Project Report

H2FC European Infrastructure
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Application No. 2025
Short title Solid oxide fuel cell experimental analysis with different hydrocarbons

Objectives: short, medium and long term (<250 words)

Testing of selected fuel compositions on a SOFC stack. The test campaign will include: *Open circuit voltage measurements; *Polarization curves; *Fuel cell temperature measurements.

Brief summary of work carried out:

This experimental study compares the performance of CH4, CH3OH, C2H5OH and C8H18 when used in a solid oxide fuel cell. Starting from simulation results an experimental activity was developed. All the test were realized in the Fuel Cell Laboratory (FCLab) of the University of Perugia – Italy. The test were performed on a 4 cells SOFC stack based on square 10 x 10 cm2 anode supported cell. The cell used are composed of a Ni/8YSZ cermet anode, 8YSZ electrolyte and LSM /8YSZ cathode. The aim of the experimental was to compare four reformed fuel compositions with pure hydrogen, fuel performance was evaluated realizing polarization curves. In order to make a consistent comparison, it has been imposed the same low heating value for all fuels. Air rate was kept constant during all tests at 400 Nl/h. Reference flow rate of hydrogen was selected equal to 60 Nl/h. All the test were realized at furnace temperature of 750 °C. After stack start up and acceptance test, as indicated by the supplier, each gas composition was sent to the stack and after waiting one hour at OCV for stabilization a complete polarization curve was realized. Each polarization was done starting from OCV and increasing current with 2 A step. Each polarization point was kept for 2 minutes. The procedure was interrupted and reversed when 0,6 V was reached in any of the cells.

Main achievements intended for publication <250 words

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 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 permits 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 fuel cell reaches the highest performance when hydrogen is considered as input fuel. Methane, ethanol, methanol

and diesel surrogate produce similar fuel cell performance especially at medium/high current densities. As for low current densities, ethanol, methanol and diesel surrogate fuels produce better fuel cell performance.

Difficulties encountered <250 words

No major difficulties were encountered over the execution of this project.

Further comments:

No