Hydrogen compression and storage through a Metal Hydride based Compressor

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Hystore Technologies Ltd.

5th Hellenic Forum for Science Technology and Innovation, July 5-7, 2017, Athens, Greece

Presentation's Structure

- Hystore Technologies Ltd
- Metal Hydride basics
- MHC's operational principle
- Experiments – Results
- ATLAS-MHC project

Hystore Technologies Ltd

- Established in August 2003
- Privately own SME
- Research & Development, Production, Consultation in Industry and Academia
- Main area of Activity: RES & Hydrogen, Design, construction of PV Parks, Hydrogen Technologies, “Green” Hydrogen Production, Storage and Utilization, Hydrogen Compression, H2/Fuel Cells,
- Metal Hydride Tanks (MHT) with a capacity of 10X litersH2 storage
- We are a unique (probably the only one in EU) European Company producing MHT - MHC

Hystore Technologies Ltd

Facilities (Ergates Industrial Area)

Hystore Technologies Ltd

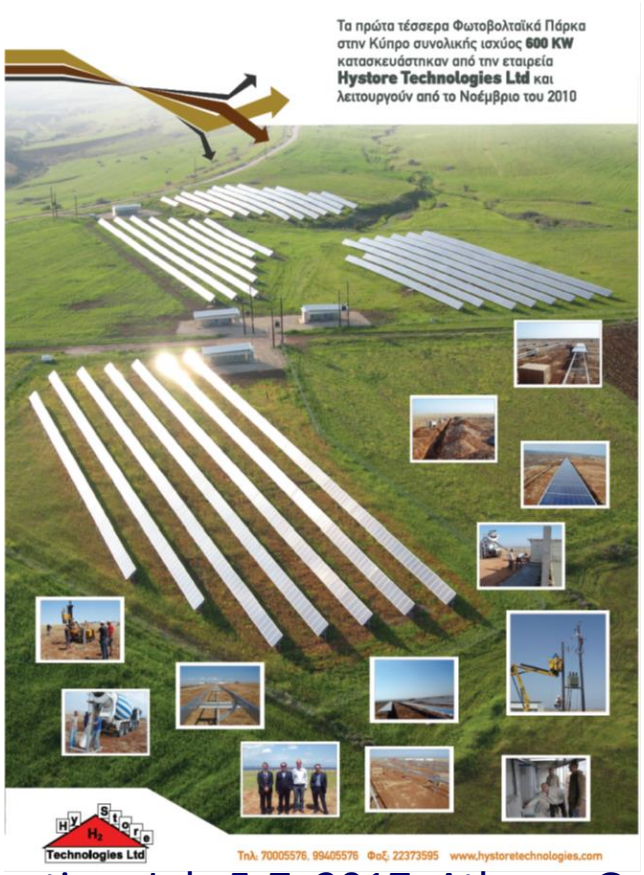
Grid-connected Photovoltaic Station (5.25kW) Producing and Recording the Actual Electricity Output since 2006

Hystore Technologies Ltd

- Hystore Technologies Ltd succeeded on getting FOUR (4) licenses for the installation and operation of PV parks with a capacity of 150 KW each.
- They are in operation since November 2010.

