# Modelling of Transport Professes in Fuel Cells

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**Abstract:**

Fuel cells are highly efficient energy conversion systems, thus numerous projects for installation in power plants have been considered. Several types of fuel cells have been investigated and applied till nowadays, among which Solid Oxide Fuel Cells (SOFCs) and Polymer Electrolyte Membrane Fuel Cells (PEMFCs) have attained the wider acceptance in terms of applications. For any case, transport within a fuel cell is a key factor to its performance. Since there are serious difficulties in realizing prototypes, a well-established multi-dimensional simulation is essential for the better understanding of the role of the main parameters that affect the performance of a fuel cell. In the present work, a three dimensional mesoscopic model examining the fluid flow along with the fundamental transport phenomena occurring in a typical fuel cell, i.e. heat transfer, mass transport and charge transfer, has been developed. The flow field was simulated according to the well known Navier-Stokes equations, while the heat transfer was described by the typical conduction/convection equation and the mass transport by the convection/diffusion one. Furthermore, reaction kinetics were studied by the Butler-Volmer equation for the heterogeneous reactions occurring at the porous electrodes. The developed model was numerically solved for both SOFC and PEMFC, by using the commercially available CFD package CFD-RC© by ESI Group, which is based on the multi-step finite volume method. By taking into account a typical fuel cell consisted of an anode, an electrolyte and a cathode, it is assumed that feedstream is a hydrogen-rich gas mixture while the device is also exposed to atmospheric air of typical composition. The electrolyte is supposed to be thermodynamically optimal, being constructed by the theoretically most suitable material and having exact dimensions and characteristics for the maximization of electrical efficiency. The simulations allow the scientific investigation of the fuel cell design and operational conditions as far as feeding mixture (fuel) composition, local temperature and flow characteristics (inlet velocity) are concerned. Finally, some guidelines for optimal design of platns based on FCs is also presented.