D2.3: Delivery of SEUs for evaluation in WP4

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Executive summary

A patenting action on the design of the single engineering unit (SEU) in GAMER is currently in progress. At mid-term of the GAMER project, a few SEUs have been supplied to the consortium for testing. Related information on these SEUs are available in a confidential report.

Contents

1 The GAMER project

The GAMER project aims at developing a novel cost-effective tubular Proton Ceramic Electrolyser (PCE) stack technology integrated in a steam electrolyser system to produce pure dry pressurized hydrogen. The electrolyser system will be thermally coupled to renewable or waste heat sources in industrial plants to achieve higher AC electric efficiency and efficient heat valorisation by the integrated processes. The project aims at establishing a high volume production of novel tubular proton conducting ceramic cells. The cells will be qualified for pressurized steam electrolysis operation at intermediate temperature (500-700°C). They will be bundled in innovative single engineering units (SEU) encased in tubular steel shells, a modular technology, amenable to various industrial scales. GAMER focuses on designing both system and balance of plant components with the support of advanced modelling and simulation work, flowsheets of integrated processes, combined with robust engineering routes for demonstrating efficient thermal and electrical integration in a 10kW electrolyser system delivering pure hydrogen at minimum 30 bars outlet pressure.

Partners of GAMER are:

Partner (short name)	***Country***
SINTEF (SINTEF)	*Norway*
Coorstek Membrane Science AS (CMS)	*Norway*
CSIC, Instituto de Tecnología Química (CSIC)	*Spain*
Carbon Recycling International (CRI)	*Iceland*
University of Oslo (UiO)	*Norway*
MC2 Ingenieria y Sistemas SL (MC2)	*Spain*
Shell Global Solutions International B.V. (SGSI)	*The Netherlands*

The consortium covers the full value chain of the hydrogen economy, from cell and SEU manufacturer (CMS), system integrators (MC2, CRI), through researchers (SINTEF, UiO, CSIC), to end users in refineries, oil and gas, chemical industry (CRI, SGSI, with advisory board members YARA and Air Liquide). All along the project, these experienced partners will pay particular attention to risk management (technical, economic, logistic, business) and ensure progress of the technology from TRL3 to TRL5. The overall consortium will perform strategic communication with relevant stakeholders in order to ensure strong exploitation of the project's results.

2 The novel tubular SEU

In the GAMER project, we focus on the demonstration of an innovative, low cost and modular hydrogen production technology utilising *tubular proton conducting ceramic cells* and their inherent advantages for steam electrolysis:

- *Scalability and modularity* of the electrolyser system: the electrolyser is designed for scale (small, medium, large);
- *Reduced operation and maintenance costs* compared to planar stack towers: possible to "isolate" one or several SEUs from the system without shutting it done completely; possibility to change some SEUs;
- *Reduced risks* in case of leakage due to low volume of SEU;
- *Lower operating temperature* (600°C) than SOE reducing degradation associated to cation diffusion, and enabling use of lower cost steel for pressure vessel;
- *Production of pure dry hydrogen* at the anode side, preventing risk of oxidation encountered in SOE (see figure 2);
- *Increased safety*: In PCE, any increase in pH_2O increases the pH_2. In contrast, the SOE must have a high pO_2 alone at one electrode to balance the pH_2O+pH_2 at the opposite electrode. Pure hot high pressure O_2 is risky;
- *Increased robustness of tubular cells*, in particular, when exposed to pressure differentials compared to planar cells;
- *Reduced sealing area* compared to planar cells.

This novel design concept has also challenges, which are addressed in GAMER:

☝ Current collection is challenging compared to planar technology. This is alleviated in GAMER by the use of lower current density cells.

☝ Lower current density of the cells compared to SOE. This is compensated in GAMER by increased surface area and lower cost of PCE cells.

A patenting action on the design of the single engineering unit (SEU) in GAMER is currently in progress. At mid-term of the GAMER project, a few SEUs have been supplied to the consortium for testing. Related information on these SEUs are available in a confidential report.

3 Acknowledgements

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