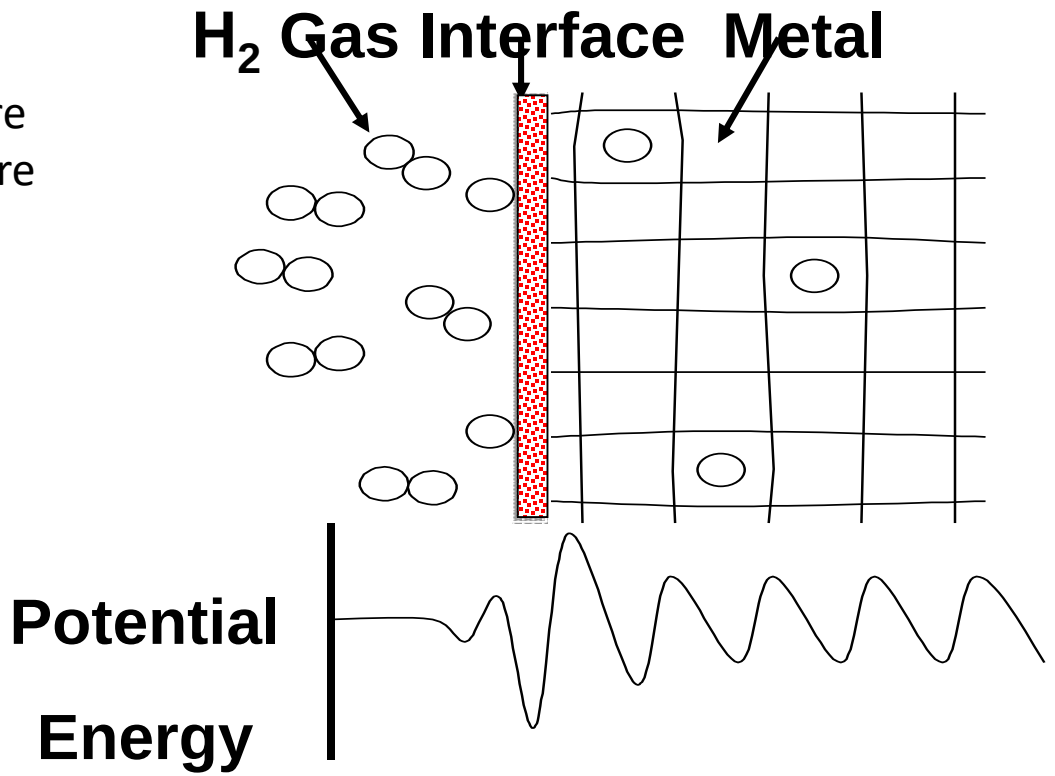
Hystore Technologies Ltd

First PV-Parks in Orounta-Cyprus 4X150 kW



Metal Hydride basics

- Metal alloys
- H_2 absorption inside lattice structure
- H_2 desorption from lattice strucuture
- High weight storage medium
- Low hydrogen pressure



Metal Hydride basics

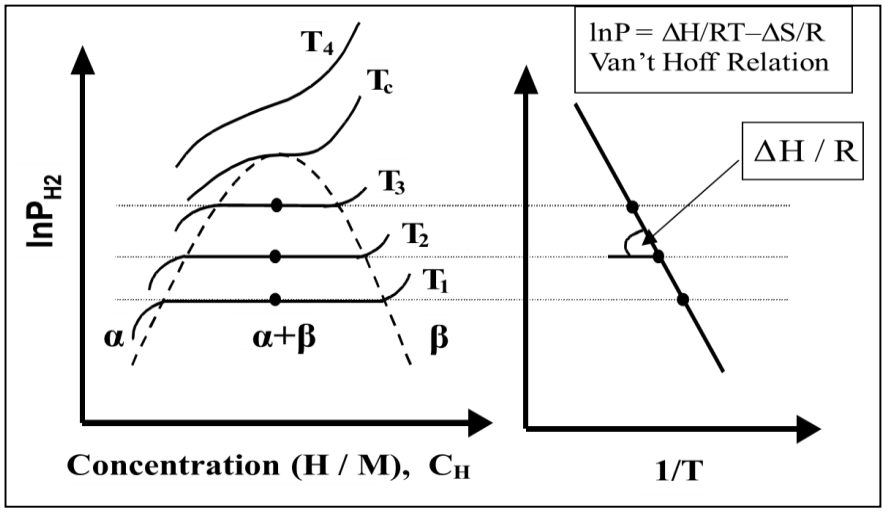
Thermodynamics

- H_2 absorption - desorption

$$M + \chi/2\ H_2 \leftrightarrow MH\chi$$

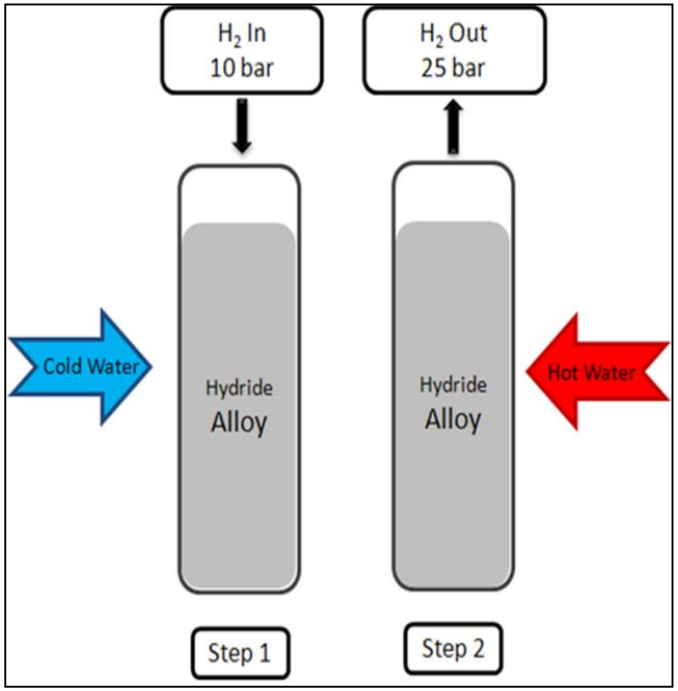
- Equilibrium pressure increases with temperature according to van't Hoff relation:

