Application 2025

Solid oxide fuel cell experimental analysis with different hydrocarbons

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Abstract

Solid oxide fuel cell is a promising technology for the conversion of chemical energy into electricity and heat. Besides to hydrogen, this type of fuel cell can use different fuels such as natural gas alcohols and gasoline. In particular, alcohols such as methanol or ethanol (CH3OH, C2H5OH) can be produced by renewable energy sources. Compared with hydrogen, alcohols have the advantage of easy storage and safe handling. They show a reasonable energy density and may be appropriate particularly for applications in remote areas not covered by electrical grid. Natural gas and gasoline (C8H18) have the advantage of the existing distribution and dispensing infrastructure. This experimental study will compare the performance of CH4, CH3OH, C2H5OH and C8H18 when used in a solid oxide fuel cell.

Project description

The aim of the project is to study the performance of a stack SOFC when fed with reformed hydrocarbon fuels. With this aim the reforming of such fuels can be simulated via a theoretical model of a steam reformer. The model, already available, is based on thermodynamic equilibrium calculated with minimum Gibbs energy method based on Lagrange multipliers. Four different fuels are considered: methane, ethanol, methanol and diesel surrogate (C8H18). Selected reforming temperature is 800°C to guarantee complete reforming reaction and a stack inlet mix of H2, CO, CO2 and H2O in quantity and composition depending on selected fuel. For each simulation the steam quantity is regulated as minimum to guarantee no carbon deposition. The use of the short stack will permit to integrate geometrical evaluation on the study. In a short stack the effect of temperature can be evaluated and can give indication on internal reaction behavior. In addition a short stack, compared to single cell, permits to increase utilization of fuel and to approach operative conditions.

The access to Fuel Cell Laboratory technically consist in testing the selected compositions into a SOFC stack. The test campaign will include:

- Open circuit voltage measurements;
- Polarization curves;
- Fuel cell temperature measurements.

Operative temperature of the stack is 750°C. Test has to be designed so that the fuel flow will permit a comparison between different composition. This can be done selecting a specific approach such as constant total flow, constant hydrogen flow or constant equivalent hydrogen flow. Based on these tests for each fuel input, system performance will be evaluated. Considering all activities such as test campaign definition, realization of experiment and data analysis the access will last indicatively 30 days.

The results of the project will be a join publication in an International Journal (to be defined).