ECOHYDRO

ECONOMIC MANUFACTURING PROCESS OF RECYCLABLE COMPOSITE MATERIALS FOR DURABLE HYDROGEN STORAGE

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Coordinator Beneficiary	INSTITUT MINES-TELECOM, FR
Beneficiaries	HAESAERTS FOR HYDROGEN, ELECTRA COMMERCIAL VEHICLES LIMITED, BASALTEX NV, FEV TR OTOMOTIV VE ENERJI ARASTIRMAVE MUHENDISLIK LIMITED SIRKETI, LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY, MAHYTEC SARL, PROMAT RESEARCH AND TECHNOLOGY CENTRE, TEMSA SKODA SABANCI ULASIM ARACLARI ANONIM SIRKETI, M.D.P. MATERIALS DESIGN AND PROCESSING SRL, CENTRE TECHNOLOGIQUE NOUVELLE-AQUITAINE COMPOSITES and MATERIAUX AVANCES, ARKEMA FRANCE SA, POLITECHNIKA WROCLAWSKA, AIRBUS, KATHOLIEKE UNIVERSITEIT LEUVEN

https://ecohydro-project.eu/

PROJECT AND GENERAL OBJECTIVES

ECOHYDRO's global objective is to ensure an economic process for manufacturing recyclable composite materials for durable hydrogen tanks through the usage of high-strength carbon fibre, low-viscosity thermoplastic liquid resin and instant in-situ photopolymerisation for composite pressure vessels.

ECOHYDRO has six ambitious general objectives:

- Identify and develop multi-functional sustainable materials enabling a circular design and reducing the whole life cost of hydrogen storage solutions.
- Develop standardised inspection and repair methods that improve safety aspects of hydrogen storage and increase the lifetime of hydrogen storage solutions.
- Develop smart solutions that allow for cross-application uses of hydrogen storage to reduce the total number of storage tanks produced.
- Demonstrate increased storage size and reduced capital cost for aboveground storage of hydrogen.
- Demonstrate increased tube trailer payload, reduced capital cost and increased operating pressure for road transport of hydrogen.
- Demonstrate increased gravimetric capacity, conformability, reduced capital costs and increased tank gravimetric efficiency for onboard storage of hydrogen in heavy-duty truck and aviation applications.

NON-QUANTITATIVE OBJECTIVES

- Increase of public acceptance of hydrogen technologies by improving the safety aspects of hydrogen storage in tanks.
- Improvement of public perception of composite material solutions by developing new recycling technologies.

PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

Testing of various initiators for polymerising acrylic resin through photopolymerisation, thermal polymerisation, and dual polymerisation.

- Modification of acrylic resin with phosphorus comonomers for fire resistance.
- addition of special fillers to enhance thermal insulation while optimising the balance with resin viscosity.
- Creation of self-healing acrylic resin to repair cracks at the fiber/matrix interface.
- Impregnation of different fiber rovings with acrylic resin.
- Optimisation of winding parameters.
- Analysis of microstructures and mechanical properties of the composites, revealing good properties for carbon fiber composites but lower for basalt fiber due to defects.
- Numerical modelling for the filament winding process as well as simulations for resin flow and fiber deformation.
- Finalisation of preliminary designs for four hydrogen storage demonstrators, focusing on various storage types.
- Start with thermal and mechanical modelling for the aviation demonstrator, along with multi-scale damage modelling and the development of a digital twin for monitoring hydrogen tank lifecycle.
- Initial work on hybrid and physico-chemical recycling and development of a life cycle analysis model.

FUTURE STEPS AND PLANS

- Mechanical and thermal characterisation (including cryogenic tests, hydrogen permeation, etc.) of newly developed functional materials.
- Optimisation of manufacturing process in terms of process defects and energy consumption.

- Modelling of manufacturing process and damage analysis.
- Process monitoring and structural health monitoring by sensor integration and data analysis by an artificial intelligence algorithm.
- Optimisation of recycling process and life cycle analysis of the new materials and manufacturing process.
- Improvement of the preliminary design of demonstrators.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?	SoA result achieved to date (by others)	Year for reported SoA result
Project's own objectives	Storage size (Above ground storage)	tonnes	20	5		1.1	2020
	Cost reduced (Above ground storage)	€/kg	600	700		750	2020
	Trailer payload (Road transport of hydrogen (Gaseous H_2))	kg	1 500	700		850	2020
	Trailer capital cost (Road transport of hydrogen (Gaseous H_2))	€/kg	350	450		650	2020
	Operating pressure (Road transport of hydrogen (Gaseous H_2))	bar	700	500		300	2020
	Storage tank capital cost (Onboard storage of hydrogen in heavy duty truck applications (Gaseous H_2))	€/kg H_2	300	500		600	2020
	Increase in gravimetric capacity (Onboard storage of hydrogen in heavy duty truck applications (Gaseous H_2))	%	7	6.5		6	2020
	Tank gravimetric efficiency (Onboard storage of hydrogen for aviation applications (LH_2))	% weight	35	15		12	2020
	Increase of the number of safe cycles before replacement (Safety and lifetime of hydrogen storage)	Number of cycles	7 500	5 000		5 000	2020
	Life cost reduction (Life cost of hydrogen storage solutions)	%	50	50		N/A	2020

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