$$\ln P = \Delta H^o / RT - \Delta S^o / R$$



Metal Hydride basics

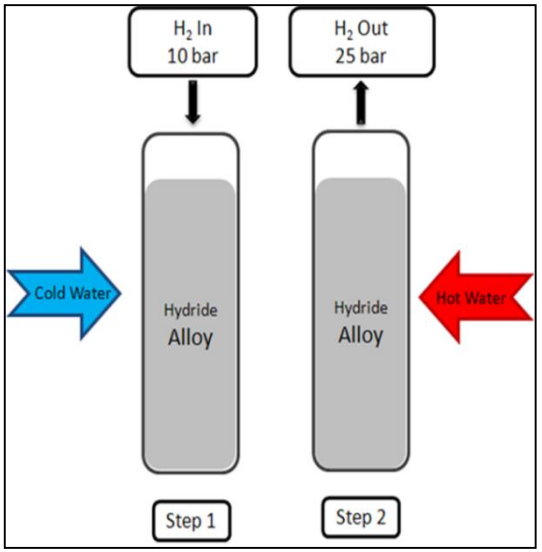
- Main characteristic: Desorption pressure > absorption pressure in higher temp.

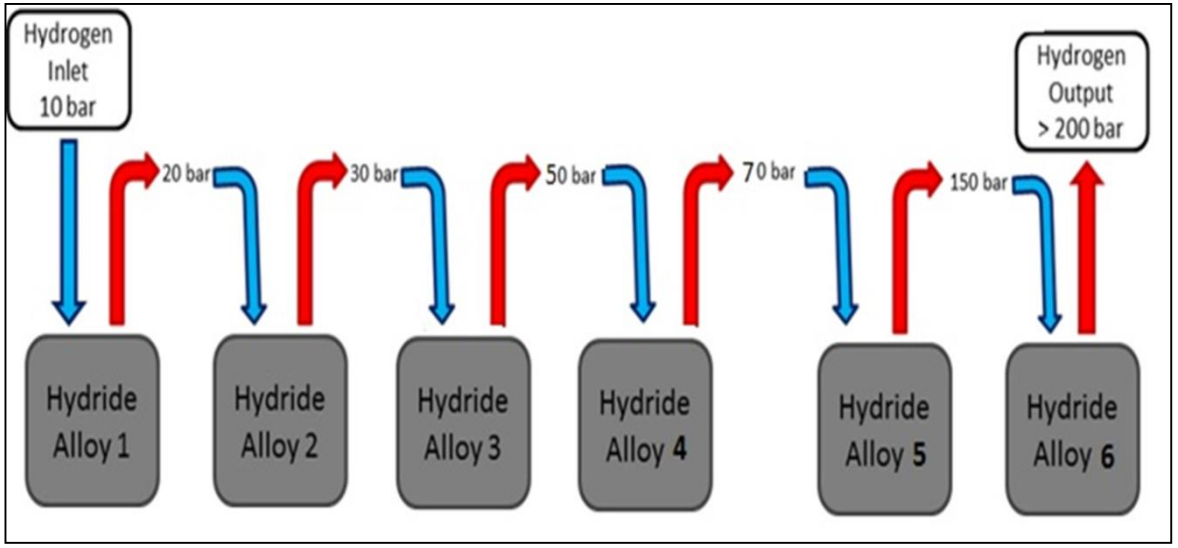


- Cold water supply during H_2 absorption
- Hot water supply during H_2 desorption in higher temp.

