UNLOHCKED

UNLOCKING THE POTENTIAL OF LOHCS THROUGH THE DEVELOPMENT OF KEY SUSTAINABLE AND EFFICIENT SYSTEMS FOR DEHYDROGENATION

Project ID	101111964
PRR 2024	Pillar 2 – H_2 storage and distribution
Call topic	HORIZON-JTI-CLEANH2-2022-02-05: Efficient system for dehydrogenation of liquid organic hydrogen carriers for application to long distance transportations
Project total cost	EUR 2 941 312.75
Clean H_2 JU max. contribution	EUR 2 941 312.75
Project period	1.6.2023–31.5.2026
Coordinator	Universidad del País Vasco / Euskal Herriko Unibertsitatea, Spain
Beneficiaries	Centre national de la recherche scientifique, Commissariat à l'Énergie Atomique et aux Énergies Alternatives, Framatome GmbH, Heraeus Deutschland GmbH & Co. KG, HyGear BV, HyGear Fuel Cell Systems BV, HyGear Hydrogen Plant BV, HyGear Operations BV, HyGear Technology And Services BV, Noordwes-Universiteit

https://unlohcked.cnrs.fr/

PROJECT AND GENERAL OBJECTIVES

By advancing breakthrough research on liquid organic hydrogen carrier (LOHC) technologies, Unlohcked aims to develop a radically disruptive, versatile and scalable LOHC dehydrogenation plant. Firstly, highly active and stable catalysts not containing critical raw materials (CRMs) will be developed to reduce LOHC dehydrogenation at moderate temperatures. Secondly, a solid oxide fuel cell system will be developed to be thermally integrated in the dehydrogenation process. The heat demand of the dehydrogenation unit will be fully covered by the fuel cell, while generating electric power. The surplus of hydrogen will be exported. These innovative systems, when fully integrated, will significantly increase the overall efficiency (> 50 %) of hydrogen and electric power production from LOHCs.

The main objectives of this project are:

- to develop a CRM-free or low-CRM catalyst with a high conversion rate, selectivity and productivity for dehydrogenation;
- to scale up one of the catalysts developed, from a gram at laboratory scale to multiple kilograms for the demonstration unit;
- to develop a breakthrough integrated system in which the reactor is thermally coupled to a solid oxide fuel cell, simplifying the dehydrogenation plant and improving its thermal efficiency;
- to demonstrate the feasibility of producing H_2 and generating renewable electricity from LOHC-stored hydrogen by heat integration between endothermic hydrogen release and exothermic fuel cell operation.

NON-QUANTITATIVE OBJECTIVES

- To reduce capital expenditure (i.e. owing to the use of less expensive materials, no chemical reagents and no cleaning cycles, and the extended lifetime of materials) and operational expenditure (i.e. owing to a continuous mode of operation and optimised process controls).
- To decrease the cost of transporting H_2, including by demonstrating the feasibility and cost-effectiveness of using LOHC technologies to transport H_2 from on-shore tanks to on-shore tanks all-inclusive.
- To develop a scale-up plan through techno-economic analysis in order to improve techno-economic viability, to include, in particular, comparisons with alternative H_2 technologies for long-distance transport.
- To put the EU at the forefront of H_2 technologies, to ensure a competitive and commercial advantage in Europe to incentivise future investments.
- To reduce the environmental impact of H_2 technologies, by reducing the use and release of toxic substances and CRMs with a huge environmental impact.
- To contribute to the European Green Deal goals through developing a fully CO_2-free dehydrogenation system.

PROGRESS AND MAIN ACHIEVEMENTS

After the first year of the project, we are in the middle of developing CRM-free and low-CRM catalysts; so far, we have created catalysts with conversion rates, selectivity and productivities close to those of the SOA catalysts.

FUTURE STEPS AND PLANS

- Continue developing catalysts at a laboratory scale to improve their conversion, selectivity and productivity, but mainly their stability, in order to reach the project's targets.
- Start designing the reactor to be integrated in the dehydrogenation unit.

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	KPI 1: grade of conversion of CRM-free or low-CRM catalysts	%	95	86		85	2022
	KPI 2: catalyst selectivity	%	> 99.8	98.8		82	2022
	KPI 3: catalyst productivity in dehydrogenation	$gH_2/gcat/min$	> 0.02	8		0.0212	2022

Clean Hydrogen Partnership
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