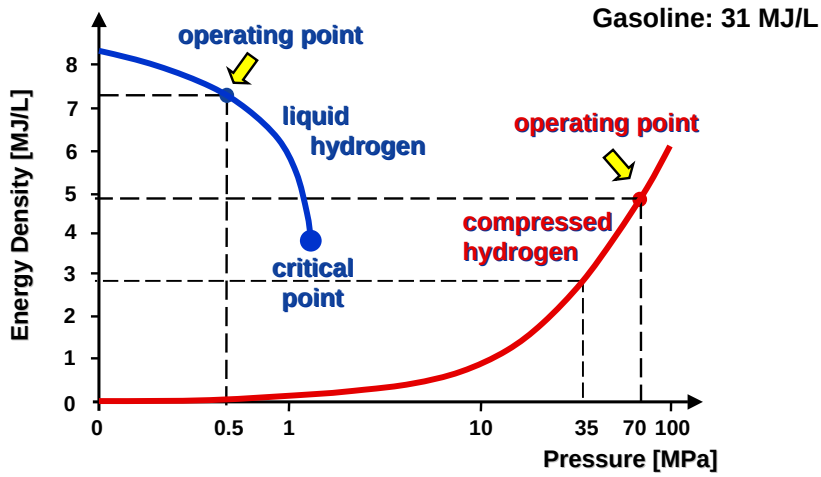
Storage Systems for mobile Applications

Dr. Günter Krainz
MAGNA STEYR Fahrzeugtechnik AG & Co KG

Hydrogen and Fuel Cell based Energy Systems
in a Future sustainable Energy World
31.3. – 1.4.2004
Vienna

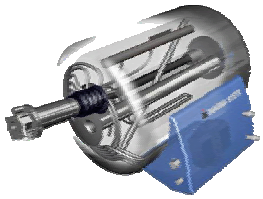
System requirements



Hydrogen Storage Technologies

Source: Dynetec

- **Compressed Hydrogen Gas**
  - *20 - 70 MPa*
  - *Steel vessel*
  - *Compound vessel*

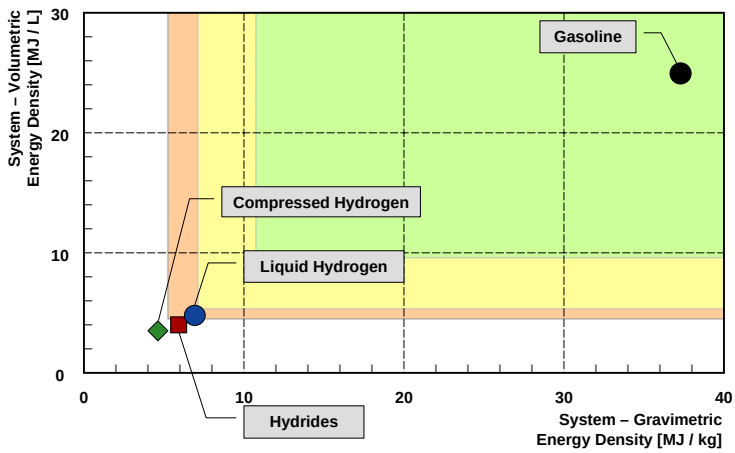


- **Liquid Hydrogen**
  - *Cryogenic storage at 20 K*
  - *Steel vessel, Aluminium vessel*
  - *Compound vessel*

