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The gas permeation method for characterization of active transport in polymer hybrid materials containing ionic liquids

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Abstract

The new method of gas transport characteristics (permeability, diffusion and solubility coefficients)) analysis of polymer hybrid materials containing ionic liquids (IL) was proposed. This method provides to evaluate contributions of passive and active transport in transport parameters using formalism of double sorption model. This method is based on separation of passive transport contribution for non-interacting with IL gases (H_2, He, O_2, N_2, CH_4 and etc.) using well-known dependences of diffusion coefficients from gas kinetic diameter and solubility coefficients from Lennard-Jones potential. Then the contributions of active transport in diffusion and solubility coefficients for interacting with IL gases (CO_2 and etc.), effective diffusion coefficients between carriers, effective solubility coefficients of gases in active media and equilibrium constant of gas and IL interaction can be determined using formal double sorption model. All these parameters for polymer membrane materials based on cross-linked copolymers synthesized in the presence of difference IL concentrations (0-52 % of mass.) were determined. It was shown that previously obtained extreme dependences of CO_2 permeability coefficients from IL containing in material could be explain by dependences of effective diffusion coefficients between carriers and equilibrium constant of CO_2 and IL interaction from IL concentration in material. The equilibrium constant on IL containing from 25 to 37 % of mass. is constant and its value is 44 cm Hg^{-1}, but under the growth of IL concentration from 41 to 52 % of mass. the equilibrium constant decrease and its value is 21 cm Hg^{-1}. This result has confirmed the previous supposition about transition from selective IL "solution" in cross-linked polymer to less selective cross-linked polymer "solution" in free IL at IL concentration near 40 % of mass.. Thus this variant of gas permeation method could be used for identification of gas transport mechanism in membranes, for evaluation of active transport parameters and explanation of transport parameters changes depending on IL content in hybrid material.