Gas Separation by Membranes Based on Cyclic Pressure Swing Permeation

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A novel process mode for gas separation by membranes based on cyclic pressure swing permeation was presented. It involved feed pressurization and permeate evacuation in a cyclic fashion to increase the pressure difference across the membrane and the feed to permeate pressure ratio. The feed pressurization and permeate evacuation were preferably done using a single pump capable of pressurization and suction. Different from membrane gas separations that are based on transient permeation taking advantage of the differences in sorption uptake rates or desorption falloff rates, this pressure swing permeation process was still based on the selective permeability of the membranes to different gas components. Unsteady-state permeation associated with the pressure-vacuum swing permeation was analyzed to elucidate the working principle of the process, and a parametric study was carried out to evaluate the effects of design and operating parameters on the separation performance.

To illustrate the feasibility and effectiveness of the process, air separation for oxygen enrichment and CO2 capture from flue gas by the pressure-vacuum swing permeation were evaluated. It was shown that the gas separation efficiency was enhanced by means of the pressure-vacuum swing, and both the product purity and product throughput were higher than those obtained from conventional steady-state permeation using the same membrane under similar operating conditions.