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Mass transfer in absorption/membrane integrated hybrid systems for gas separation

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A mass-transfer model in a membrane permabsorber is considered. The membrane permabsorber is a integrated membrane system involving a liquid flowing along a non-porous polymeric gas-separation membrane. The membrane permabsorber can consist of at least one membrane absorption module (absorber) and one membrane desorption module (stripper). The liquid absorbent moves along membranes between a absorber and a stripper at different flow rates and temperatures. The use of flowing-liquid absorbents in combination with non-porous gas-separation membranes permits two gas separation operations, that is, membrane and absorption, in one system.

The use of asymmetric non-porous flat-sheet membranes with a very thin diffusion layer and a new configuration for a membrane permabsorber with the liquid flowing between membranes along turbulence-promoter spacers allows a decrease in diffusional resistance greater than can be obtained with a conventional liquid membrane design.

In terms of the phenomenological theory, the mass-transfer in above-mentioned membrane absorption system can be regarded as diffusion in a composite membrane, in which the inlet and outlet sides are spatially separated from each other, and the link between them is obtained by forced circulation of a liquid absorbent.

The phenomenological theory of mass transfer in the membrane permabsorber in the steady state, with and without taking into account reversible chemical complexation of gas mixture components with a selective "carrier", is considered. Basic systems of differential equations for mass balance in the membrane permabsorber are proposed. The analytical solutions of above-mentioned systems of equations have been proposed. The quasicirculation mode of operation of a membrane permabsorber is considered, and the principle of the process optimization is discussed, and the modes of membrane permabsorber with co-current and countercurrent flows of gas and liquid are compared.