PROJECT FINAL REPORT

Publishable Summary

FCH JU Grant Agreement number: 244821

Project acronym: ASSENT

Project title: Anode Sub-System Development & Optimisation for SOFC systems

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Name of the scientific representative of the project's co-ordinator, Title and Organisation:

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1. The Objectives

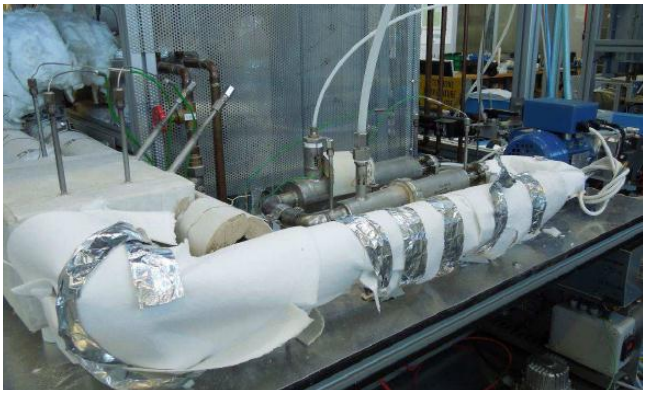
The objective of this project was to find optimal anode subsystem concepts that are validated for small-scale and large-scale SOFC systems to be implementable into a real system to fulfil performance, lifetime and cost targets for stationary applications. To find optimal anode subsystems to be validated, conceptual analysis and evaluation of the feasibility of the different recycle solutions for the anode subsystem was carried out. In addition, sensing techniques were tested, evaluated, and also developed, where available techniques were not sufficient. Optimum components should be viable for mass production.

Whilst much effort and resources are devoted to cell and stack issues, less attention has been paid to the balance of plant, or components and sub-systems required for an operational system. Components and sub-systems such as fuel processing, heat and thermal management, humidification, fluid supply and management, and power electronics are as fundamental to successful commercialisation of fuel cell systems as the cell and stack. This is the main reason and basic idea which lead our consortium to propose this work. In this project the development work specifically addresses SOFC technology but some of the results might also support development of MCFC technology.

2. The work carried out

The main work of this project was in evaluating different process approaches for fuel and water management in the case of natural gas and biogas. Process approaches included e.g. fuel and recirculation management with a recycle blower-based approach and/or an ejector-based approach, and water circulation with condensing from the anode off-gas/exhaust gas and evaporating back to loop. Relevant process options were first evaluated on conceptual level and the results were used as a basis for detailed feasibility evaluation. The aspects taken into account in the conceptual analysis were effects on electric efficiency and process simplicity implying easiness of controllability, and requirements on diagnostics accuracy to provide insights into failure mode prevention. In detailed evaluation, the suitable approaches were analysed more thoroughly in terms of component availability and reliability, achievable diagnostics accuracy, controllability, effects on reformer, mechanical integration feasibility to whole system, safety control, failure mode prevention, cost effects etc..

The concrete and final work of the project was to validate optimal anode subsystem concepts in small-scale and large-scale SOFC systems to fulfil performance, lifetime and cost targets for stationary applications.



Small-scale blower based recirculation subsystem

Large-scale ejector based recirculation subsystem

3. Main results

Four different optimised subsystems were validated successfully: two in large-scale and two in small-scale. These subsystems solution could be implementable into a pre-commercial system after the project.

Dedicated cost analysis (DtC) was conducted within ASSENT and parallel CATION projects to support the understanding of overall commercial feasibility of different process approaches. Based on this analysis, a good understanding on the economies of scale was achieved. As a result, it can be concluded that with certain additional stack related development steps a commercially feasible system having investment cost (excl. stacks) of less than 2000 €/kW can be achieved.

4. Conclusions

The project has focused on the development of the whole anode subsystem because there were not commercially available anode subsystems or critical components, which could be utilised in SOFC technology. The project has increased the system understanding, developed diagnostic tools for controlling whole FC-systems and evaluated commercially viable subsystem solutions. This will help to develop sub-systems that are viable for mass production, and can be implemented into a real system to reach performance, lifetime and cost targets for stationary applications in upcoming pre-commercial demonstration projects.

5. Potential impacts

SOFC technology is immature, but is seen as having more potential than other fuel cell technologies both in terms of applications and efficiencies and costs. Based on lower cost ceramic materials SOFC technologies are believed to have the greatest potential in becoming cost competitive with incumbent technologies. High electrical and CHP efficiencies will directly impact fuel supplies, whilst low or negligible NO_x and SO_x emissions and no particulate matter will contribute to cleaner air. SOFC units can therefore improve fuel security, sustainability, competitiveness, efficiency and flexibility, and lower carbon emissions that will contribute to meeting the objectives of Europe's Energy Policy. Looking into the future the fuel flexibility of SOFC systems will allow units to transition from the common hydro-carbon fuels of today through to future potential fuels such as bio-fuels and hydrogen. The focus will be on technologies for SOFC units with the potential for costs less than 1500-2000 €/kW or 3000-4000 €/kW for large- and small-scale applications respectively, have 40 000 - 60 000 hours durability and efficiencies of 45-60% in power generation mode and 80% + for CHP mode.

The nature of the project has been mainly technical and because of that it does not bring much relevant information for the policy makers or civil society. However, it brings a lot of information and good results for the industrial actors whose aim is to commercialise the fuel cell system.

6. List of beneficiaries

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