Source: FZK

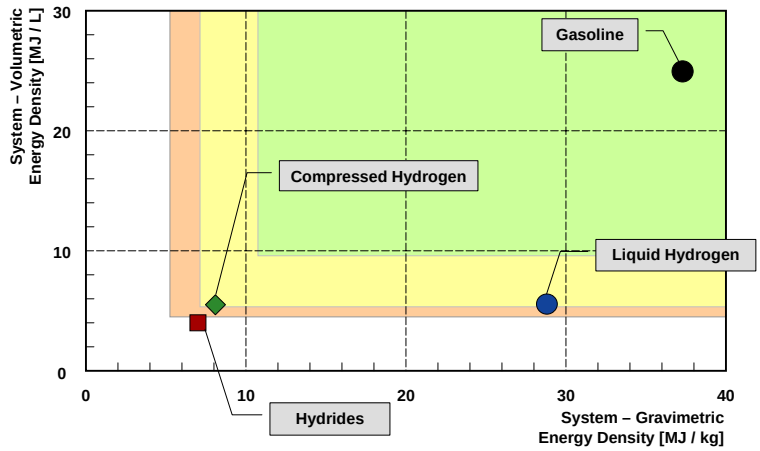
- **Hydrogen Storage in Solids**
  - *Metal hydrides*
  - *Alanates*

System Requirements



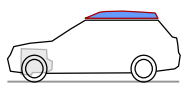
State of the Art

System Requirements

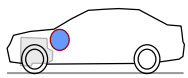


Goals for the next Generation

System Requirements



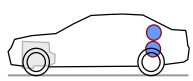
1 Tank, roof rack



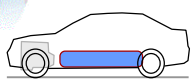
1 Tank, in front of the instrument panel

1 Tank, behind the passenger compartment

2 Tanks, below the passenger compartment



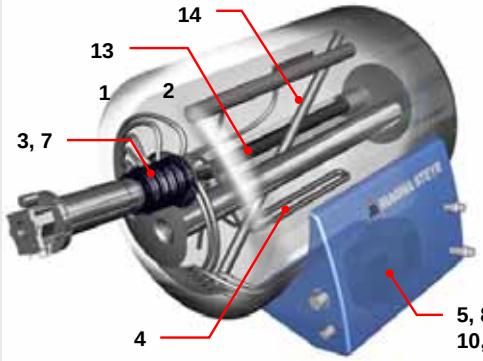
2 Tanks, behind the passenger compartment

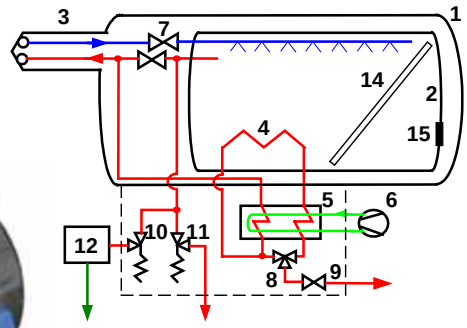


1 Tank, in the center tunnel

Liquid Hydrogen Storage System

- outer vessel
- inner vessel
- JC-coupling
- heater
- heat exchanger
- cooling water pump
- cryogenic valves





- pressure regulator
- shut-off valve
- boil-off valve
- safety valve
- boil-off system
- support post
- hydrogen level sensor
- burst disk

Standards and Regulations

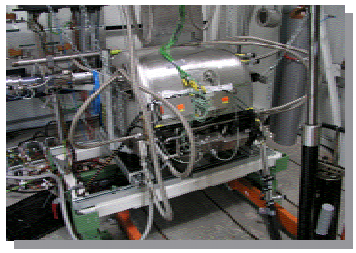
Designed in aspect to *EIHP* regulations
(European Integrated Hydrogen Project)

Draft for Regulations, Revision 14

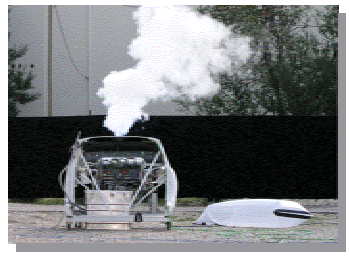
I **Specific components for hydrogen vehicles**

II **Installation of specific components for using in vehicles with liquid hydrogen storage systems**

