Abstract

The report summarizes the results of the numerical simulations of proton exchange membrane fuel cell (PEMFC) by computational fluid dynamic (CFD) software. The code employed is CFD-ACE+ developed by ESI-CFDRC Company. The purpose of the study is to assess the capabilities of CFD-ACE+ code in the simulations of PEMFC.

The phenomena involved in the water and heat management of PEMFC are very complicated. The phenomena involved include the flow of multi-component and multi-phase fluid in an open channel and through porous media, the electrochemical reactions at catalyst layers, the evaporation and condensation of water, conduction and convection heat transfer.

A three-dimension single cell PEMFC model is built and the input values of the physical and chemical parameters of PEMFC are collected from the literatures surveyed. The measured polarization curves of a PEMFC can be reproduced by the present simulations. The PEMFC simulation results of CFD-ACE+ are examined and discussed in detail to check the consistency of the simulated results.

Sensitivity studies are performed. The parameters considered in the sensitivity studies are the direction of flow (co-flow and counter flow), the thermal conductivities of membrane-electrode assembly (MEA), the coefficient of the proton in the JANNAF method which calculates the enthalpy of the mix gases, the thermal boundary condition of fuel cell outer surface (constant temperature and convective).

The result of the simulations demonstrated that CFD-ACE+ has the capabilities to simulate the hydrodynamic phenomena of PEMFC. However, the code does not provide enough output about liquid water flow in the channel and its distribution in the fuel cell.

Key words: PEMFC, PEFC, CFDs, heat and water analytic.