# NUMERICAL INVESTIGATION ON PERFORMANCE ENHANCEMENT OF SCALED UP DIRECT METHANOL FUEL CELL USING NOVEL FLOW FIELD DESIGN

**ABSTRACT**

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# ABSTRACT

Fuel cell technology is gaining momentum in commercialization and it is viewed as a next generation of power production to replace conventional non-renewable power production systems. The fuel cell stack design demands expertise from various fields such as mechanical, electrical and chemical engineering and continuous collaboration is required to address the key issues faced by Polymer Electrolyte Membrane Fuel Cell (PEMFC) system. For portable system and auto motives to be powered, PEMFC is seen as an alternative technology to sort out the issues of conventional and battery powered systems.

The massive commercialization of PEMFC is hindered by key issues like handling, storage and safety norms of hydrogen fuel. Methanol is substituted as an alternative to hydrogen fuel in fuel cell technology. Direct usage of methanol in fuel cell without reformation makes it Direct Methanol Fuel Cell (DMFC). Methanol is preferred over hydrogen because of its high energy density and safe handling. But power produced by DMFC is way behind PEMFC and it needs more development. Because of easy storage and handling, it has a potential of powering portable devices or handheld devices like mobile and laptop chargers.

Numerical modeling of DMFC aids in understanding complex problems like species distribution, charge transfer, heat dissipation and reactant transfers through flow channels, porous layers and solid membrane. Further, numerical studies are best in optimizing operating parameters and cell geometry to understand various physics involved in enhancing cell

performance. The present study aims to improve cell performance by modifying existing channels to cater key issues faced by DMFC. The performance of modified channel is tested against traditional serpentine channel to identify reasons behind performance enhancement. Cell performance is studied with different anode and cathode channel combination to find its impact on both sides. From this, a best flow channel combination for anode and cathode is predicted. The polarization plot revealed serpentine anode and zigzag cathode channel enhanced cell performance by distributing reactant uniformly. The zigzag channel on cathode side improved electrochemical activity by ensuring uniform oxygen and water concentration.

Further, the same combination is scaled up to 100 $cm^2$ active area to study its performance improvement against DMFC model with serpentine channel only. Different serpentine models are reported in literature by various researchers. Three different models of serpentine channel are chosen and its suitability on anode side is studied. The geometric study of zigzag channel is carried out to optimize the best geometry for cathode side. The channel width and rib width influence on cell performance is studied to optimize best geometry of zigzag channel. The serpentine channel's rectangle corner is reported to have more amount of reactant supply by changing flow direction. So, impact of number of bends in zigzag channel and its effect on cell performance is studied to optimize it.