Modeling the Effect of Cross Flow Roughness on Solid Oxide Fuel Cells

by

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ABSTRACT

A three-dimensional SOFC model was used to study the use of enhanced heat transfer and mixing techniques to possibly increase the performance and available power density in a planar solid oxide fuel cell (SOFC). Fluid transport within the channel dictates the ability of the reactants to reach the reacting surface. Transport also is essential to prevent damaging temperature gradients from developing across the fuel cells. The objective of this study was to determine if applying mixing techniques to fuel cells had the potential to improve the heat/mass transport properties of the cell and to subsequently increase the performance of the cells.

FLUENT computational fluid dynamics software was used for modeling the SOFC fuel cells. Complementary numerical results showed that the introduction of various shaped fins and ribs into duct flow at very low Reynolds numbers can achieve modest enhanced mixing. These hydrodynamic results indicated that the ideal rib shape and pitch spacing were rectangular ribs spaced 3.5 mm apart.

A three-dimensional model of a single SOFC unit cell was modeled using several rib geometries developed in the preliminary hydrodynamic study and the results of the fuel cell model were analyzed. From the sharp edged sawtooth design in which the area of the electrolyte increased 16% over the plane channel design, the power density increased 13.3% if the power density is calculated from the plan area of the cells. However, if the power density is calculated from the actual area of the electrolyte, the power density of the sharp edged sawtooth design decreases 2.3% with respect to the power density produced in the plane channel fuel cell design. Similar results were occurred in the other fuel cell designs in this study. These results indicated that the enhanced mixing and heat transfer techniques had a modest effect on improving the heat and mass transport in the cell. The techniques predominantly increased the surface area of the fuel cell which led to increased volumetric power density.