SC2: ZEOLITE MEMBRANES FOR GAS SEPARATION

PILOT LINE

5 & 6

Showcase 2, is a service for testing membranes for gas separation under almost realistic conditions through lab and field tests. DBI GUT offers a service for testing the membranes and in this showcase is testing the membranes from pilot lines 5 & 6. This service is one of the many services that the company offers – as they offer a lot of services around the value chain of natural gas and all other gases for the gas industry.

SERVICE & IP OWNER

- DBI has been offering this membrane testing service for the last 12 years
- DBI is testing the membranes from PL5 & PL6

PL 5 OWNER

- Flat sheet polymer membrane production

PL 6 OWNER

- Zeolite membranes

THE CONTEXT

CO_2 is a primary greenhouse gas (GHG) and it is estimated that stationary CO_2 emissions are responsible for more than 60% of the overall CO_2 global emissions. CO_2 is also the main impurity of natural and biogas followed by water and higher hydrocarbons ($C \geq 4$) which have to be separated after exploitation or production, respectively. Membrane technology is, since 1970s, one of the most studied techniques for the separation and sequestration of CO_2 from non-polar gases (such as CO_2/N_2, H_2/CO_2 and CO_2/CH_4 gas mixtures). Even though polymeric membranes are economically and technologically attractive, they are restricted by their performance, known as the Robeson limit where permeability is sacrificed for selectivity and vice versa. Membrane materials have expanded into the use of zeolites on ceramic substrates. High selectivity, fluxes, temperature and pressure stability are the advantages of this type of membranes. However, only hydrophilic zeolites for water separation from organic solvents (NaA, ERI, SAPO-34) are in the market on an industrial scale. Zeolite gas separation membranes are not available. An option to combine the advantages of polymers and porous, inorganic materials are the so-called mixed matrix membranes (MMMs). The application of porous fillers like zeolites, graphene derivatives, activated carbon or metal organic frameworks, among others, due to their strong thermal and chemical resistance as well as high tunability results in increased permeability and selectivity. On the other hand, NF is used for efficient and economical separation of different mixtures that involve water and organic solvents. It is a membrane filtration-based method that uses nanometer sized through-pores that can sieve small species such ions, molecules or colloids from solvents. The original use of NF was connected with water treatment (water softening). However, in recent years, NF is used in other industrial applications such as: i) oil and petroleum chemistry for purification of gas condensates and removal of tar components in feed, ii) fine chemistry and pharmaceuticals for room temperature solvent exchange and non-thermal solvent recovery, iii) medicine in the extraction of amino acids and lipids from blood, and iv) natural essential oils in fractionation of crude extracts.

THE CHALLENGE

Zeolite membranes are of growing interest for gas separation because of high thermal, hydrothermal and mechanical stability and high selectivity combined with high fluxes. SAPO-34 (CHA) is reported as excellent membrane for the separation of CO_2 and other small, polar molecules from CH_4. Zeolite ZSM-5 (MFI) was successfully tested for separation of n-butan from CH_4. Both types of membranes were successfully tested in lab-scale size real natural gas treatment. INNOMEM will allow for first time natural gas treatment with industrial scale zeolite membranes. In parallel improved polymeric flat sheet membranes will be introduced into the investigation. So, INNOMEM allows development of low energy consuming and low footprint gas treatment processes on place of exploitation that is also well suited for small scale and offshore applications.

KEY DRIVERS OF THE SERVICE: THE VALUE PROPOSITION

Membrane producers offering testing services mainly just characterize their products with simple gas analysis of just one single gas permeation or just a mix of two which does not really reflect the behaviour of the product in real life. In comparison, DBI GUT's service is more complex and makes a bigger effort to get a clearer and more accurate result of how a membrane is behaving under real life conditions.

Rapid and flexible

- They are able to quickly adapt and meet the needs of the experiment that is planned

More realistic

- They adapt to the real expected conditions and are able to generate more complex gas mixtures under more harsh conditions that are comparable to the real conditions

Adaptable

- For the field testing in particular, they are very adaptable with their equipment setups to ensure the optimization of the testing in the real environment and ensure that it can withstand the harsh field atmospheres