SYDDANSK UNIVERSITET
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Functional Materials and Nano Technology

Carbon Molecular Sieves for separation of Hydrogen and Carbon Dioxide

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Introduction

Safe storage of hydrogen is an important task to overcome, if hydrogen is to be widely used as an energy carrier in our society. One solution is to store the hydrogen in combination with super critical CO_2, reducing the risk of explosion considerably. However, most applications of hydrogen require high purity feeds, and hence a separation step is necessary, in order for this storage method to be viable. Traditional gas separation technologies such as Pressure Swing Adsorption are costly affairs, and so in this project, the feasibility of utilizing membrane technology for the desired separation is investigated.

Carbon Molecular Sieving (CMS) membranes are manufactured by pyrolysis of a polymer membrane. It is possible to adjust the pyrolysis conditions, so the remaining carbon structure is nano-porous, which enables the membrane to allow passage for molecules of a certain size. The goal of this work is efficient separation of hydrogen and CO_2 (illustrated in figure 1). Hollow polymer fibers will be manufactured at NTNU in Norway in collaboration with professor May-Britt Hägg and her group. The pyrolysis, construction of membrane modules and gas separation tests will be performed at TEK-SDU* in Odense.

Manufacturing polymer fibers

The polymer fibers will be manufactured using a spinerette. Cellulose and polysulfone will be used as precursor materials in this work. The effects of varying experimental conditions such as diameter, wall thickness, bore fluid and air gap will be investigated.

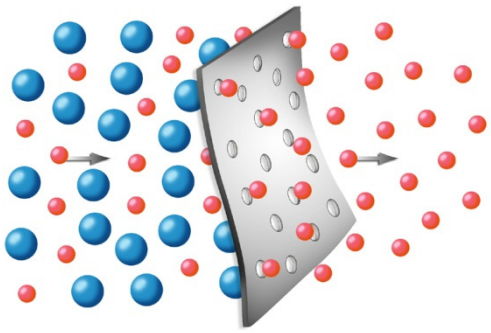

Figure 1. Illustration of the molecular sieving mechanism. [1]

Pyrolysis

Pyrolysis of the precursor fibers will be done in a cylindrical oven. CMS-membranes with varying gas separation properties will be manufactured by changing the temperature profile of the pyrolysis (figure 2).

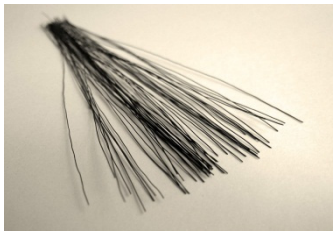

Figure 2. Pyrolysed hollow fibers. [2]

Constructing membrane modules

The CMS hollow fibers will be arranged in a steel tube with Swagelok fittings (figure 3), so the module can easily be mounted in the experimental setup for gas separation analysis.

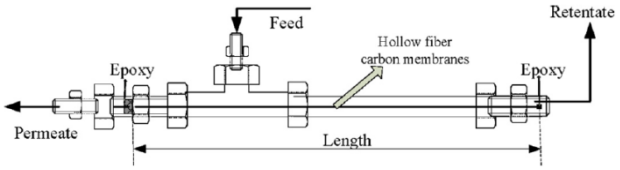

Figure 3. Diagram of hollow fiber module [3]

Experimental setup for gas separation analysis

The membrane modules will be placed in an experimental setup like the one illustrated in figure 4. The setup makes it possible to determine the permeability of the CMS-membranes. Both single- and mixed gas analysis will be made. FC and PC refers to flow- and pressure controllers.

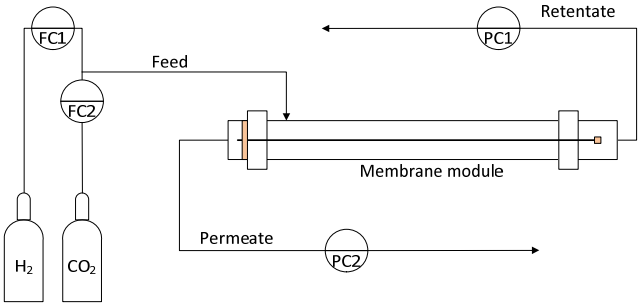

Figure 4. Experimental setup.

References
[1] www.ornl.gov
[2] sciencedirect.com
[3] Xuezhong He, May-Britt Hägg *Journal of membrane Science 2012* **390-391** Page23-31

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