Optimal Design of a Fuel Cell Bipolar-Plate using Large-Scale CFD Simulations

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Recently, computational fluid dynamics (CFD) model has been actively developed for PEM (Proton Exchange Membrane) fuel cells. In this study, the CFD model, developed by USC (University of South Carolina), have been utilized to optimally design the flow-field of a bipolar-plate for PEM fuel cells. Typically, commercial-scale fuel cells have large active areas (ranging from 200 cm^2 to 450 cm^2) due to which the number of computational cells is excessively large in a CFD simulation. First, several design candidates for a new bipolar-plate were designed using basic mass and heat balance calculations and then the performance of those designs were estimated using the CFD simulations. A huge number of computational cells (ranging from 5 millions to 16 millions) for FVM (Finite Volume Method) calculations were required for obtaining converged solutions. According to the simulation results, the design candidates were funneled into a final design. Finally, a unit cell was fabricated using the final design and the performance was verified through experimental test.