

## Assessment of Hydrogen Compatibility of Steel and Polymer Materials

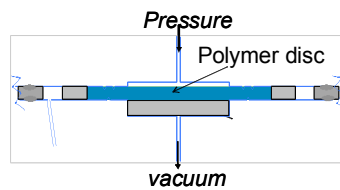
### Objectives

- ❖ Tools are necessary to assess the compatibility of materials exposed to compressed hydrogen to develop storage cylinders and components with high level of performance & safety.
- ❖ In case of composite storage cylinders made of plastic liners, hydrogen dissolution and diffusion in polymers is a major issue and the materials have to be characterized toward hydrogen permeation.
- ❖ In case of steel liners, boss and components, hydrogen can cause premature failure by embrittlement of steel.

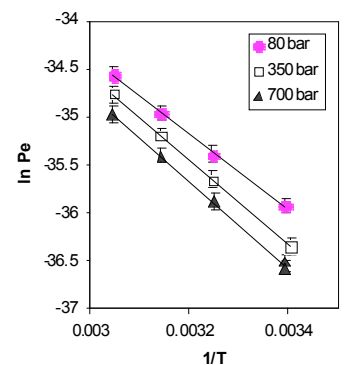
### Achievements

#### Assessment of hydrogen permeation on liner samples

- ❖ Development of a test bench dedicated to hydrogen permeation measurement on thick polymer disks (~ few mm) up to 700 bar
- ❖ Permeation rate determined at steady state
- ❖ The effects of temperature, pressure and material type (CEA, COMAT) have been studied.
- ❖ Results can be correlated to microstructure and give orientation for material development, selection and liner design.

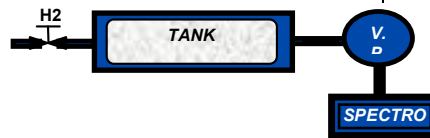


Schematic representation of the permeation cell (left). Evolution of the hydrogen permeation rate of CEA materials with pressure & temperature (right)



#### Assessment of hydrogen permeation at cylinder scale

- ❖ CEA prototype fulfils EIHP and ISO H<sub>2</sub> permeation requirement (< 1 Ncm<sup>3</sup>/h/L)

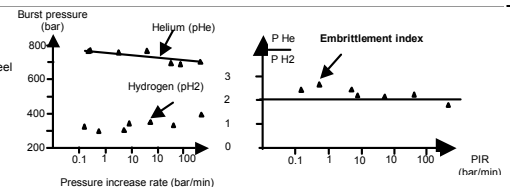
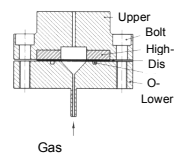


Gas & tank temperature recording

Schematic representation of the permeation test bench on cylinders

#### Assessment of H<sub>2</sub> embrittlement using the disk test method (ISO 11114-4)

- ❖ Measurement of the burst pressure at different pressurization rates for He and H<sub>2</sub> on an embedded disc specimen and compatibility to H<sub>2</sub> demonstrated if the index *i* (defined as the ratio of the burst pressures in He and H<sub>2</sub>) is lower than 2
- ❖ Evaluation of 5 steel samples from Faber: 1 complies with the requirement



Disk test cell and example of an embrittlement index calculation

### Future Perspectives

- ❖ Permeation on disc sample is a useful tool to benchmark liner materials. However the correlation between liner samples and cylinders permeation rates is not trivial and has to be further investigated.

Partners	❖ Air Liquide 	❖ Faber 	❖ CEA 	❖ COMAT 

Website: [www.storhy.net](http://www.storhy.net)



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