# Modeling an Ejector for Hydrogen Recirculation in a PEM Fuel Cell

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## Introduction

Ejectors are passive devices used to induce a secondary flow by momentum and energy transfer from a high energy primary jet. Their main advantages are that they have no parasitic power, no moving parts and require little maintenance.

The primary flow, which comes from a high pressure tank, is accelerated in a nozzle and reaches sonic conditions. This low pressure and high velocity flow interacts with the fluid in the suction chamber and induces a secondary flow due to its low pressure and by shear stress action between both flows. Both flows mix in the mixing chamber and a diffuser is added to increase pressure at the outlet.

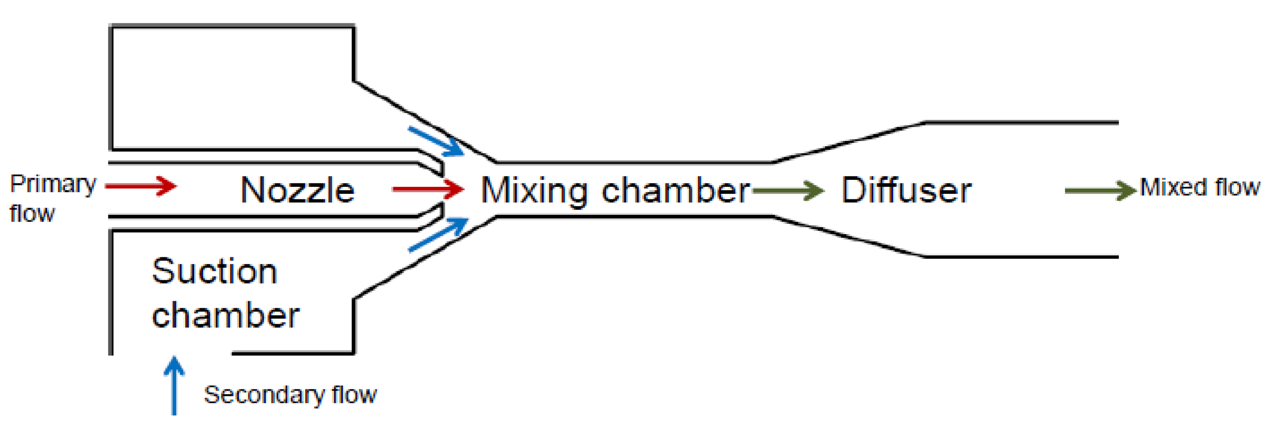


**Figure 1**. Ejector

Ejectors can be used to recirculate fuel in PEM Fuel Cells systems, helping to increase both their durability and performance.

In the present work a CFD model has been developed to design ejectors to be used in PEM FC systems. The model has been validated experimentally and then used to design an ejector for hydrogen recirculation in Test Station 4 of IRI's Fuel Cells Laboratory.

## Computational Methods

A 2-D axisymmetric model has been implemented using the Favre-averaged Navier Stokes equations approximated using the k-ε turbulence model and assuming that the gas follows the ideal gas law. The physics interface used is the CFD module's High Mach Number Flow.

