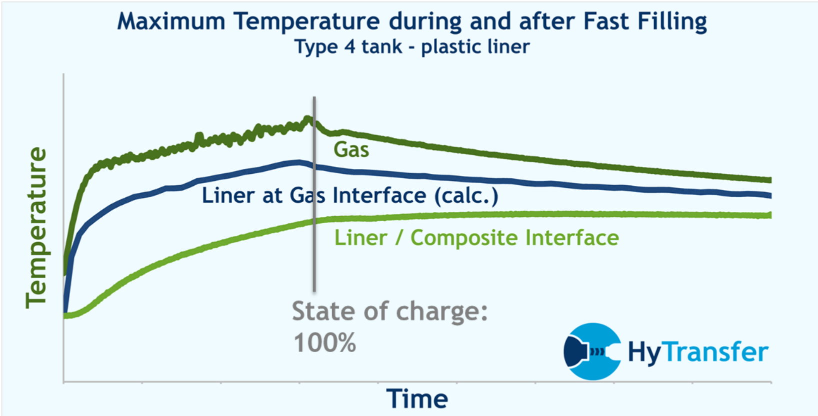
www.HyTransfer.eu

HyTransfer

Pre-Normative Research on Gaseous Hydrogen Transfer

Results from First Experiments



During a fast fill of a hydrogen tank, the gas heats up significantly more than the tank wall. After a fast fill, the maximum gas temperature quickly drops. The liner temperature slightly increases but never reaches the maximum gas temperature.

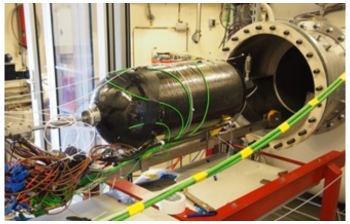
➪ When refuelling an FCEV: higher gas temperatures than today can be accepted

Experimental Parameters

83 filling and emptying experiments were performed on single tanks in three different laboratories. These are some of the varied parameters:

- Maximum pressure: 87.5 MPa
- Starting pressure: 2 MPa
- Environmental temperature: up to 50°C
- Pre-cooling temperature: -40°C, -20°C, 0°C
- Mass flow rate: 2-8 g/s (8 g/s = fast filling within 3 min)

Impressions of the Experiments



Instrumented type 4 tank entering the experimental chamber at JRC

An experiment with a type 4 tank with many integrated and attached termocouples at Air Liquide

Next Steps

2015	2016						
12	1	2	3	4	5	6	7

- Experiments on tank systems (12/2015 – 3/2016)
- Techno-economic analysis (2/2016 – 6/2016)
- Recommendations for RCS (5/2016 – 7/2016)

FUEL CELLS AND HYDROGEN JOINT UNDERTAKING

The research leading to these results has received funding from the Fuel Cells and Hydrogen Joint Undertaking under Grant agreement n° FCH-JU-2012-1 325277.

Coordination:
Ludwig-Bölkow-Systemtechnik GmbH (LBST), Daimlerstr. 15, 85521 Ottobrunn, Germany
Email: info@HyTransfer.eu Further information: www.HyTransfer.eu

Coordination | Industry | Research & Testing | Regulations, Codes & Standards | Funding

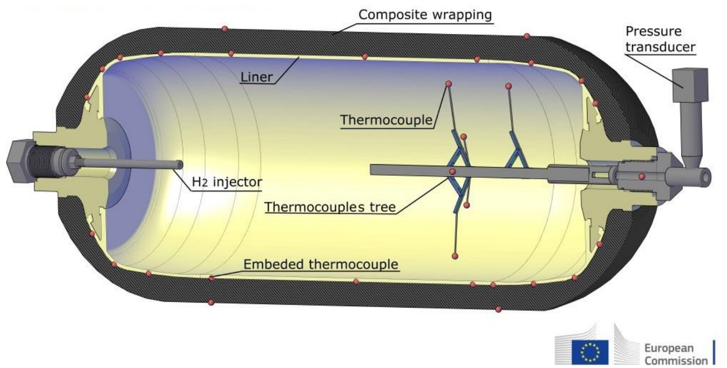
Motivation

Performance and profitability of CGH_2 HRS can be improved by reducing pre-cooling requirements

When filling a hydrogen tank the gas heats up. In reverse, when emptying a tank it cools down. This is especially relevant when fast-filling an FCEV and emptying a hydrogen trailer. Global regulations limit the temperature range for FCEV equipment from -40 to +85°C. Today, this is implemented by limiting the gas temperature and by pre-cooling the hydrogen to -40°C at the HRS. But the most extreme temperatures occur only in the gas, not in the tank wall. This may allow to reduce pre-cooling efforts.

The aim of HyTransfer is to recommend an improved gas transfer procedure for implementation in global regulations, codes and standards (RCS). Reduced pre-cooling requirements enable reduced HRS down-times and equipment costs as well as reduced energy demand.

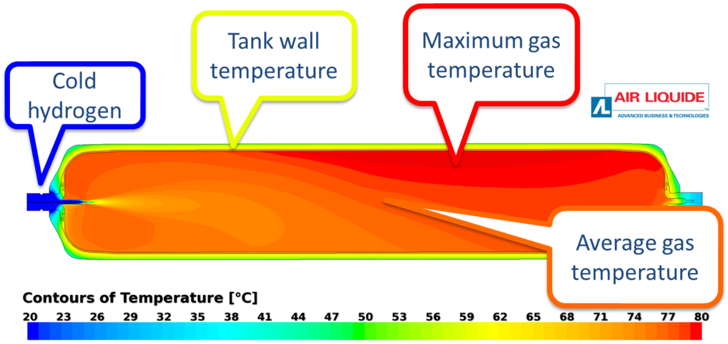
Experimental Setup



Experiments were performed with three different kinds of tanks: 40 l type 3 tanks (metal liner), 36 l type 4 tanks (plastic liner), and 531 l type 4 tanks (plastic liner).

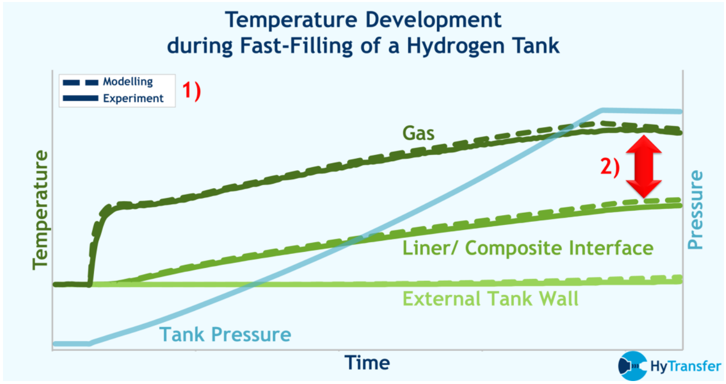
Each tank was equipped with about 40 sensors to measure the temperature at any time during the experiments: six to ten thermocouples inside the gas, 30 at the liner-composite interface and six on the outside of the tank wall.

Results from Single Tanks



The experimental results were used to optimize a CFD model. The image shows the different temperature regions during a filling process. The tank wall is significantly cooler than the gas.

On the basis of the very detailed CFD model, a simple thermodynamic model was developed that yields the average temperature for gas and tank wall.



1) The simple model is very accurate, the deviation from experiments is only around 3 K

2) The tank wall temperature differs up to 20 K from the gas temperature at the end of the filling process

Supported by the results from single tank experiments, the models were refined and are now suited to precisely predict maximum and average temperatures.