REACTT

RELIABLE ADVANCED DIAGNOSTICS AND CONTROL TOOLS FOR INCREASED LIFETIME OF SOLID OXIDE CELL TECHNOLOGY

Project ID	101007175
PRR 2024	Pillar 1 – Renewable hydrogen production
Call topic	FCH-02-3-2020: Diagnostics and control of SOE
Project total costs	EUR 2 712 322.50
Clean H_2 JU max. contribution	EUR 2 712 322.50
Project period	1.1.2021–31.12.2024
Coordinator	Institut Jožef Stefan, Slovenia
Beneficiaries	Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile, AVL List GmbH, Bitron SpA, Commissariat à l'énergie atomique et aux énergies alternatives, École polytechnique fédérale de Lausanne, Haute école spécialisée de Suisse occidentale, SolydEra SA, Teknologian tutkimuskeskus VTT Oy, Università degli Studi di Salerno

https://www.reactt-project.eu/

PROJECT AND GENERAL OBJECTIVES

Reactt will realise a monitoring, diagnostic, prognostic and control (MDPC) tool for reversible solid oxide cell (rSOC) stacks and systems to increase stack lifetime by 5 %; reach a production loss rate of 1.2 %/1 000 h; increase availability by 3 %, targeting overall availability of 98 %; and reduce operation and maintenance costs by 10 %. The additional cost of the MDPC tool will not exceed 3 % of the overall system manufacturing costs.

NON-QUANTITATIVE OBJECTIVES

- **Education/training.** Inclusion of the topic of solid oxide cell technologies in MSc and PhD study programmes.
- **Public awareness.** The web page and dissemination material are the first step towards raising public awareness.
- **Safety.** Fault detection, isolation and mitigation in solid oxide electrolyser cells (SOECs) / solid oxide fuel cells (SOFCs) preclude process disruption and potential hazards.
- **Regulations and standards.** The formulation of a new work item proposal is to be submitted to Technical Committee 105 of the International Electrotechnical Commission.

PROGRESS AND MAIN ACHIEVEMENTS

- The second release of the updated MDPC tool, with enhanced communication functionalities concerning the local system controller and the excitation unit, has taken place. The tool is low-cost, yet with high computational performance.
- An innovative excitation module for stack perturbation with conventional sinusoidal and non-conventional discrete random binary signal has been developed.
- An extensive experimental campaign has been conducted on SOEC 4 short stacks, a segmented cell stack and two 70-cell stack boxes. Valuable and comprehensive datasets under carefully selected degradation scenarios have been acquired.
- A framework of the model-based approaches has been settled for feature extraction. It entails two types of approaches.
- First is the passive approach, utilising conventional signals and the simplified lumped models of the stack and system.
- Second is the active approach, which requires additional perturbation of the stack to get the complete fingerprint of the stack dynamics in terms of the electrochemical impedance spectra. The spectra are further deconvoluted and interpreted by using equivalent circuit models.
- A real-time optimisation (RTO) strategy for operating solid oxide electrolysis systems at optimal efficiency has been proposed. The RTO problem is formulated as a constrained nonlinear optimisation problem and, at this stage, constraint adaptation with input filtering has been selected as the RTO solution approach. The first simulation results have been obtained using a simulated SOEC system. The proposed RTO scheme effectively pushes the system to higher levels of efficiency and maintains the system there, despite perturbations, by tracking active constraints.

FUTURE STEPS AND PLANS

An application for a project extension has been made. The main activities will be focused on the final integration of the MDPC tool and its validation on the two 70-cell SOEC stacks and a 25-cell rSOC stack.

PROJECT TARGETS

Target source	Parameter	Unit	Target	Target achieved?	SOA result achieved to date (by others)	Year for reported SOA result
MAWP addendum (2018–2020)	Q & M cost	€/(kg/day)/year	120		N/A	N/A
	Availability	%	98	⚙	95	2022
	Electrical consumption at rated capacity	kWh/kg H_2	39		40–45	2022

Clean Hydrogen Partnership
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