MHC's operational principle

- Taking advantage of metal hydride's main characteristic and by employing successively higher pressure hydride alloys in stages and in series, high pressure ratios are generated

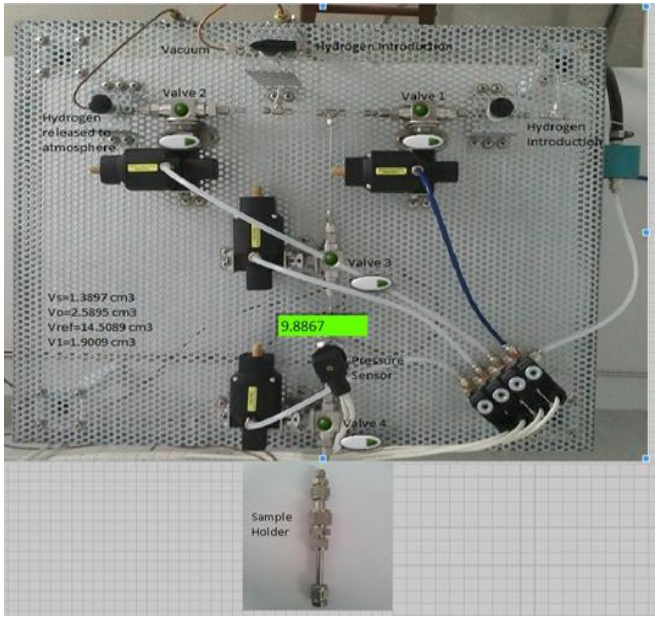


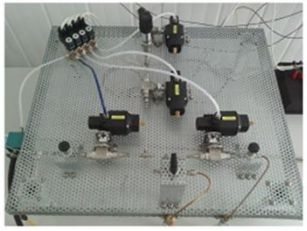


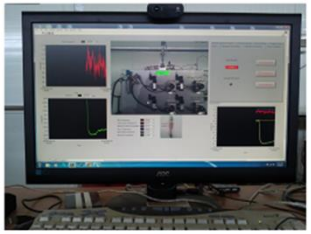
- H_2 absorption pressure < H_2 desorption pressure for each MH in each stage
- Progressive hydrogen pressure increase from stage-to-stage

Experiments

- Main objective → PCT curve for each MH in every stage
- Experimental valve setup



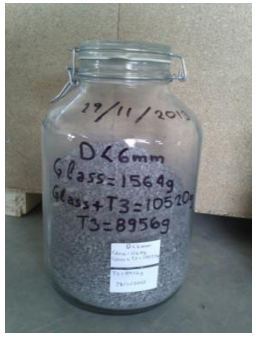


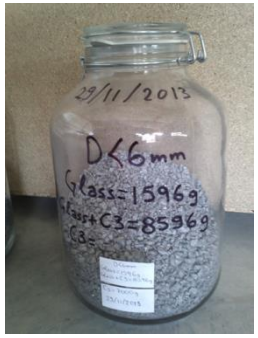


- Fully automated operation based on LabVIEW software

Experiments

- MH sample preparation
- MH sample activation under vacuum





- Temperature range: 10 – 80 ^{0}C
- Pressure range: 1 – 200 bar

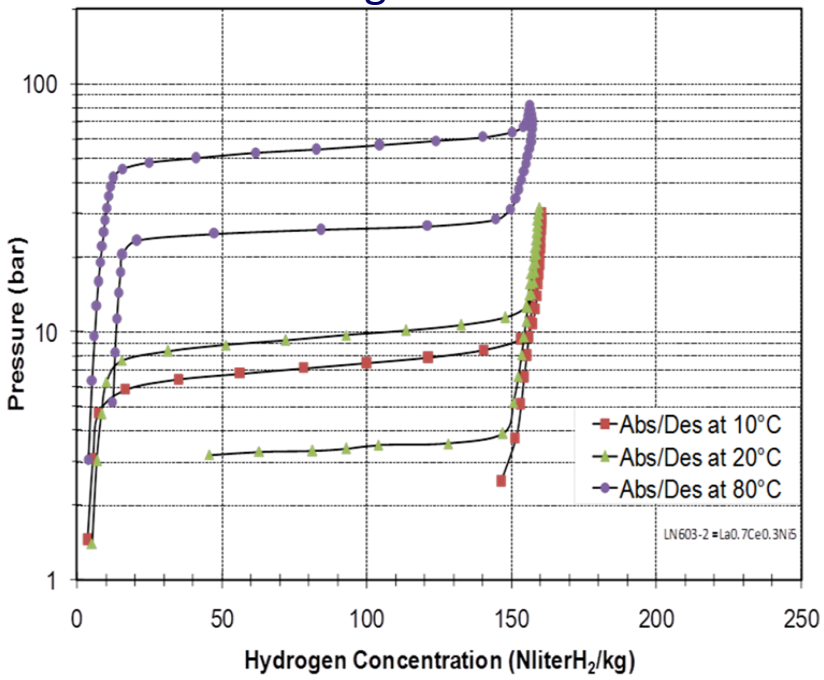
Experiments

- AB_5 and AB_2 type MH measured
- AB_5 → A: La, B: Ni
- AB_2 → A: Ti, Zr και B: Cr, Mn, Fe, V

