AEMELIA

ANIONIC EXCHANGE MEMBRANE WATER ELECTROLYSIS FOR HIGHLY EFFICIENCY SUSTAINABLE, AND CLEAN HYDROGEN PRODUCTION

Project ID	101137912
PRR 2025	Pillar 1 - H_2 Production
Call Topic	HORIZON-JTI-CLEANH$_2$-2023-01-01
Project Total Costs	2 764 927.00
Clean H_2 JU Max. Contribution	2 764 926.75
Project Period	01-01-2024 - 28-02-2027
Coordinator Beneficiary	COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, FR
Beneficiaries	SPECIALTY OPERATIONS FRANCE, MATGENIX, CLAIND SRL, SINTEF AS, Rhodia Laboratoire du Futur, FUNDACION TECNALIA RESEARCH and INNOVATION, SOLVAY SPECIALTY POLYMERS ITALY SPA, CONSIGLIO NAZIONALE DELLE RICERCHE, IMPERIAL COLLEGE OF SCIENCE TECHNOLOGY AND MEDICINE, CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS

https://aemelia.eu/

PROJECT AND GENERAL OBJECTIVES

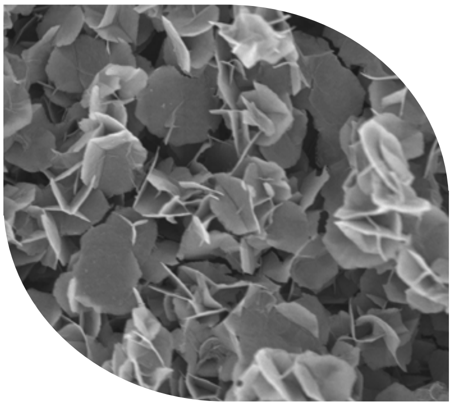
AEMELIA accepts the challenge to design and prototype an anion-exchange membrane electrolysis (AEMEL) method that meets and surpasses Hydrogen Europe's 2030 targets for performance, durability, safety and cost. For example, AEMELIA targets:

- A current-density of 1.5 A cm-2 at low voltage (1.72 V).
- An energy-efficiency of 46.2 kWh/kg or 86% of maximum theoretical efficiency, to increase H_2 production while decreasing energy consumption, compared with CLAIND's actual product ((1.76 V (47.1 kWh/kg) at 0.5 A/cm^2 in 0.2 M KOH at 42°C and 10 bar).
- A levelised cost of hydrogen of 2.5 €/kg H_2 (17% lower than the 2030 target).
- A degradation rate enabling a 10-year lifetime.
- A capital expenditure which is expected to reach 2030 targets by upscaling.

NON-QUANTITATIVE OBJECTIVES

AEMELIA intends to bring new technology for anion-exchange membrane WE based on the following:

- An innovative route for electrode preparations without ionomer.
- Implementation of recombination catalyst and electrodes without any platinum group metals in the stack.
- Increased cell efficiency through use of pulsed supply current due to small time periods for oxygen bubble release.
- Design of optimal membrane backbone and side chain to sustain high hydroxide conductive, despite high operating temperature (t> 60°C), through a machine learning approach.
- Machine learning investigation of low environmental impact solvent use to dissolve polymer for preparing ionomer dispersion solution.



PROGRESS, MAIN ACHIEVEMENTS AND RESULTS

- Development of a data-driven methodology to support membrane optimisation using deep learning.
- Analysis of SYSENQO's Beion membrane showing high hydroxide conductivity (236 mS/cm at 50 °C), but its use is limited due to fluorination.
- Investigation of Ni_2P as the first non-PGM recombination catalyst, targeting promising activity for oxygen reduction reaction (ORR) and hydrogen evolution reaction (HER).
- Development of ionomer-free electrodes, using NiMo and NiFeB coatings with thermal treatments showing enhanced activity.
- Investigation of $NiMoS_x$ catalysts for HER, targeting overpotential reduction.
- Preliminary cell testing highlighting temperature-dependent performance differences among membranes, with Fumatech and Piperlon excelling under different conditions.
- Optimised stack design through computational fluid dynamics.
- Development of an environmental assessment method.

FUTURE STEPS AND PLANS

Ionomer-free electrodes:

- Adhesion improvement of physical vapor deposition (PVD) based anode.
- Testing of PVD based cathode and electrodeposited anode at single cell level.
- Testing of electrode prepared with chemically activated porous transport layer (PTL) fibers at single cell level.
- Establishing cell performance and ageing tests.

Classical route of electrodes preparation avoiding fluorinated ionomer, such as Nafion:

- Testing of molybdenum sulfide-based cathode catalyst with an alternative to Nafion.
- Thermal treatment of NiFeO allowing electron conductivity enhancement of the OER catalyst.

The development on polymers should allow to down select a fluorine-free polymer able to sustain high hydroxide conductivity at 80°C. This polymer should be soluble in eco-friendly solvent. To find out this compound, the machine learning already in use needs to be fed with more data, that may come from the literature.

Beside the stack design and the importance of the position of the manifold, the flow design's influence will be investigated. A final design of the full stack will be fixed by the end of 2025, in order to start the manufacturing.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Achieved to date by the project	Target achieved?
Project's own objectives	Safe and sustainable: Fluorine-free ionomers and membranes prepared with green and safe solvents via a cost-effective process.	-	No fluorine polymer and safe solvent for the ionomer dissolution.		
	Development and testing of CRM-free electrodes and PGM-free RC for AEMEL cells and stacks.	g/kW	0	0 mg/cm² on the electrodes, 0 mg/cm² for the recombination catalyst (need more additional development)	
	High performance, long lifetime, and safe components, and stack.	% @ 1.5 A/cm²	84.5	67% @ 1.2 A/cm²	
	TEA shows low-cost hydrogen towards.	€/kg	3	-	
	To ensure market entry by 2031 and ~750MW capacity by 2036 (Number of companies willing to test AEMELIA development).	Number	6	-	

Clean Hydrogen Partnership
Co-funded by the European Union