Implementation and characterization of an ejector based hydrogen recirculation system for a PEM fuel cell

One of the issues that needs to be studied in order to improve the durability of a PEM[1] fuel cell system is the management of the hydrogen feeding procedure. It has been demonstrated that their efficiency and durability are improved when using a hydrogen recirculation system. In the recirculation mode, the unused gas is returned to the inlet by a pump or a compressor or using a passive device such as an ejector.

Ejectors are devices used to induce a secondary flow by momentum and energy transfer from a high energy primary jet. Their application for the recirculation system of a fuel cell is very beneficial due to their low maintenance, no moving parts and no parasitic power.

In this work, an ejector has been designed to be implemented in a PEM fuel cell test station to analyze how ejector based hydrogen recirculation systems affect PEM fuel cells. The proper design of an ejector must take into account several geometrical parameters that can only be studied using Computational Fluid Dynamics (CFD). Thus, a CFD model has been implemented using COMSOL Multiphysics' CFD module's High Mach Number Flow.

The model proposed solves the problem of the ejector using an axisymmetric 2D geometry. As the density of the fluid is variable, the Favre averaged Navier-Stokes equations are used. These equations are approximated using the standard k-ε turbulence model and assuming that the gas follows the ideal gas law.

After developing the model, an experimental ejector was designed, manufactured and tested experimentally to validate the model. Results showed that the model is capable of capturing the mass flows obtained for different operative conditions.

Finally, the geometry of the ejector to be implemented in the PEM fuel cell test station was obtained by carrying out a parametric study to find the optimum geometrical parameters.

[1] PEM: Proton Exchange Membrane