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Metal foams as flow distributors in comparison with serpentine and parallel flow fields in proton exchange membrane electrolyzer cells

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Abstract

The arrangement of flow field in a proton exchange membrane electrolyzer cell (PEMEC) plays a significant role on distribution of reactants over the active area of electro-catalyst and transfer of products toward the outlet of PEMEC. In this paper, the performance of a PEMEC with metal foam as flow distributer is investigated and compared with two common flow fields. A numerical analysis is conducted based on a three-dimensional model of a electrolyzer with parallel pattern flow field (model A), double path serpentine flow field (model B), parallel flow field and metal foam as a flow distributor (model C), and a simple channel that is filled with metal foam (model D). The performance of four different models are compared to each other in terms of current density, temperature, hydrogen mass fraction and pressure drop distribution. The current density for model A, model B, model C, and model D at voltage of 1.55 V are 0.3, 0.41, 0.43 and 0.44 A/cm^2, respectively. The results indicate that model D has the best performance in comparison with other models in terms of pressure drop and uniformity of hydrogen mass fraction and temperature. There is no significant difference between models B, C, and D in terms of current density, but the pressure drop in the model B, model C and model D are 736, 9.72, and 4.917 kPa, respectively. It is concluded that utilization of metal foams has advantages such as high electrical conductivity and low weight, and an appropriate foam permeability should be selected to optimize the pressure drop.

Keywords: PEM electrolyzer; Metal foam; Flow distributor; Three-dimensional model; CFD modeling

1. Introduction

Today's concerns regarding global warming, population growth, industrial pollutions and the rapid decline of oil resources have led to use of renewable energy resources. Hydrogen is recognized as a reliable alternative for fossil fuels. Hydrogen can be produced using different