fig. 1b). From the spectra in Fig. 1b we have concluded that the temperature treatment of the membrane in the air at 80-100°C le to an increased appearance of higher values of diffusion coefficient D, probably due to the development of microcracs.

II. Pulse method for the gas permeability measurement /3,4/ is based on the measurement an inert gas concentration pulse passed through the membrane. This gas is inserted in t form of an infinitely thin pulse at the membrane input, and the time T necessary for at taining the maximum flux at the membrane output is determined. The appearance of a devi tion of T from the standard T_{st} value can be considered as a signal of a damage of the membrane separator. In Fig. 2a the results of this method in investigation of polyvinyl trimethylsilane is demonstrated.

III. Differential inert gas pulse method is based on the interruption of the steady flc of the inert gas creation of a series of subsequent pulses which are inserted at the me brane input. The response curves obtained at the polyvinyltrimethylsilane membrane outp are demonstrated in Fig. 2b.

IV. Double pulse method for the gas permeability measurement. Two subsequent radioacti inert gas rectangular pulses are inserted at the input of the membrane (the time interv between the pulses being equal to their widths) and the passage of the double pulse at the output response is measured (see Fig. 3). The single peaked response curve (curve 1, Fig. 3) corresponds to the perfect state of the membrane, splitting of the single peak a double peak (curves 2-6, Fig. 3) indicates the appearance of a microcracs of the membrane.

Conclusion

The principles and application of several experimental techniques for diagnostics of pc lymer gas separation membranes based on the diffusion of radioactive inert gases are ou