Solid oxide fuel cell test bench system integration

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Abstract

Solid Oxide Fuel Cells (SOFC) is a technology in continuous development due to of the usefulness of high temperature fuel cells.
In this work, some possibilities on how to profit the high temperature in which this kind of fuel cell operates are presented. Depending on the power supplied by the SOFC selected, these possibilities have to be studied to find out the viability of these proposals.

Bor4store project

The transition towards a sustainable, carbon-free and reliable energy supply system capable of meeting the increasing energy demand is considered one of the greatest challenges of the 21st century. In order to integrate renewable energy sources, being unevenly distributed in location and time, advanced energy storage systems have to be developed.
The aim of this work comes from the European project "Fast, reliable and cost effective boron hydride based high capacity solid state hydrogen storage materials" (Bor4store). This European project follows an integrated, multidisciplinary approach for the development and testing of novel, optimized and cost-efficient boron hydride based H_2 storage materials with superior performance for specific fuel cell applications.
The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative under grant agreement nº 303428.
The participation of Abengoa Hidrógeno in this project consists on the development of a test bench with a Solid Oxide Fuel Cell, integrated with a Metal Hydride tank (MH), but also involves the choice of the stack, its characterization and the testing procedure.

Thermal integration of the system

The whole system of the Bor4store is divided in two different subsystems: SOFC subsystem and MH tank subsystem. The next picture shows the SOFC subsystem.

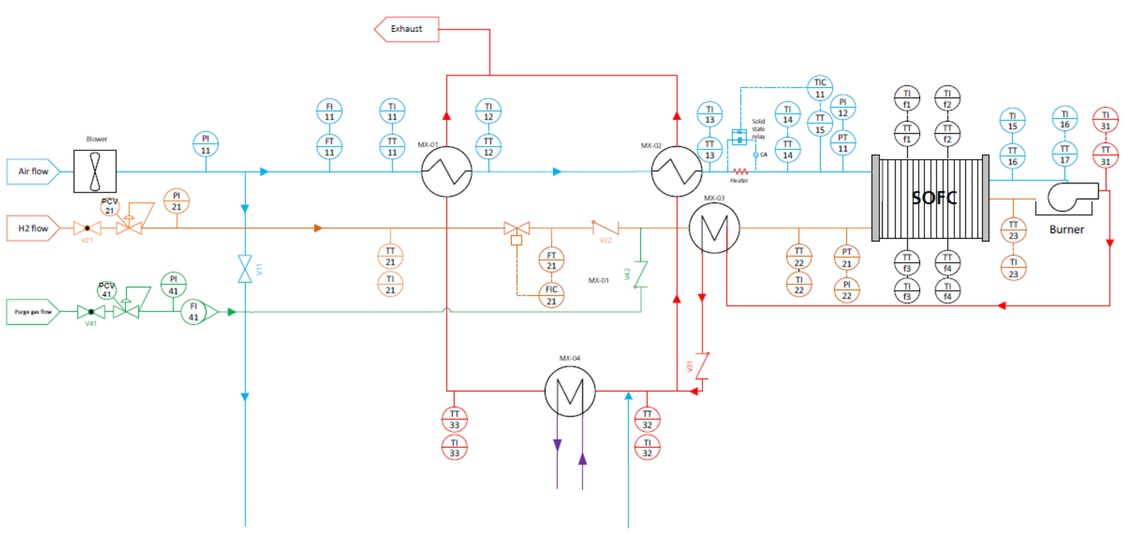


Fig. 1. P&ID of SOFC system test bench

The SOFC has been built by Sunfire and consists on a test bench composed by the Solid Oxide Fuel Cell (1 kW), four heat exchangers for the thermal integration with the tank and the gases pipes, a blower for feeding air to the fuel cell and an afterburner where the exhaust gases are burned to eliminate any possible mixture of hydrogen and oxygen at these high temperatures.