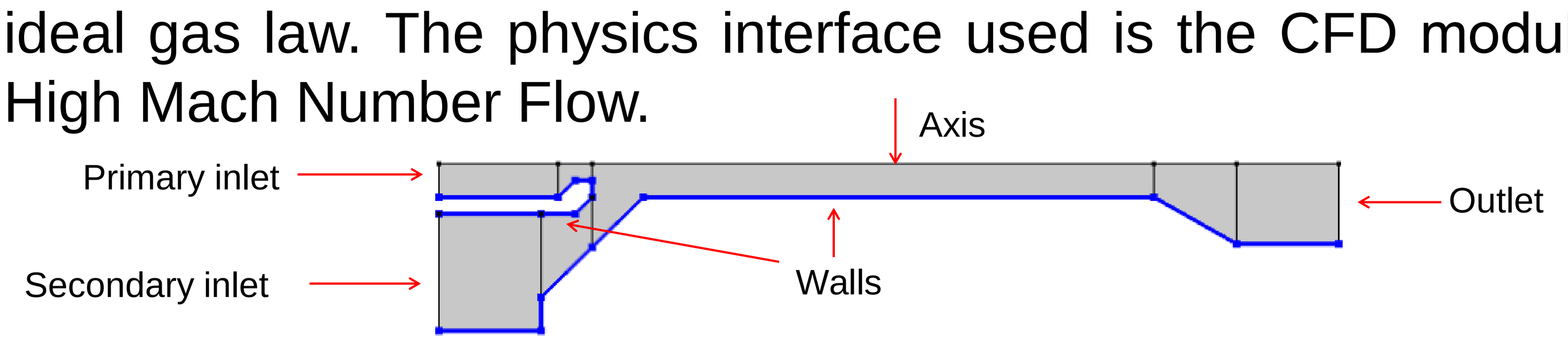


**Figure 2**. Geometry and boundary conditions

## Results

The computational results showed a good agreement with experiments.