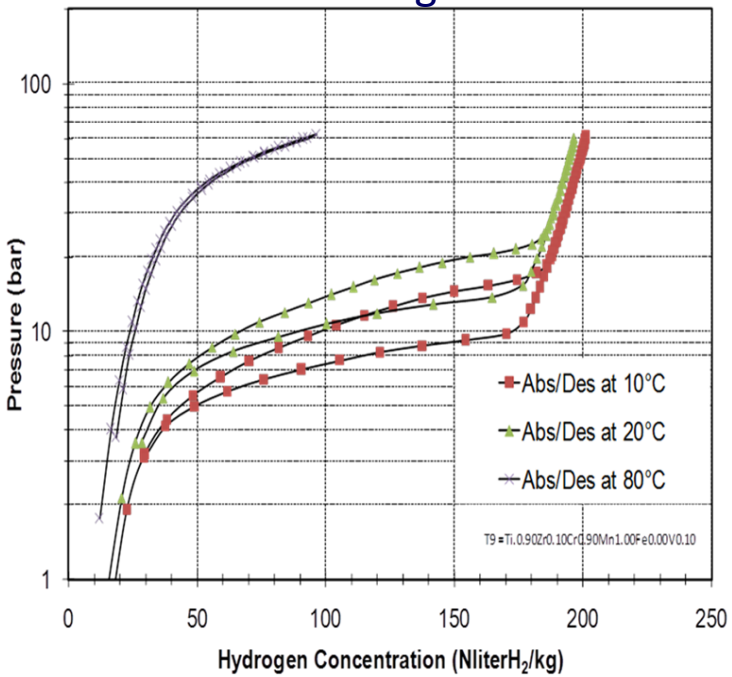
MHC's stage	Metal Hydride code name	Metal Hydride type
1	LN603-2	AB_5
2	T_9	AB_2
3	T_3	AB_2
4	T_{11}	AB_2
5	VF_{26}	AB_2
6	VF_{28}	AB_2