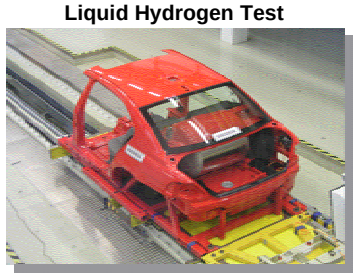
- *Inner tank – burst test*
- *Thermal resistance in case of fire*
- *Thermal resistance regarding to durability*
- *Refueling test (max. filling rate)*
- *Pressure test*
- *Leakage test*
- *Fatigue test*
- *Function test*
- *Resistance against corrosion*
- *Resistance against dry heat*
- *Ozone test*
- *Temperature cycle test*
- *Pressure cycle test*
- *Hydrogen digestibility - investigation*



Liquid Hydrogen Test



Vacuum Burst Test



Vehicle Crash Test

Cryogenic Flame Test

StorHy

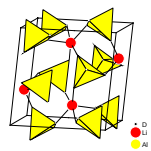
Hydrogen Storage Systems for Automotive Application

MAGNA STEYR coordinates the Integrated Project StorHy including 38 companies and institutions from 13 nations (5 OEMs, 14 research institutes and 19 suppliers).

Time frame:	**2004 – 2008 (5 years)**
Start of the Project probably:	**March 2004**
Budget entire program:	**€ 18.7 mio**
Requested EU Grant:	**€ 10.7 mio**

StorHy – Hydrogen Storage Technologies

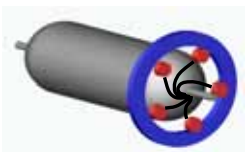
The goal of **StorHy** is to introduce ***innovative*** and ***cost competitive storage solutions*** to the market as quickly as possible through research and development as well as demonstration activities, including production technologies.

Pressure Storage	***Cryogenic Storage***	***Solid Storage***
		
Source: Dynetek	*Source: BMW*	*Source: IFE*

StorHy – Subproject Pressure Storage

New technologies – Sensing, filling and recycling techniques for 70 MPa pressure vessels

Reduce hydrogen permeation through the liner and optimize the winding technology

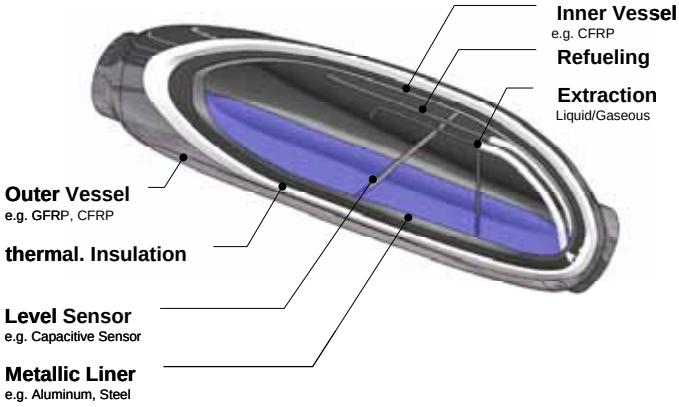


Fast filling at high pressure

StorHy – Subproject Cryogenic Storage

New technologies – Lightweight LH_2 tank

- Investigation of composite materials to be used for vessels regarding their mechanical, thermal and chemical properties
- Considering commercial constraints of a mass market

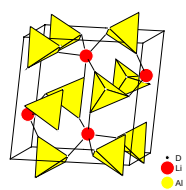


StorHy – Subproject Solid Storage

New technologies – Advanced metal hydrides

Mobile applications:
> 5 wt% hydrogen (e.g. IEA goal)

- **Alanates**
  - **LiAlH4: 10.6 wt% hydrogen**
  - **NaAlH4: 7.5 wt%**
  - **KAlH4: 5.7 wt%**
  - **Mg(AlH4)2: 9.3 wt%**
- **Borohydrides, Li-N-H system etc.**
- **New promising cadidates (carbon, complex hydrides)?** ← *Technology Watch*



StorHy – Partner