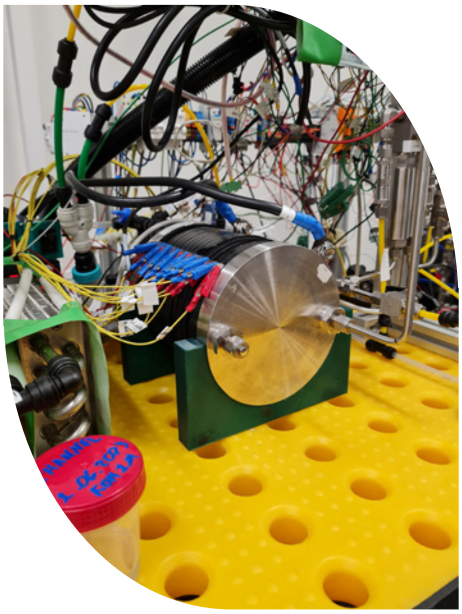
CHANNEL

DEVELOPMENT OF THE MOST COST-EFFICIENT HYDROGEN PRODUCTION UNIT BASED ON ANION EXCHANGE MEMBRANE ELECTROLYSIS

Project ID	875088
PRR 2024	Pillar 1 – Renewable hydrogen production
Call topic	FCH-02-4-2019: New anion exchange membrane electrolysers
Project total costs	EUR 1 999 906.25
Clean H_2 JU max. contribution	EUR 1 999 906.25
Project period	1.1.2020–30.6.2023
Coordinator	SINTEF AS, Norway
Beneficiaries	Enapter SRL, Evonik Creavis GmbH, Evonik Operations GmbH, Forschungszentrum Jülich GmbH, Norges teknisk-naturvitenskapelige universitet, Shell Global Solutions International BV

https://www.sintef.no/projectweb/channel-fch/



PROJECT AND GENERAL OBJECTIVES

The EU-funded project Channel aimed to develop a cost-efficient 2 kW water electrolyser stack based on the emerging anion-exchange membrane electrolysis (AEMEL) technology for producing high-quality, low-cost green hydrogen from renewable energy sources. This project's aim included the development of stack components ranging from the non-platinum-group-metal-based electrocatalysts to the balance of plant. The Channel project had as its objectives the (i) optimisation and utilisation of advanced anion-exchange membranes (AEMs) and ionomers, (ii) development of cost-efficient and stable catalysts for high-performance electrodes, (iii) development of system models to help guide the stack design and integration of components into the stack and to aid the design of the balance of plant and (iv) market analysis and cost and performance assessment based on the experimental results of the Channel 2 kW stack prototype.

NON-QUANTITATIVE OBJECTIVES

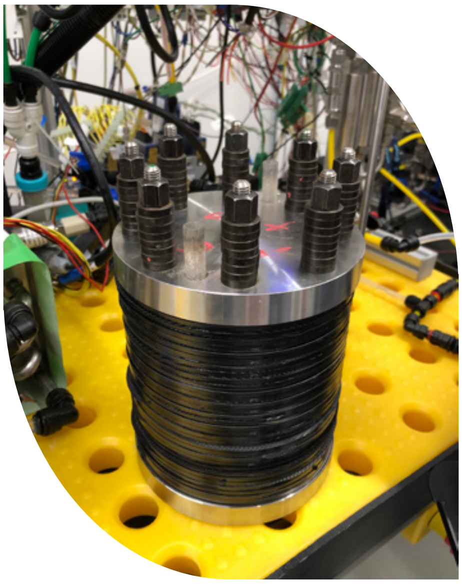
- Promotion of the AEMEL technology by organising technical workshops and contributing to science and technology through publications and participations in conferences.
- Establishment of the AEM-Hub – Reshaping Green Hydrogen Production, together with Newely and Anione.
- Release of the transient AEM model code on the public platform Github.

