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Local water content distribution measurements with neutron imaging for CFD model validation of 50 cm2 PEMFCs

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The Thermal Engineering Group (Energy Engineering Department) at the University of Sevilla has been working over the last years on the development of 3D models for PEM Fuel Cells. The modelling framework is CFD (Computational Fluid Dynamics), where not only the integral polarization curve but also local distributions of all key variables are obtained and investigated.

Model results have been already validated against experimental polarization curves obtained in test benches for 50 cm2 real cells in a wide range of operating conditions. The agreement of the validation results is satisfactory and have been published in a set of journal papers. However, it is known that as the polarization curve is an integral output of the cell, a more detailed validation is in general requiered. This can be achieved by means of the measurement of local variables, such as local current density distribution measurements over the cell active area (using segmented cells for example).

In this project, the use of neutron imaging for the measurement of local distribution of liquid water inside the cell in different operating conditions is proposed. The experimental data obtained (neutron radiographs) will be used for the assessment of the degree of validity of the liquid water distributions obtained from the CFD models for the same operating conditions. This constitutes a fundamental information to validate the models and use them with a stronger confidence for the research and development of PEMFCs. Potential disagreements between model results and experimental measurements will be used for a better understanding of water transport phenomena within the cell and the consequent better assessment of the different CFD model parameters required by the liquid water transport/conservation equations.

It is expected to carry out a set of 5-10 experiments per day, for different operating conditions (stoichiometric factors, reactant relative humidity, current density, cell temperature and pressure) in steady state operation. Also the possibility for performing measurements in dynamic (transient) conditions can be analysed. The duration of the experimental measurements is expected to be in the range of 4-5 days, including one initial day for cell integration in the installation provided and initial debugging.