Results

1st Stage LN603-2



2nd Stage T9



H_2 absorption: 7 bar

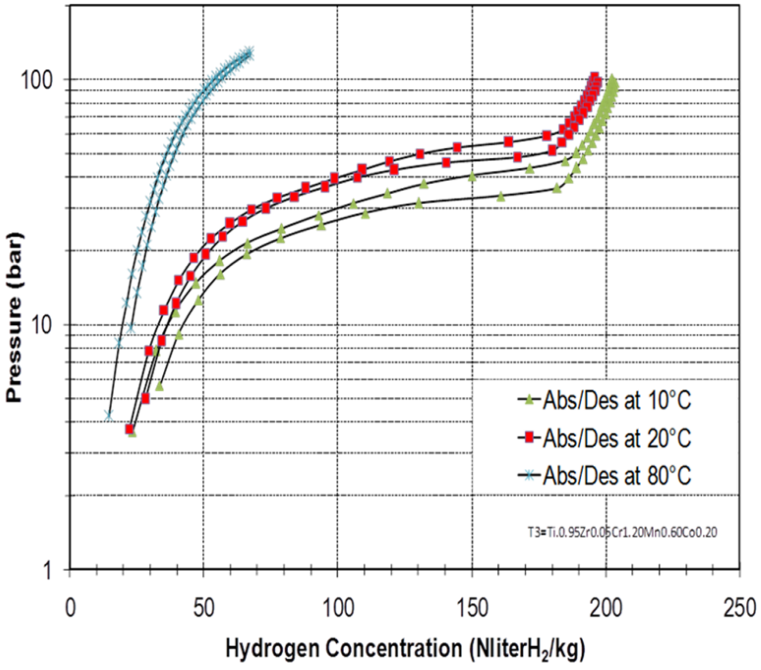
H_2 desorption: 10 bar

H_2 absorption: 6 - 7 bar

H_2 desorption: 18 - 20 bar

Results

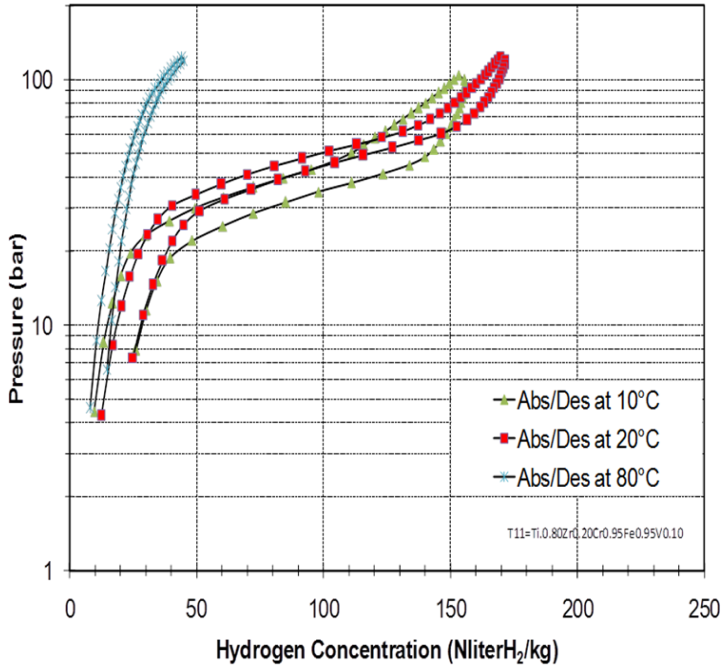
3rd Stage T3



H_2 absorption: <20 bar

H_2 desorption: 30 bar

4th Stage T11

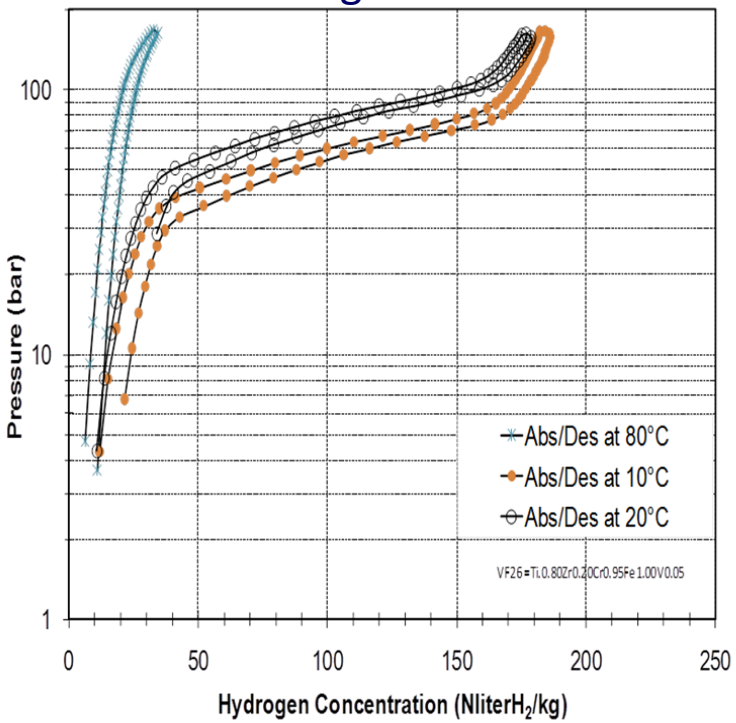


H_2 absorption: <30 bar

H_2 desorption: 50 - 60 bar

Results

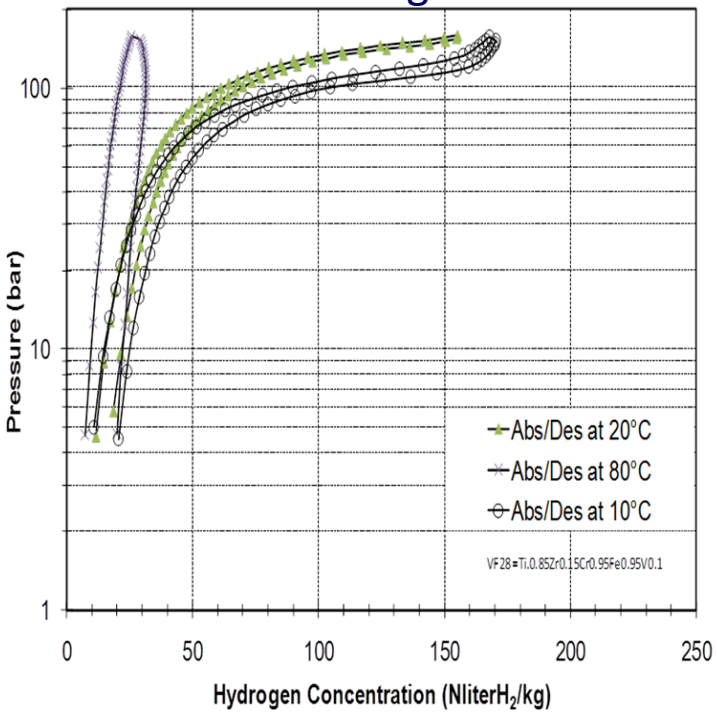
5th Stage VF26



H_2 absorption: <60 bar

