THOR - 826262

Online workshop on
Safe Storage of Compressed Gas Hydrogen
in road transport applications
and related infrastructure

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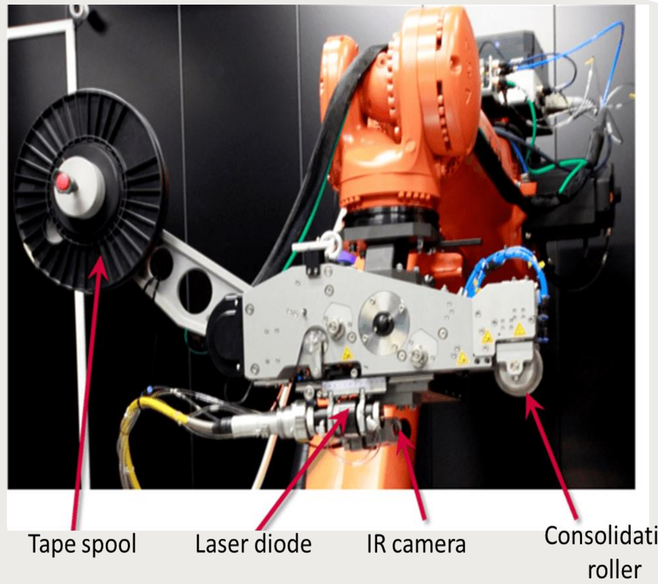
THOR, Thermo plastic H2 Optimized & Recyclable tank

Workshop on Safe Storage of Hydrogen

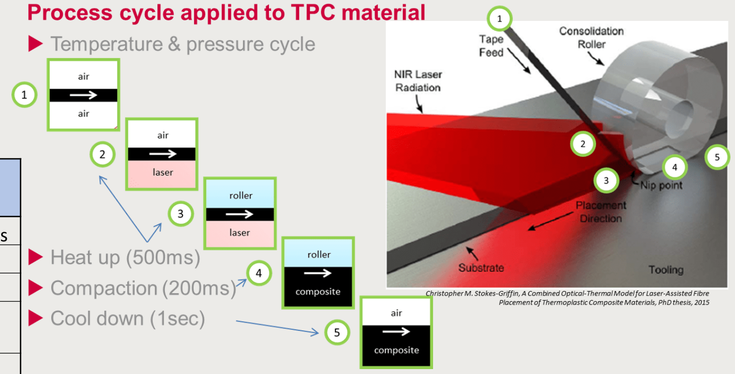
Project Brief

- Demonstrate a thermo plastic gaseous H2 high pressure tank (700 Bars WP)
  - Validate a Proof of Concept for a 700 Bar, 60 liters tank for mobility and transport
  - Definition, concept & process (CETIM) to manufacture thermoplastic tanks
    - Include safety aspect of the technology and a study for a leak before burst in fire or no object propelled in burst case
- Safety responsible person / institution
  - CSM Rina will make the tests (in Atex controlled area)
  - AL, Faurecia, take care of safety depending on usages
  - NTNU, CNRS will work on tests modeling to predict fire behavior of tanks
- Project issues specific for hydrogen storage
  - Temperature resistance for rapid gas filling
  - No H2 contamination coming from polymer & composite
  - Collapse free (fast defueling) / no blistering



Process cycle applied to TPC material

- Temperature & pressure cycle
- Heat up (500ms)
- Compaction (200ms)
- Cool down (1sec)



Christopher M. Stokes-Griffin, A Combined Optical-Thermal Model for Laser-Assisted Fibre Placement of Thermoplastic Composite Materials, PhD thesis, 2015

	Structure type	Location	Role in the project	Safety
Faurecia	GE	Bavans - Fr	Project coordinator. Tank design	Mobility usages
Air Liquide	GE	Paris - Fr	Transport & distribution of H2	Transport
Cetim	Tech Center	Nantes - Fr	Manufacturing of the technology	No
SIRRIS	Tech Center	Leuven - Be	Composite pattern design, modelling	Burst design
CSM Rina	Tests Center	Roma -It	Tests regarding R134 for the project	On tests
NTNU	Uni	Trondheim, No	Fire detection & behavior	Sensors
CRNS	Uni	Poitiers - Fr	Material characterisation	Fire resistance
Cetim Grand Est	Tech Center	Mulhouse - Fr	Recyclability	No

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Regulations, Codes and Standards applied

Tests type	Conditions	Regulation applied
Ambiant cycling test followed by a burts	45000 cycles, ambiant T°, 125% Working Pressure	EC79 or GTR13
Ambiant cycling test until failure followed by a burts	Ambiant T°, 125% Working pressure	EC79 or GTR13
Burst tests	Not below 2.25 WP (1575 Bar)	EC79 or GTR13
Accelerated Stress Rupture	125% working pressure at high temperature (80°C)	EC79 or GTR13
Extreme temperature cycling (-40°C to +85°C)	80% WP, temperature cycling + 20% of cycles @ 125% WP	EC79 or GTR13

Main tests for gas transportation :

- Burst pressure @ 2,36 x WP → 1652 bar
- Cycling 15 000 cycles @ 826 bar
- High temperature cycling (65°C) for 70 hours → no drop in burst pressure
- Impact test : 3 000 cycles @ 875 bar without burst + 15 000 cycling until leaking
- Extreme temperature cycling @ 85°C / 5 000 cycles + -40°C / 5000 cycles + burst test more than 1 380 bar
- BONFIRE test : leak but no burst

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Risk Assessments related to safety

WP No	Del No	Title	Comments
WP1	D15	Quality assurance and risk management plan	Related to the project consortium and product
WP2	D24	Process evaluation report	To identify the key process parameters which could affect the tank performances
WP3	D28	Validated numerical model of a wound thermoplastic dome	Correlation to be done regarding the modeling and the final tests (burst, ASR, bone fire, …)
WP3	D30	Numerical design of an optimized thermoplastic pressure vessel	To achieve at least the same level of safety than thermoset tanks
WP3	D31	Optimization of the design and assessment of the failure behaviour of the optimized thermoplastic pressure vessel	Leak before burst design to avoid having burst in case of fire
WP4	D34	First optimised tank prototype	For the validation of the product on a 60 liters water volume tank
WP5	D36	Fire resistance: Experimental report at sample scale	Tests means developped to characterize the fire resistance of a thermo plastic matrix
WP5	D38	Optical fibres as distributed sensors for fire measurements	Validation of temperature sensing with optical fiber device for on board storage systems
WP5	D39	Report on fire testing campaign, comparison with numerical predictions, and conclusions concerning optical fibre detection capacity	Bone fire test and modélisation of the fire resistance
WP5	D41	Report on hydrogen filling and emptying test, and accuracy of the gas temperature calculations	Modeling of the filling & emptying to insur that the tank will resist to extreme temperature, correlated with experimentations.

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Prevention and mitigation

- THOR project goal is to develop a new technology of compressed H2 vessels with a thermoplastic matrix
  - Performance and safety to be better than thermoset vessels (low standard deviation, better numerical prediction without chemical reaction to manage)
  - H2 Storage Systems will be built with TPRD & OTV (temperature & pressure)
  - For fire, a leak before burst design will be evaluated by simulation
  - Optical fibers for temperature measurement will also be evaluated
    - Goal to use it for the fire detection and release gas (to replace in the future the TPRD)

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Safety issues observed so far

- No safety issue met since begining of the project

FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

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