Optimisation of Polymer-Based Bipolar Plates Using Numerical Calculation

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Fuel cells have gained significant attention for portable and lightweight energy applications due to their high energy density and environmental benefits. Polymer-based proton exchange membrane fuel cells (PEMFCs) are particularly suitable for drones and portable electronics, where weight reduction and manufacturability are critical factors. Our goal in this study was to optimize the design of polymer-based bipolar plates for small-scale fuel cell applications by improving gas flow distribution and manufacturability. Computational Fluid Dynamics (CFD) simulations were conducted to evaluate different channel geometries, and injection moulding simulations were used to assess manufacturability. The final optimized processing parameters and part design, featuring a counter-flow configuration with semi-circular and U-shaped channels, demonstrated improved gas flow uniformity, reduced pressure drop of the gasses, and minimized part deformation caused by manufacturing. These findings contribute to the advancement of polymer-based fuel cells, enhancing their efficiency and feasibility for lightweight applications in transportation and portable energy solutions.

Keywords: proton exchange membrane fuel cell, computational fluid dynamics, channel design, optimization, injection compression molding

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