ECN

Energy research Centre of the Netherlands

The MEMCAP Process Development Unit

Testing of membrane reactors for CO_2 capture

The MEMCAP facility is a process development unit (PDU) for testing membrane reactors that can be implemented in power plants with CO_2 capture. It has a capacity of 8 tubular membranes of 50 cm long, and can be operated up to 40 bar and 600°C. The PDU will demonstrate the feasibility of membrane reactors at a bench scale size. It will be used for testing of reactor concepts, and the study of membrane and catalyst characteristics.

The facility

The PDU can supply gas mixtures with a varying composition and flow rate at high pressure. These are heated and then fed to the membrane reactor. In the membrane reactor hydrogen is produced and immediately separated from the other gases by the membrane. The MEMCAP PDU produces two product streams: a hydrogen product and a stream with the components that are not separated by the membrane, which is a CO_2-rich product. The products gas streams are cooled and water is removed.
Gas analysis is performed on all feed and product streams. It is even possible to analyse the product streams of the individual tubes of the membrane reactor.
The facility allows for exchange of membrane reactors so, different reactors and reactor concepts can be tested.

Key features

Gas supply	CH_4, CO, H_2, CO_2, N_2, steam
Max Pressure	40 bar
Max Temperature	600°C
Membranes	Pd-alloy membranes
Max	8 membranes of 50 cm length
Max.Capacity	25 kW H_2
Reactions	Steam methane reforming or Water-gas shift
Operation	Fully automatic

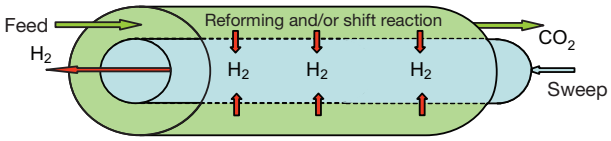
Unit Hydrogen and Clean Fossil Fuels
P.O. Box 1, 1755 ZG Petten
The Netherlands

T: +31 (0)224 564571
F: +31 (0)224 568504

Contact: Daniel Jansen
jansen@ecn.nl
www.ecn.nl/hsf

The concept

Membrane reactors allow for conversion of natural gas into two separate streams of H_2 (for power production) and CO_2 (for underground storage). The conversion is done catalytically through steam reforming and/or the water-gas shift reaction.



Parallel to the reaction hydrogen is removed from the reaction zone by Palladium-alloy hydrogen selective membranes. Separation is improved by using a sweep stream. When implemented into a power plant, the advantage of this concept is that H_2/CO_2 separation is done at high temperature, thus limiting heat transfer costs and improving the efficiency of the power plant. Also the selective removal of hydrogen shifts the equilibrium of the reactions towards high conversion allowing for high conversions at more favorable temperatures, which also reduces the costs.

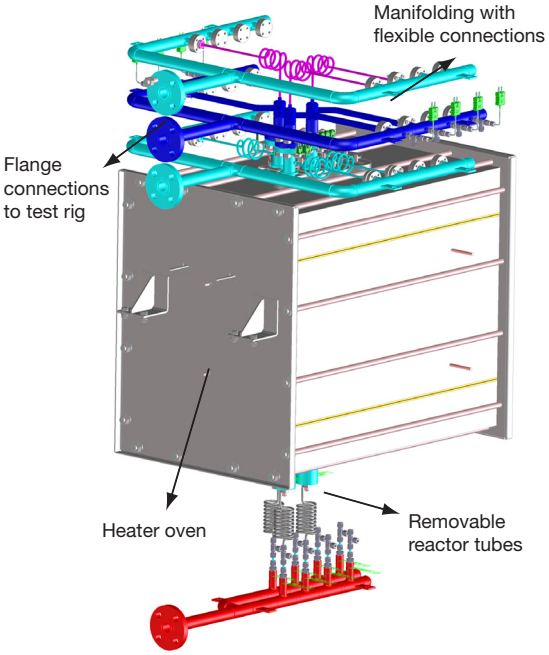
Membrane reactor construction

The current design of the membrane reactor that will be tested is derived from an envisaged full scale steam methane reformer type reactor with membranes inserted into the reactor tubes. Heating is done by radiating electrical elements, mimicking radiant burners. The reactor is also suitable for conducting adiabatic membrane water-gas shift reaction experiments.

The projects

The facility has been constructed as part of the ECN programme on CO_2 capture, the CATO programme, and the CACHET project. CATO is the Dutch national research programme on CO_2 Capture and Storage. The consortium consists of research organisations, industry and NGO's. CATO is supported by the Dutch Ministry of Economic Affairs (EZ) and CATO consortium partners.

Cachet is a 3-year integrated research project to develop technologies that reduce greenhouse gas emission technologies. Development focuses on four pre-combustion technologies for conversion of natural gas while simultaneously capturing carbon dioxide. Cachet is supported by the European Commission and eight leading energy companies participating in the CCP-2 consortium.



Unit Hydrogen and Clean Fossil Fuels
P.O. Box 1, 1755 ZG Petten
The Netherlands

T: +31 (0)224 564571
F: +31 (0)224 568504

Contact: Daniel Jansen
jansen@ecn.nl
www.ecn.nl/hsf

b-09-008