PROGRESS AND MAIN ACHIEVEMENTS

- Channel successfully developed alternative low-cost non-platinum-group-metal catalysts for hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) using simple and scalable synthesis methods. The electrocatalysts were synthesised by combining materials such as nickel, iron and molybdenum in an optimal composition and structure so that they exhibited comparable performance and stability to those of the precious metals, demonstrating that switching to non-precious-metal electrodes is a promising route for AEMEL.
- The Ni-based HER catalyst achieves Channel's performance and stability targets at less than 1 M KOH (– 10 mA/cm^2 at < 100 mV overpotential in 0.5 M KOH) with excellent batch-to-batch reproducibility. The catalyst showed an outstanding 1000 hours of stability in chronoamperometry measurements and displayed only 26 μV/h in chronopotentiometry mode. The Ni-based OER catalyst also achieved Channel's performance and stability targets at less than 1 M KOH (10 mA/cm^2 at < 300 mV overpotential). The catalyst presented excellent stability in chronoamperometry measurement for more than 500 hours.
- A joint test protocol for single-cell electrolysis measurements was developed. Single-cell testing performed in different set-ups showed significant differences due to differing hardware. The optimised membranes and electrodes reached the single-cell performance target of 1 A/cm^2 at 1.85 V. A long-term test of more than 1 000 hours at 1 A/cm^2 showed good stability of all components.
- Contribution to the AEM test protocol harmonisation workshop alongside NEWELY and ANIONE.

Clean Hydrogen Partnership
Co-funded by the European Union

CHANNEL



FUTURE STEPS AND PLANS

The project has finished, with further opportunities having been identified.

- Although Channel achieved optimised electrodes and membranes that reached the performance target of 1 A/cm^2 at 1.85 V (single-cell tests) with good stability of all components in a long-term test of more than 1 000 hours at 1 A/cm^2, a lot of effort is needed to translate the idealised testing system at the lab scale into real stack operation. The lower-than-expected stack performance achieved evidenced that more time is required to transfer and optimise the integration of lab-scale developments for the industrial level. However, this does not mean that stack performance is not achievable. The projected cost analysis showed that capital expenditure of < EUR 600/kW at a 500 kW system scale is possible based on the Channel AEMEL stack technology. When all the technical targets are met and desirable stack performance is achieved, partners will exploit the technology and create new market opportunities, both inside and outside Europe, which will create new job opportunities.
- In addition, a computational model of AEMEL was developed, which was used to simulate the cell performance and lifetime under varying operational scenarios. The model achieved a reasonably good fit to the experimental data, particularly within the large ohmic region above about 0.5 A/cm^2. Efforts are still needed to improve the performance of the model in the kinetic region by refining the electrochemical kinetic submodel used in the catalyst layer.

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	OER catalyst stability	mV	< 25 mV degradation over 1 000 hours in RDE	33	⚙	N/A	N/A
	Single-cell performance (at 1 A/cm^2)	V	1.85	1.85	✓	1.85	2023
	OER catalyst performance	mV	< 300 mV (at 10 mA/cm^2) in 1 M KOH	237 mV (1 M KOH) 270 mV (0.1 M KOH)	✓	Ir-based catalyst (250 mV at 10 mA/cm^2)	2023
	HER catalyst performance	mV	< 150 mV (at 10 mA/cm^2) in < 1 M KOH	60 mV in 1 M KOH, 120 mV in 0.1 M KOH at 10 mA/cm^2	✓	Pt-based catalyst (30 mV at − 10 mA/cm^2) in 1 M KOH	2023
	HER catalyst stability	mV	< 25 mV degradation over 1 000 hours in RDE	26 mV/1000 h, 3 μA/h at − 0.2 V (RHE)	⚙	N/A	N/A
AWP 2019	Membrane OH^- conductivity (RT and 60 °C)	mS/cm	RT: > 50 60 °C: > 90	RT: > 50 60 °C: 95–105	✓	~ 120 (50-micron membrane from Sustainion) 40–45 mS/cm FAA-3 (Fumatech)	2023
	Ionomer OH conductivity (60 °C)	mS/cm	Not specified	> 60	✓	N/A	N/A