H_2 desorption: 80 - 90 bar

6th Stage VF28

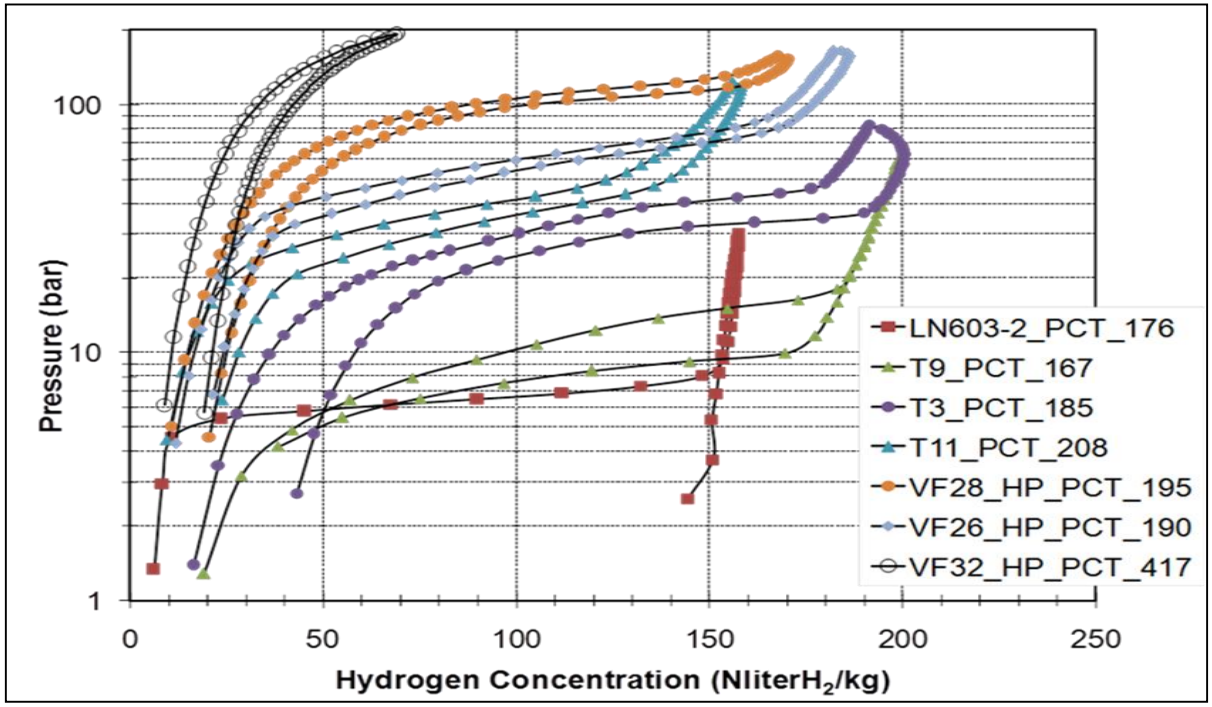


H_2 absorption: <90 bar

H_2 desorption: >120 bar

Results

- PCT Curves for every stage in 10 ^{0}C



- Metal Hydride based Compressor with no moving parts (P > 200 bar)

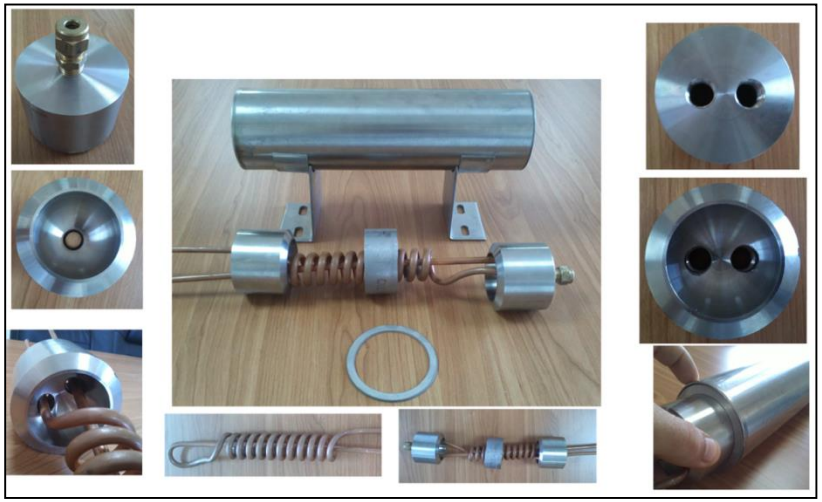
Results

MHC's construction based on Metal Hydride experimental results

- Integrates separate cold and hot water supply system
- Cooling temperature → 10 ^{0}C
- Hot water temperature → 80 ^{0}C

