INNOMEM

SC3: MIXED MATRIX MEMBRANE FOR LIQUID AND GAS SEPARATION

Inorganic and MMMs for natural gas and biogas treatment and MMMs for water treatment by nanofiltration (NF).

PARTNERS	*PILOT LINE*	*CURRENT TRL*	*EXPECTED TRL*
polymem MEMBRANE MANUFACTURER tecnalia Inspiring Business	1	6	n/a

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

MMM (mixed matrix membranes) combine the advantages of polymers and porous, inorganic materials, reaching increased permeability and selectivity. Over the last few years, new materials have been incorporated such as carbon nanotubes. In case of Nanofiltration (NF), various membranes with different structures have been studied and synthesized (e.g. TFC) The added value is provided by different production methods (PL#1,8,9,14), to realise nanofiltration membranes as well as gas separation membranes in different geometries (Planar, tubular and HF). This will allow enhancing their permeation properties as well as their chemical resistance. The Value Proposition will be further updated during the project exploitation work.