

HYPRAEL

ADVANCED ALKALINE ELECTROLYSIS
TECHNOLOGY FOR PRESSURISED H₂
PRODUCTION WITH POTENTIAL FOR NEAR-
ZERO ENERGY LOSS



Project ID	101101452
PRR 2025	Pillar 1 - H ₂ Production
Call Topic	HORIZON-JTI- CLEANH ₂ -2022-01-03
Project Total Costs	3 134 235.00
Clean H ₂ JU Max. Contribution	2 653 915.00
Project Period	01-03-2023 - 28-02-2026
Coordinator Beneficiary	FUNDACION PARA EL DESARROLLO DE LAS NUEVAS TECNOLOGIAS DEL HIDROGENO EN ARAGON, ES
Beneficiaries	RHODIA OPERATIONS, SPECIALTY OPERATIONS FRANCE, VECO BV, GREEN HYDROGEN SYSTEMS A/S, Rhodia Laboratoire du Futur, AGFA GEVAERT NV, SOLVAY SPECIALTY POLYMERS ITALY SPA, FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV

<http://hyprael.eu/>

PROJECT AND GENERAL OBJECTIVES

HYPRAEL's goal is to develop and validate the next generation of alkaline electrolysis (AEL) for highly pressurised H₂ production (at least 80 bar). In addition, an immense increase in energy efficiency will be made possible by raising the temperature to at least 120 °C. HYPRAEL will achieve these goals and move beyond the state-of-the-art by performing research covering areas from design and advanced assessment of electrocatalysts and polymers to the engineering and process intensification of an innovative cell design in four phases: (i) materials development for pressurised electrolysis with an elevated temperature; (ii) material screening for applicability in pressurised electrolyzers (both phases will be performed at lab scale and in a single cell with an area of 10 cm², 1-30 bar, 80-120 °C; (iii) scale up of the most promising materials from phase 1 and 2; and (iv) scale up of developed materials and their integration into an advanced stack.

The validation of the components scaled up in phase 3 will be performed in the existing test bench of FHa designed in the frame of the Grid integrated multi megawatt high pressure alkaline electrolyzers for energy applications project (Elyntegration) at 60 bar, 120 °C, 6-15 kW (pilot scale), whereas the demonstration at the target pressure of above 80 bar, at a minimum temperature of 120 °C and in a cell stack of at least 50 kW capacity will be developed by

Green Hydrogen Systems in a new test bench. In addition, the HYPRAEL concept will focus on developing an energy efficient high-pressure electrolyser while addressing the circularity principle of the EU objectives for a carbon neutral economy.

NON-QUANTITATIVE OBJECTIVES

- Contributing to climate neutrality by producing green hydrogen with zero CO₂ emissions and utilising renewable energy, thereby supporting climate change mitigation.
- Advancing industry, innovation, and infrastructure by fostering technological advancements in electrolysis and promoting the development of a sustainable hydrogen infrastructure.
- Enhancing access to affordable and clean energy by providing a renewable energy source and reducing operating costs through high-pressure hydrogen production, eliminating the need for additional compression.
- Promoting responsible consumption and production by optimising resource utilisation, improving efficiency, and minimising environmental impact.
- Strengthening international cooperation by encouraging global partnerships for the development and deployment of green hydrogen technology.



PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

- Development and testing of long-term stable substrates and Raney Ni-based catalysts for hydrogen and oxygen evolution in high-temperature, pressurised electrolysis.
- Focus on achieving stability in 120°C, 40 wt.% KOH.
- Design of a new test infrastructure to accommodate these extreme conditions, as durability data for materials and sensors under such conditions is limited.
- Insight achieved into the behaviour of the Ni-based catalyst layers on Ni substrates concerning temperature, coating thickness, and substrate form factors through uniform testing.
- Adaption of the IFAM's 3EA test infrastructure in Dresden to measure at temperatures above 100°C, preventing electrolyte contamination from Si or Fe.
- Observation of a slight degradation, which can be attributed to the highly concentrated KOH solution (40 wt%). Even at 80°C, the higher concentration has a negative impact. It is worth mentioning that the catalyst system can be used as a bifunctional system for hydrogen evolution reaction and oxygen evolution reactions.

- Successful coating of AGFA separators using atmospheric plasma spraying, to improve durability under high-temperature, high-pressure electrolysis. The current separators used in state-of-the-art alkaline electrolyzers are not designed for increased temperature and pressure. The optimisation strategies focused on pore structure, hydrophilicity enhancement and the thermal stability. Polymers of different families with enhanced stability have been screened for the required temperature and KOH concentration.
- Optimisation of Zirfon membrane through a method developed to reduce gas cross-over caused by higher pressure.
- Upgrade of FHA's pilot-scale test bench, with component and control logic selected to meet high-pressure, high-temperature demands.

FUTURE STEPS AND PLANS

- Development of materials for pressurised electrolysis at elevated temperature.
- Screening of materials for applicability in pressurised electrolyzers.
- Scale up of developed materials and integration into an advanced stack.
- Validation at relevant environment and scale.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Target achieved?
Project's own objectives	Temperature	°C	120	
	LCOH	€/kg	≤3	
	Pressure	bar	80	
	Energy efficiency	%	improvement 2-4%LHV	
	Long-term stable and highly active materials improving stack durability for harsh environment conditions	%/1 000h	Stack degradation meeting the target of maximum 0.1 %/1 000 h efficiency loss at 1 A/cm².	