Results

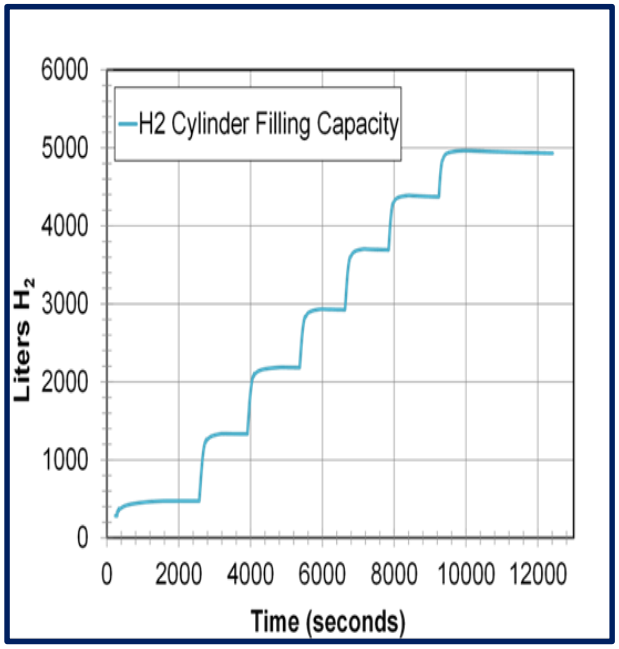
MHC's construction



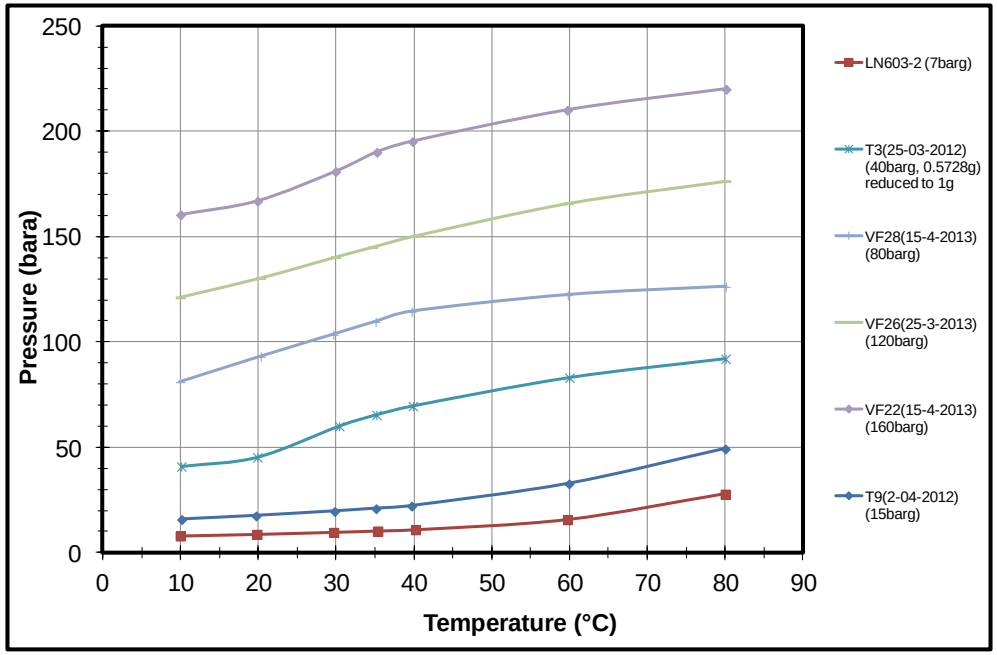
- Double tubes
- Metal hydrides are in direct contact with copper tubes

Results

MHC's operation



H_2 Cylinder Filling Capacity



MHC's P – T graph

“Advanced Metal Hydride Hydrogen Compressors – Pilot development and Market Penetration”

(ATLAS – MHC, FP7-PEOPLE-2013-IAPP/612292, 2014 - 2018)

http://www2.ipta.demokritos.gr/atlas-mhc/index.html

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