DEVELOPMENT OF MEMBRANE MATERIAL FOR A MEMBRANE CONTACTOR FOR NATURAL GAS SWEETENING

Karen Nessler Seglem, Taek-Joong Kim, May-Britt Hägg*
Norwegian University of Science and Technology
karen.seglem@chemeng.ntnu.no, taek-joong.kim@chemeng.ntnu.no,
***may-britt.hagg@chemeng.ntnu.no**

Keywords
Membranes
Membrane contactor
Natural gas sweetening

Abstract
The gas-liquid membrane contactor is an alternative separation process for the removal of CO_2 from natural gas. In gas-liquid membrane contactors the advantages of both membrane technology and absorption processes are combined. The absorption liquid performs the selectivity of the system, while the membrane acts as a barrier between the gas and the liquid. The concept of the contactor is illustrated in Figure 1.

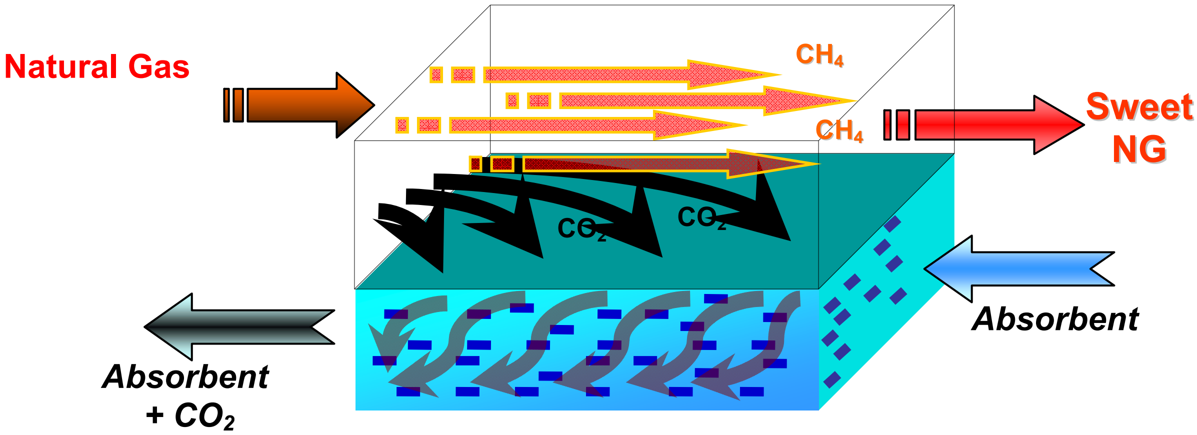

Figure 1: The concept of a membrane contactor

Mass transfer between the two phases can then be obtained without dispersing one phase into the other. Compared to separation by a membrane alone, very high selectivity is obtained in the contactor by the absorption liquid, even at very low acid gas concentration without loss of CH_4. The membrane barrier between the phases gives the advantage of more flexible operation conditions as the two streams can be operated independently at a constant available contact area. Higher gas and liquid flow rates can be used without the danger of entrainment of droplets or flooding, which could be a problem in conventional absorption towers. An essential advantage is the high gas-liquid contacting surface area per unit contactor volume, resulting in a small footprint. In addition, there is the possibility of linear scale up by membrane modules.

New nanostructured membrane materials to be applied in a membrane contactor for removal of CO_2 from high pressure natural gas are to be developed. The reports on high pressure conditions in membrane contactors are scarce, and there lies the potential of developing new, efficient membrane materials rather than applying commercial ones. Today, mostly microporous polymer membranes are investigated and used in the membrane contactor process, though various asymmetric and composite membranes have also been tested for this application. The CO_2 mass transfer coefficient for the process is highest for a gas-filled membrane, compared to the membrane pores being filled with liquid. Therefore the membrane material will need to be hydrophobic, in order to keep the liquid from entering the membrane pores. Mechanical strength of the membrane will also be an important property. As previously mentioned, the selectivity of the system is obtained by the absorption liquid, so a high CO_2 selectivity for the membrane material is not needed.

Poly(4-methyl-2-pentyne) (PMP) and poly(1-trimethylsilyl-propyne) (PTMSP) with nanoparticle fillers for mechanical strength will be the polymers explored for the membranes to be used in the contactor. An amine solution will be used as absorption liquid. PMP and PTMSP are both glassy, high free volume polymers, with a very high permeability; PTMSP has the highest permeability of all known synthetic polymers. The membrane needs to be characterized with respect to pore size, pore size distribution, porosity, and mechanical strength before testing in the laboratory set-up.

A new membrane contactor experimental set-up for flat-sheet membranes will be applied. It will be possible to vary gas flow rate, liquid flow rate, temperature and pressure in order to investigate these variables’ effect on the process. Pressures up to 40 bar will be applied. The target value of CO_2 capture is 95%.

Challenges, initial results and experimental plans will be reported in the presentation.