Application 2020

Molten Carbonate Fuel Cell---Identification of the performances for modeling purposes

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Abstract

An important contribute to the development of fuel cells comes from the improvement of mathematical models that permits reduction of cost and time for evaluation of performances in operation conditions. Mathematical models of molten carbonate fuel cells are mainly based on equations approximating the voltage-current curve (E = f(i)), obtained from experimental data. This directly connects the models with specific experimental data creating difficulties in determination of fuel cell performance for conditions much different than those during experiments. The project will permit, via access to experimental facilities of University of Perugia, an improvement of the models already developed by Warsaw University of Technology. In particular the project will focus in investigation of possibilities of using MCFC as CO2 separator/concentrator from flue gases of power origin. During the realization of the project the models of high temperature fuel cells will be developed for system and optimizing purposes.

Aim of the project

The project concerns development and application of fuel cells, which is one of technologies that are thought to be crucial in the 21st century. Requirement of fuel cell development is included both in European Union priorities, e.g. Framework Programs and in national Energy Policy of Poland. The subject area and scope of the finished project is well placed regarding long-term and sustainable national development (including Renewable Energy Resources policy till 2025) as well as coherent with EU energy priorities. In addition the project will involve issue such as CCS that was individuated as one of the main action of EU set plan for Horizon 2020. The study will focus investigation of possibilities of using MCFC as CO2 separator/concentrator from flue gases of power origin: lignite based power plants, hard coal based power plants, Natural Gas based power plants, Cement industry, other.

The project will take into account a number of factors which were neglected in models used to date. They will be mainly based on general relationships derived from thermodynamics, chemical and electrical engineering and does not, practically, require empirical equations based only on experimental data. The models will be parameterized with the following values: type of used electrolyte (ionic and electronic resistance); electrolyte thickness (or matrices thickness); nominal/real ratio of the fed fuel/oxidizer to the fuel cell surface area (the factor

that was not included in models created before one resulting from the project and having very significant importance).

Expected outcomes

Following general outcomes are expected from the project:

- Analysis of the main parameters of high temperature fuel cells;
- Experimental research oriented to find out the specific correlations for the modeling purposes;
- Derivation of relations correlating the parameters of the model;
- Comparative analysis of the results obtained by the model and experimental data;
- Analysis of the influence of each parameter on the performance of high temperature fuel cells in conditions other than maintained during experiments.

To achieve these goals additional specific outcomes can be added:

- Test campaign definition;
- Cell validation and measurement of reference performances;
- Evaluation of reference operation condition for parameter study;
- Evaluation of cell degradation via final performances study.

The obtained results will be reported as required by H2FC project. Whenever results will reach expectations a join publication in International Journal will be submitted.

Access activity description

The access to the facility will permit to obtain experimental data for the improvement of the model. In this sense a strong cooperation for the test definition has to be activated between model developer and experimental expert. Part of the access will involve both experts to individuate model requirement in terms of input data and constrains and limits of experimental apparatus. The results will be a trade of between both parts requirement that will not reduce or limit quality and reliability of final result. In this sense a preliminary discussion was established between the two Universities that will continue as part of the project.

Work plan draft (already agreed with the technical expert of the Facility):

- I° phase: Test plan and test-bench adjustment
- II° phase: Reference tests
- III° phase: Tests according to the agreed working conditions
- IV° phase: comparison test with the starting conditions (degradation issues check) and data analysis

During the preliminary contact emerged that the Access will take advantage of the availability of a molten carbon single cell at the Fuel Cell Laboratory that will be used for experimental activity.