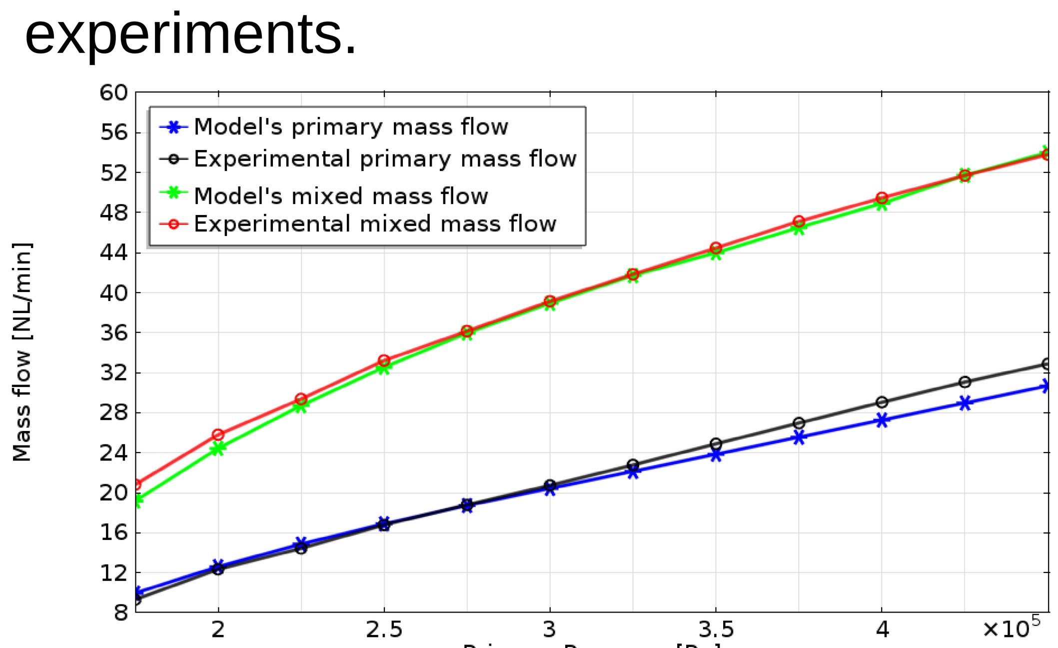


**Figure 3**. Mass flow vs. primary pressure obtained experimentally and with the model

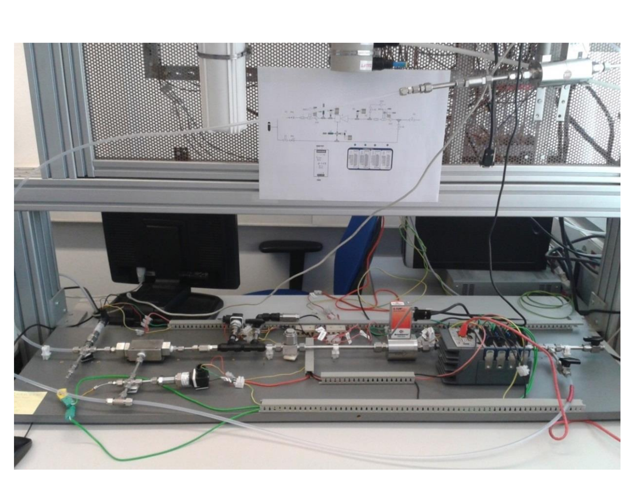

**Figure 4**. Experimental set up

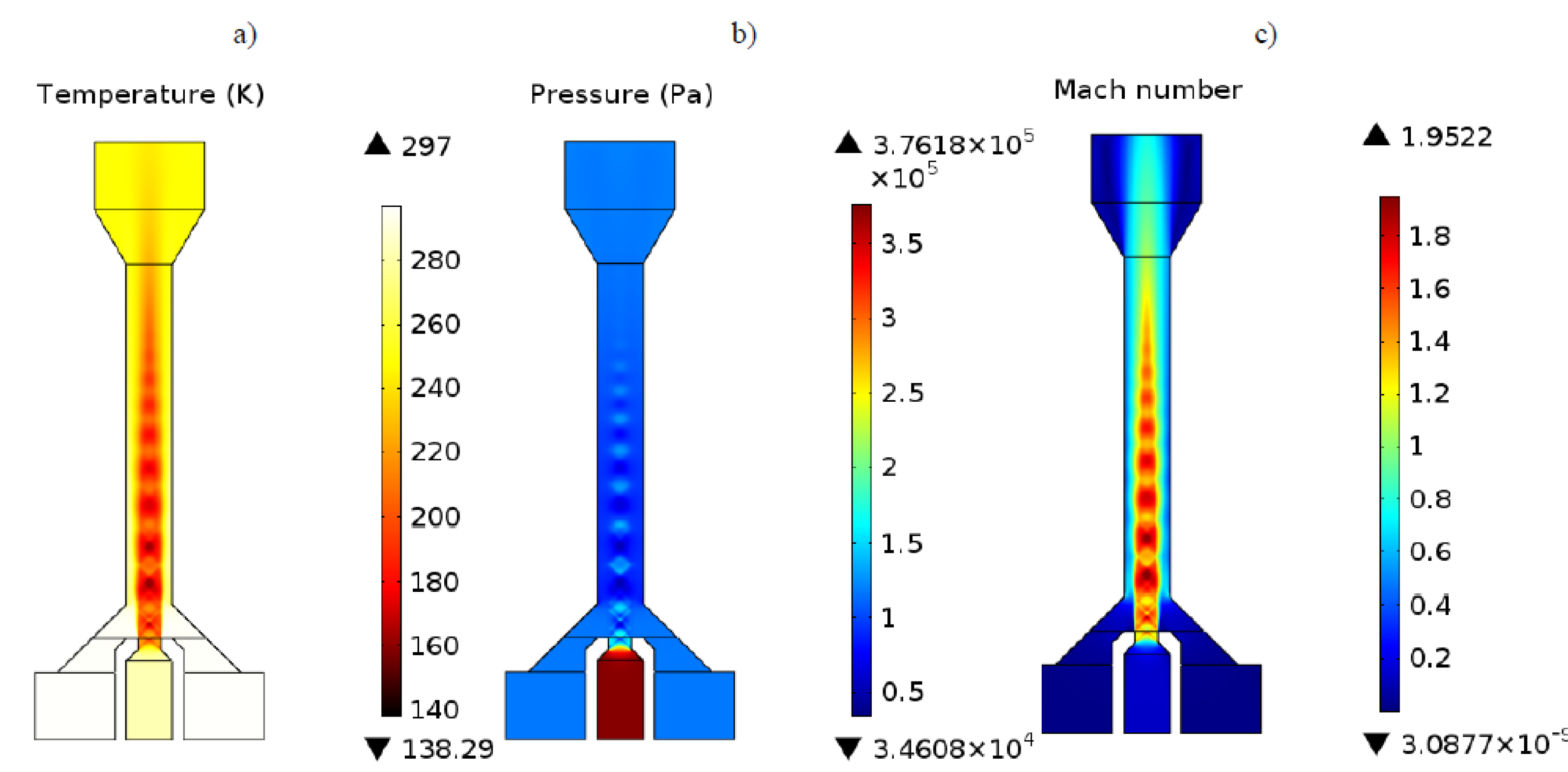


**Figure 5**. Results obtained for a primary pressure equal to 4.5 $bar_{abs}$

Several parametric studies were carried out to find the optimum geometry to be implemented in Test Station 4. The mass flows predicted by the model for the working conditions of TS4 are depicted in Figure 7.

