Use of nonporous polymeric membranes in membrane/liquid contactors for gas separation: thermodynamic and kinetic limitations of retentate selectivity

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A phenomenological analysis has been developed of a binary gas separation process in a liquid-membrane contacting system comprising polymeric flat-sheet non-porous gas-separation membranes and a liquid flowing within an absorber/stripper system. New analytical solutions of the problem, taking into account the change of concentration in the gas (feed) side are presented and numerically computed.

It is shown that that the model can be used for an estimation of the system's behaviour when it is assumed that pressure drop in gas (feed) channels is not more than 10 %. It is shown that the proposed model can be used effectively for the simulation of gas separation processes in the small-scale membrane contactors.

It was shown that the selectivity of separation of a binary gas mixture is determined either by the sorption (extraction) selectivity of a liquid used, or by the selectivity of a non-porous polymeric membrane itself, but not in their combination. The mathematical modelling included use of the following variables : diffusion coefficient of gases in a polymeric membrane, sorption of gases in polymeric membranes and flowing liquid, feed-gas and liquid flow-rates. The following dependencies have been computed: overall gas transfer rates in the system vs. liquid and feed flow rates, selectivity vs. liquid and feed flow rate, and concentration profiles vs. liquid and feed flow rates.

It was also shown that the counter-current mode of operation is advantageous in comparison to the co-current mode. The separation of the following binary mixtures have been considered : CO_2/CH_4, CO_2/H_2, CO_2/N_2. PDMS-based composite and asymmetric PVTMS membranes have been selected for modelling.

References

I.N. Beckman, D.G. Bessarabov, V.V. Teplyakov, *Ind.Eng.Chem.Res.*, **1993**, 32, 2017-2022
D.G. Bessarabov, R.D. Sanderson, E.P. Jacobs, I.N. Beckman, *Ind.Eng.Chem.Res.*, **1995**, 34, 1769-1778
D.G. Bessarabov, E.P. Jacobs, R.D. Sanderson, I.N. Beckman, *J.Membr.Sci.*, **1996**, 113, 275-284
D.G. Bessarabov, *Desalination,* **1998**, 115, 265-277