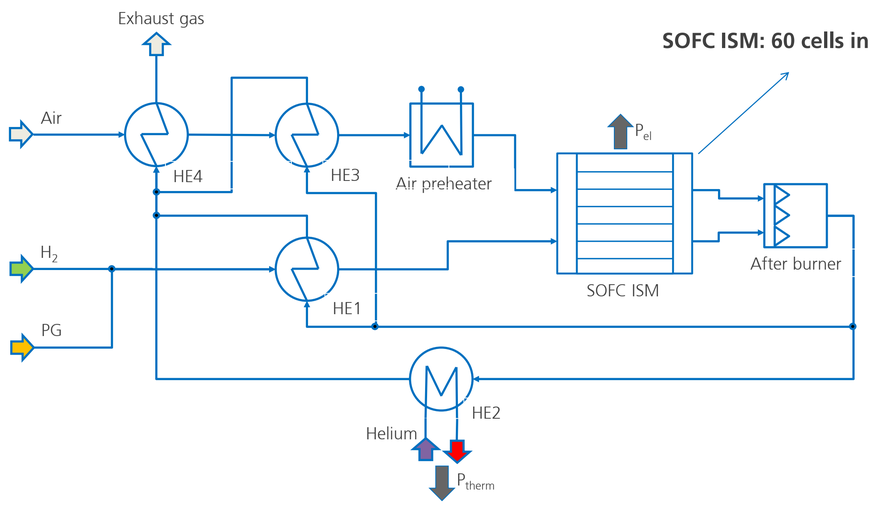


Fig. 2. Simplified P&ID of SOFC system test bench

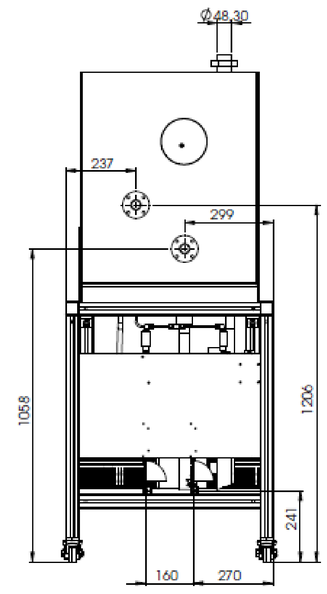
Solid oxide fuel cell subsystem characteristics

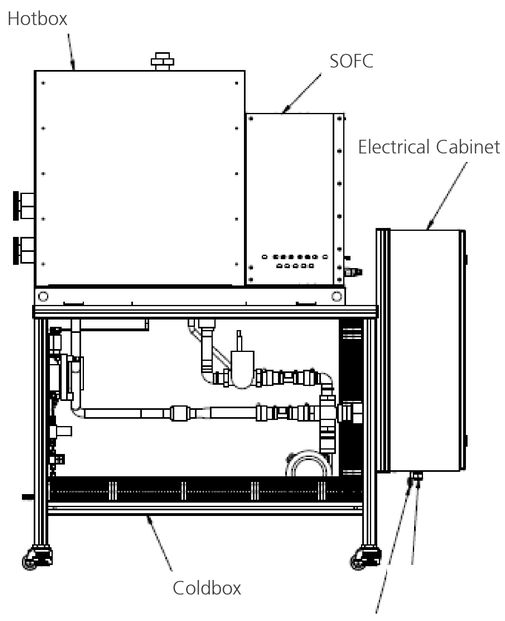
Main components of the fuel cell and the other equipment placed in the test bench present the following operational characteristics:

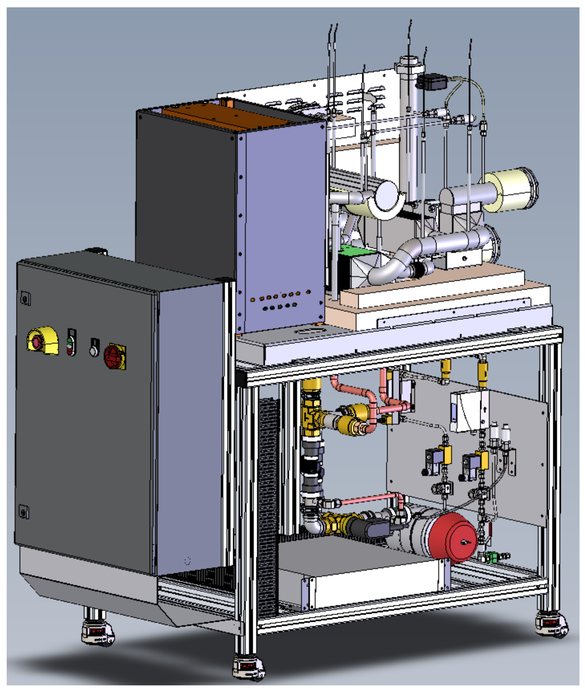
Integrated Stacks Module	Type B215, 60 cells, 1 kW_{el}
Electrical air preheater	3.5 kW, max. 250 Nl/min, designed to 1050 °C, 0.1 bar(g)
Heat exchanger 1 (H2 / ex. gas)	Designed to 1050 °C, 0.25 bar(g)
Heat exchanger 2 (He / ex. gas)	Designed to 1050 °C, 0.5 bar(g)
Heat exchanger 3 (air / ex. gas)	Designed to 1000 °C, 0.25 bar(g)
Heat exchanger 4 (air / ex. gas)	Designed to 500 °C, 0.25 bar(g)
After burner	Diffusion burner, 0.6-1.5 kW, 750-1050 °C, 0.1 bar(g)
Electrical load	1.5 kW power input

Table 1. Characteristics of main components

Mechanical layout







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