Application 2043

Investigation of phenomena affecting the liquid water balance in a 50 cm2 PEFC

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The project is aimed at investigating a set of different phenomena related to water management in PEFCs. The activities will be focused on the following aspects:

-Investigation of the effect of the flow field on the water removal capabilities of the cell. Two flow field designs will be tested for the 50 cm2 cell: serpentine flow field with five parallel paths and common manifolds, and serpentine flow field with three parallel independent paths). The cell performance (in terms of voltage and cell resistance) and water distribution measured with neutron imaging will be analysed for both flow fields, for three different current densities and three different reactants relative humidity. Therefore the matrix of testing conditions will cover 18 cases: 2 flow fields x 3 current densities x 3 reactants relative humidity. The analysis of the results will help determining the influence of the flow field on the water removal capability of the cell, and therefore design guidelines for more efficient flow fields.

-CFD model validation. The existing three-dimensional CFD models available for both flow field designs will be updated with the parameters of the cell tested, and the experimental conditions tested will be simulated. The availability of the experimental results will provide detail information for the validation of the CFD model. Once validated, the models will help to understand the three-dimensional phenomena and mechanisms involved in the water balance and cell performance.

-Cell purging strategies and effectiveness quantification. Cell purging is an important operation required for some cells, where liquid water in the cell must be minimized before the shutdown in order to ensure a successful sub-zero startup. A set of purging strategies after normal operation will be tested and its effectiveness will be addressed by means of neutron imaging, measuring the amount of residual water within the cell. Results will be used for establishing the purging parameters required for a successful cell shut-down.

-Effect of operating pressure on the liquid water content of the cell. The absolute operating pressure of the cell influences the vapour/liquid equilibrium and therefore the amount of liquid water within the cell (and thus the complete water balance of the cell). However no detailed analyses are found in the literature. Neutron imaging will be used to quantify the liquid water content in the cell for constant operating conditions, at 1.0 bara, 1.25 bara, 1.50

bara, 2.0 bara and 2.50 bara. The results will be analysed in order to determine the real effect of the operating pressure on the cell performance and liquid water content.

-Liquid water in flow field channels. Liquid water in channels diminishes the performance of the cell preventing reactants and products from being transported effectively. The different regimes of liquid water in the flow field channels (slugs, annular flow, mist, etc.) will be investigated by means of neutron imaging of the operating cell. A map of multiphase flow regimes will be developed for the cell tested.

Detailed testing protocols will be defined for all the activities in order to ensure successful experimental results.