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Optimized flow distribution for enhancing temperature uniformity across an open cathode PEM fuel cell stack

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The main objective of this work is to develop an open cathode low temperature polymer electrolyte membrane fuel cell (PEMFC) system for powering an unmanned robot. The major challenge in this work is 1.To develop a power source with higher energy de nsity 2.To have a compact design (lower volume and light weight stack) suitable for integrating with the in house robot platform.

So far the serpentine design is considered to be the o ptimal as it has the advantage of uniform flow distrib ution though with higher pressure drop. Due to the hi gher pressure drop a pump is required to supply the o xidant for chemical reaction. But with lower pressure drop and fairly uniform flow distribution open cathod e stack was designed which facilitated the use of blo wer which had a lower power consumption. In the op en cathode design the oxidant supply as well as the c ooling of the stack was taken care by the blower. The major issue of flow distribution and temperature grad ient across the stack was resolved with the present de sign.

(a) (b)

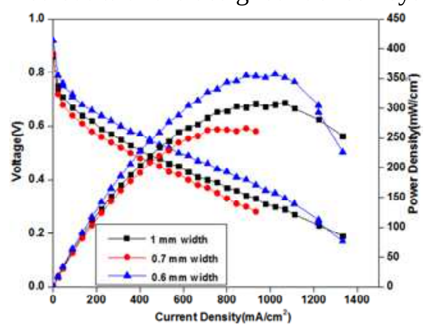
Figure1. Open cathode Fuel cell stack Model

Experimental Approach

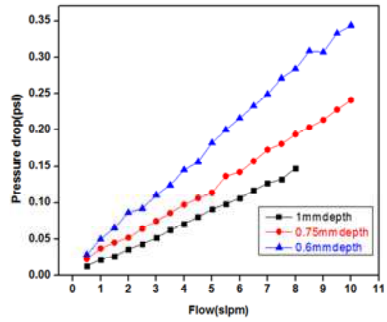
The pressure drop across the flow field which plays a dominant role in the flow distribution in a stack is tried to be optimized using simulation and experiments. The variation in performance with varying channel depth, channel width and rib width on the cathode is studied on a single cell level. The preliminary data recorded with the experiments are as shown in the fig 2. In this the width of the channel is varied and the performance as well as the pressure drop variation is compared. From the graph it was seen that the performance of the cell with 0.6mm width was better i.e., an inverse relation between the depth and the performance was observed. This was probably due to more gas molecules reaching the platinum sites due to higher pressure drop in the channel.

It was also observed that the pressure drop had a direct relation to the depth. As pressure drop decides the BOP consumption it was required to be low for higher efficiency and lower cost. So it was tried to vary the channel depth to obtain a lower pressure drop with higher performance. The design was modified to achieve the performance equivalent to that of serpentine cathode. Then based on the optimal design a stack with compact design, higher performance and lower BOP consumption is developed and tested with an in-house designed unmanned robot platform.

The temperature across the stack was observed to be uniform with less variation which resulted in a higher performance. This illustrated a uniform flow of coolant and oxidant. The Fuel cell dynamics study was carried out with the designed fuel cell system.



(a)



(b)

Figure2. (a)Fuel cell performance and (b) Pressure drop variations

References

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