## Fuel cells and hydrogen Joint undertaking

## Programme Review Day 2011 Brussels, 22 November



http://www.fch-ju.eu/

# HyCOMP

Project name

## Enhanced Design Requirements and Testing Procedures for Composite Cylinders intended for the Safe Storage of Hydrogen

(Grant Agreement N° 256671)



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- HyComp is a Pre-Normative Research (PNR) project on composite storage tank
- Launched in January 2011
- Budget: 3 802 542 € of which 1 380 728 € (36 %) is funded by FCH JU
- Partnership:



**Project presentation** 





- Context:
  - Hydrogen storage is a key issue for the extensive use of H2 as an energy vector & success of the whole hydrogen value chain



• The most mature technology for storing hydrogen is in **compressed form** in high-pressure cylinders

High pressure storage of H<sub>2</sub> (700 bar) in <u>carbon fiber composite cylinders</u> => most advanced technology at this stage



### **Project presentation**

- Composite cylinders are already in use in application markets
  - Automotive onboard storage
  - Transport of compressed hydrogen
  - Stationary storage





- Key issues:
  - Current regulations do not allow one to exploit the full potential of CF materials
  - No scientifically established rationale for determining service lifetime
  - New and revised standards are in process, but the work is done based on traditional and conservative way of determine the performance of a cylinder

A change in Regulation, Codes and Standars will most likely not be possible without a better **understanding damage accumulation mechanism** & kinetics under typical loads in service (static and cyclic loads)

### **Project presentation**

#### • Principal objectives:

- To develop a better understanding of the damage accumulation processes in composite cylinders and the degradation rate as a function of the type of load and environmental conditions
- To **enhance design requirements** for composite cylinders for storage or transport of compressed hydrogen
- To improve the full set of requirements defined for **ensuring the structural integrity** of the cylinders throughout their service life (covering design type approval, manufacturing quality assurance, and in-service inspection)
- To **improve procedures** for type approval and batch testing
- Main outcome:
  - Documentation of the real performance of composite cylinder to support Authorities and Industry in making enhanced RCS





## **Project achievements**

- WP2: Damage accumulation in the composite: impact, rate & measurements, end-of service life criteria
  - To develop a better understanding of damage mechanisms in the carbon fiber composite wrapping <u>at a material scale</u>
  - To develop predictive models for calculating residual lifetimes
    - Two approaches are envisaged : a fractal approach and a finite element modeling (both are compared in D2.1)
- WP3: Fatigue failure of cylinders
  - To better understand failure modes <u>at the cylinder scale</u> under operational loads
  - Main failure modes of T3 and T4 reviewed in D3.1
  - Gaseous tests to be carried out at JRC-IE on T3 and T4 cylinders



The experimental work of WP2 and WP3 is in progress...



Unidirectional

samples and

cross-ply plates

#### WP4: Manufacturing quality assurance: effect of variability of fiber and matrix characteristics

• State of the art : Prioritization of the most influencing process parameters to be studied in HyComp

**Project achievements** 

- The test program has to be defined in order to evaluate the influence of these parameters
- WP5: Characterization of service life
  - Accidentology report on composite cylinders used for the storage of flammable gases
    - Only a few composite cylinders has failed in-service (mainly due to vehicle fire)
    - Composite cylinders designed according to current standards present a high level of safety



## **Project achievements**

- WP6: Design requirements and testing procedures
  - Review on existing requirements for cylinders and identification of gaps and improvements
    - ISO/DIS 15869 : Gaseous hydrogen and hydrogen blends Land vehicle fuel tanks
    - GTR WP29
    - ISO/CD 15399 : Gaseous Hydrogen Cylinders and tubes for stationary storage
- WP7: Findings and recommendations for industry and RCS
  - Work has begun on identifying RCS issues and studying gaps



## **Project achievements**

#### • WP1: Management

 A public website has been designed and is available for consultation at the following address: <u>http://hycomp.eu</u>



### Alignment to MAIP / AIP

Relevance and contribution to MAIP

- "Address design & test criteria for high pressure composite storage tanks" (MAIP)
- Hydrogen storage tanks are critical part of the supply chain for the 4 application areas

Transport & refuelling infrastructure Stationary power generation & combined heat and power

Hydrogen production & distribution

Early markets

• The reliability of H2 storage tanks is crucial for the development of H2 as an energy vector



#### Alignment to MAIP / AIP

Comments on priorities and topics of AIPs

- PNR on damage accumulation in composite cylinders for the storage of H2 is a way to improve their safety
  - PNR is critical to reach deployment targets
- More efforts are needed on:
  - Adequat in service inspection methods and procedures for composite cylinders in order to ensure a optimized fitness for service
  - Fire safety of pressure vessels in composite materials
  - Cylinder recycling
  - Carbon fibre



## **Cross-cutting issues**

#### Stakeholder involvement / Dissemination:

- Automotive advisory board
  - •Objectives:
    - Characterization of the service profiles and worst case conditions to be considered for the automotive application
    - Identification and characterization of proposals for change in RCS from the automotive industry
    - Harmonization of the work in progress in HyComp with proposals and views on the activity in HyComp seen from the automotive industry
  - 3 meetings during the project (1 meeting to be organized before the end of 2011), common meetings with the HyQ project

• A workshop in a conference will be organized to disseminate the project results so that they can be used by the international hydrogen and fuel cell community (industrial stakeholders and academics)

## **Cross-cutting issues**

#### **Regulations, Codes and Standards**

- HyComp will extract and prioritize recommendations to support RCS initiatives at the international level (cylinder tests & design criteria)
- These recommendations will include:
  - Fully performance-based design criteria (including safety factors), allowing to optimize design
  - Improved procedures for design type testing
  - A common rationale for composite cylinder manufacturing quality assurance
  - A common rationale and improved methods for in-service inspections and requalification
- Expected deliverables:
  - Report on recommendations for design and testing (D7.2)
  - Summary report on recommendations to support Regulations Codes and Standards initiatives (D7.3) to define how the project findings can be integrated into ongoing or new RCS activities



#### Enhancing cooperation

Collaborations

- Collaborations / Technology Transfer:
  - A common Automotive Advisory Board will be established with the **HyQ project** (many partners are involved in both projects)
  - Standards and regulation:
    - Most partners directly contribute to international standards (ISO) and regulation development
  - Expected collaborations with many other projects:
    - **Toledo** (2011-2013): a French funded project dedicated to accidental loads on composite cylinders
    - H2E (2009-2017) : a French funded project dedicated to early markets
    - StorHy (finalized in 2008)
    - InGas (2011/2012)
    - **HyCube** (2014)



#### Enhancing cooperation

**Project future perspectives** 

- Perspectives:
  - Short term:
    - To complete the experimental test program
    - To develop a relevant model predicting residual lifetimes, based on damage accumulation in the composite for a given load
  - Long term:
    - To implement the project findings in international standards
    - To reduce the safety factor while ensuring cylinder structural integrity and safety





## Thank you for your attention Any questions ?

http://hycomp.eu

