PERMEATION OF SUBCRITICAL AND SUPERCRITICAL CARBON DIOXIDE THROUGH A MICROPOROUS SILICA AND A POLYMERIC MEMBRANE

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The use of green solvents, like supercritical carbon dioxide, has been extensively increased in recent applications to replace most of the organic solvents, which are not environmentally friendly. Supercritical fluid technology is often associated with the requirement of a large amount of energy especially due to the energy loss in the solvent regeneration step. This eventually motivates to study different solvent regeneration techniques with minimum loss of energy. The use of membranes could open some new possibilities for the regeneration of supercritical carbon dioxide. Re-compression of carbon dioxide, after its separation from solutes, can be avoided by applications of membranes. The expected energy loss in membrane separations would be due to the small pressure drop across the membrane.

In this work, a comparison is being made between the permeation of pure carbon dioxide through two different types of membranes. The first membrane is a microporous inorganic silica membrane, with pore sizes in the order of 0.6 nm. The second membrane is a composite type with a thin polymeric top layer supported on a polymeric ultrafiltration membrane. Permeation behavior is studied using transient permeation for both gaseous and supercritical carbon dioxide. The permeation behavior through the two membranes is compared in terms of the permeance, which is given by the flux divided by the pressure difference across the membrane.

At subcritical conditions, the permeance of pure carbon dioxide through both membranes increases linearly with an increase in feed pressure. The permeance as a function of the pressure difference across the polymeric membrane decreases slightly, i.e. by less than a factor of 2 for pressure differences up to 6 bars. The permeance of silica membrane as a function of the pressure difference across the membrane is constant for pressure differences up to 8 bars. Also, at supercritical conditions the permeance through the silica membrane is constant.
The permeances through the polymeric membrane are about a factor of 20 higher than the permeances through the silica membrane.