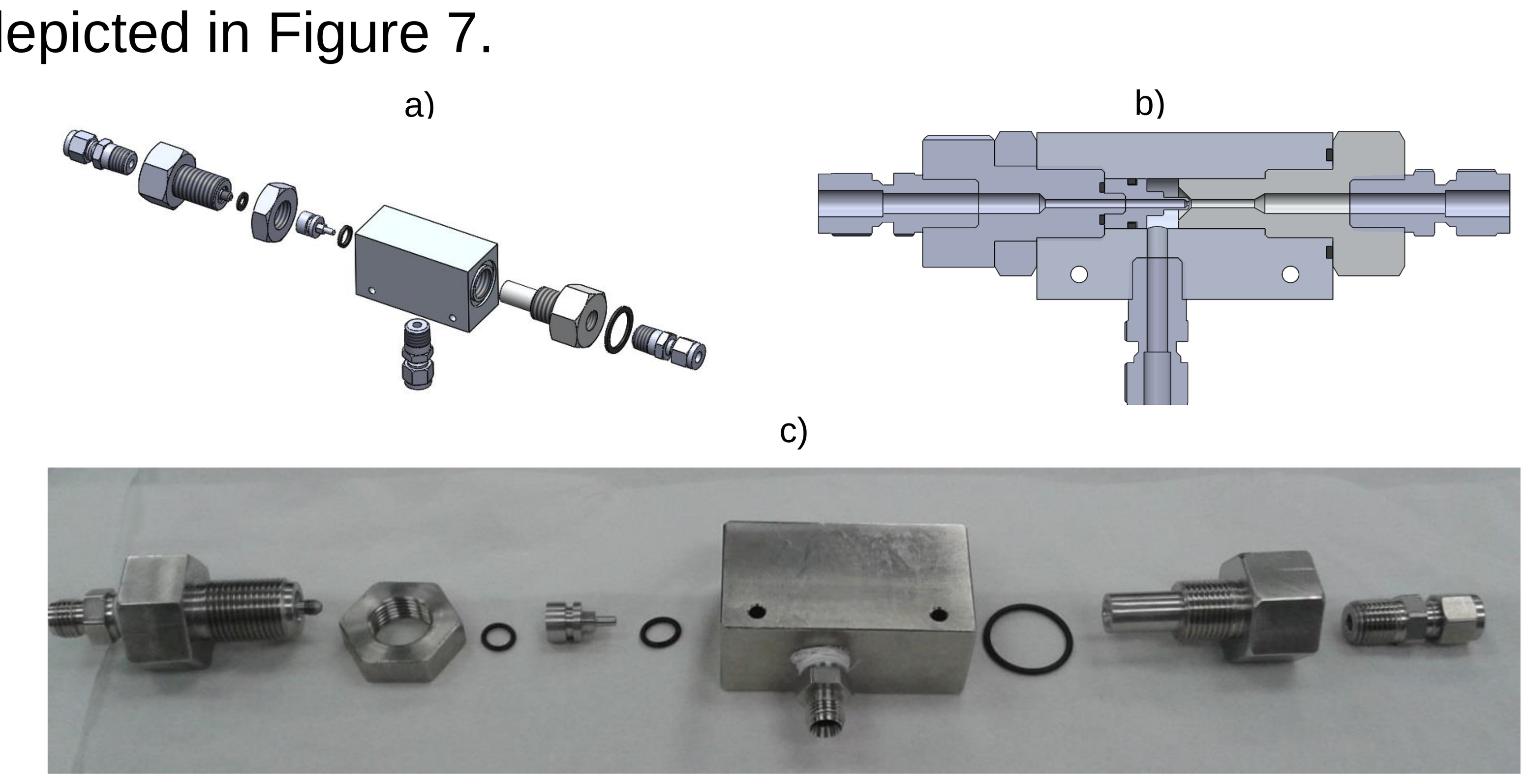


**Figure 6**. Ejector for Test Station 4. a) 3D representation of the parts b) Sectional view c) Parts of the ejector

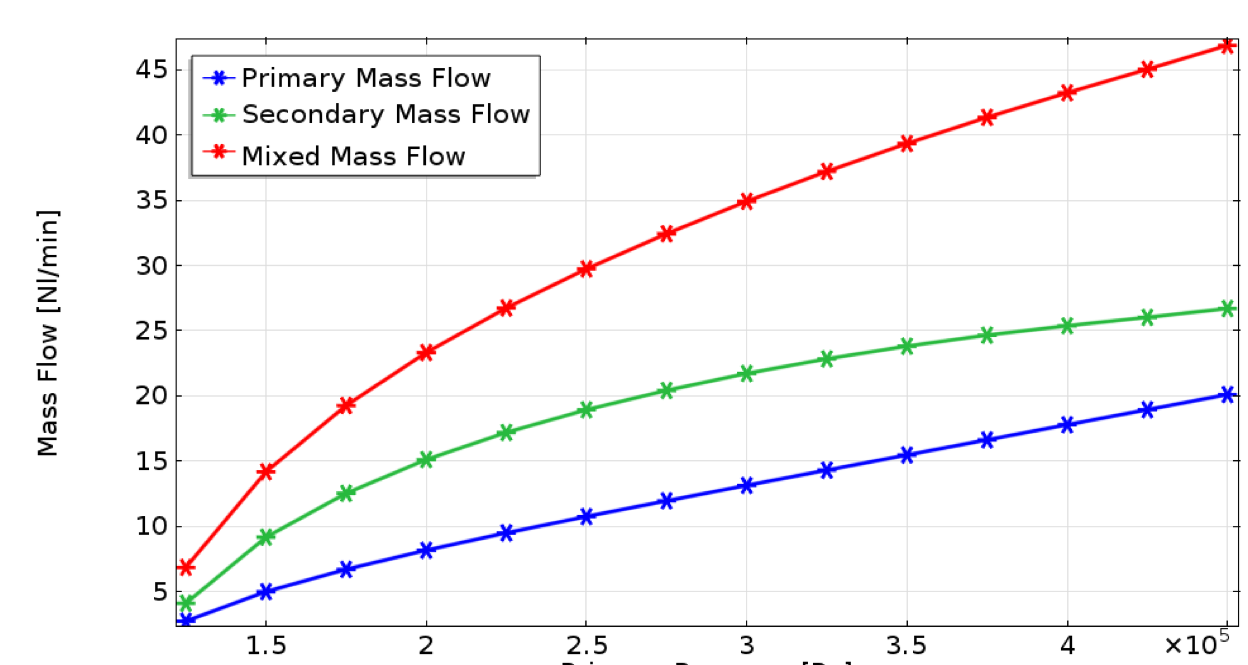


**Figure 7**. Mass flows obtained with the designed ejector

It was found that the geometrical parameters that have the most important influence over the performance of the ejector are:

- Diameter of the throat of the nozzle
- Diameter of the mixing chamber

## Conclusions

The CFD model has been implemented using COMSOL Multiphysics and has been validated experimentally. It has shown to be useful to design an ejector for fuel recirculation in PEM Fuel Cells and to study the flow within them.

## Acknowledgements

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