Analytical Studies on the Flow Distribution in Fuel Cell Stack and Manifold

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Many fuel cell systems contain the stack configuration to connect unit cells in series. The manifold plays a role to distribute flow into the unit cells. In this work, we attempt to derive some analytical results that reveal the influence of the design variables on the cell flow distribution. The analytical model in this work consists of two parts. One is the pressure drop estimation in general N-channel serpentine flow channels. By considering key features of the serpentine flow channels, we derive the model equation to predict the pressure drop, where the friction loss by channel bending is included through the pressure decomposition. Second is to consolidate each unit cell flow model into the stack and manifold modeling. Based on the literature results reported by Acrivos (Chem. Eng. Sci. 10(1959) 112-124) and Deshpande el al. (J. Power Sources 114(2005) 94-106), we derive the manifold flow distribution model equation. To verify our modeling procedure, we compare analytical predictions with numerical results by a general CFD software such as FLUENT. Through this work, essential information on the flow distribution in fuel cell stack is brought out.