CHAPTER 6

CONCLUSIONS

In final chapter of this thesis is to provide the main conclusions of the present work and recommendations for future works. The first section of the chapter gives the main conclusions that taken from the numerical and experimental results. Finally, a few recommendations are proposed for future works on both the numerical and experimental parts of the thesis. Recommendations for development a design flow field in proton exchange membrane fuel cell for improvement cell performance are given.

6.1 Conclusion

Research is study velocity and pressure distribution and electro-chemical of gas in polar plate and fuel cell by numerical modeling. The objectives are designed flow field and studied gas distribution in new flow field, which improved cell performance. The design is base on knowledge from results of gas distribution and concentration that studied on channel length, channel curvature, depth channel and inlet and outlet manifold. The experiments are building prototypes fuel cell form new flow field and testing. There are compare performance of fuel cell between numerical modeling and testing (old fuel cell and new fuel cell).

The results of different channel curve that inside curve and outside curve have influence on gas distribution in inlet curve and outlet curve, respectively. From studies, the non-fillet curve is also confirm the good configuration because it has non-uniform flow distribution and high pressure drop for the high electro chemical reaction in MEAs and water management. The result of effect flow-field path length can be concluded that changing flow-field configuration by varying path length of PEMFC by changing the number of parallel channels affect, its performance and uniformity. The longer path length gives more pressure drop. The result of effect flow-field depth and width was depend to changing depth and width channel flow-field configuration by changing the cross section area of channels can affect its velocity and mass flow rate. The lower cross section area gives higher than velocity and pressure drop. Moreover, a larger rib area reduces the contact resistance and easier water removal. The result of effect manifold flow-field was concluded that changing flow-field configuration by varying sizing of manifold can affect its gas distribution go to channel. The manifold gives show velocity distribution in take and out of channel and pressure drop. And effect curve manifolds flow-field were shown changing flow-field configuration by varying curve and fillet of manifold can affect its gas distribution go to channel. The curve manifold gives show gas distribution in take and out of channel and pressure drop. From results, there are can be used for design flow field to improve performance.

In this studied on velocity and pressure distribution are found 6 channels serpentine and non-fillet curve flow field has better performance more others because it has gas distribution all flow field area and good pressure distribution therefore it has

high flow rate for pulse water out of cell. Electro-chemical reaction in this flow field shown the concentration of gases is decrease and concentration of water is increase along length channel but in 6 channels serpentine and non-fillet curve flow field is concentration of hydrogen is decrease rapidly from inlet. From results of velocity and pressure distribution and electro-chemical of gas in polar plate and fuel cell are used for guideline in design new flow field, which helps pulse water out of cell, good gas distribution and moderately pressure for improved cell performance.

The new flow field is 2 ways multi-serpentine flow field with header, it combines between 6 channels serpentine flow field and header inlet at upper and middle flow field which inlet separate 3 channels to right and left of flow field. Outlet is combine 3 channels to 6 channels for help pulse and rest water. This flow field shown it has better performance more others because it has high flow rate and pressure drop, good gas distribution. Concentration of hydrogen is high decrease along length channel and concentration of water is high increase along length channel that it same serpentine flow field which has good electro-chemical reaction. The last, building of new flow fields are single cell prototypes and testing cell performance.

The experiment shown 2 ways multi-serpentine with header flow field fuel cell with old fuel cell (2 types) is controlled at room temperature and 50-70 ^{o}C cell temperature that current density and voltage and power density is used to considerate. New fuel cell has current density about 622.2 mA/cm^2 and 6 channels serpentine fuel cell has 565.2 mA/cm^2 and 4 channels serpentine fuel cell has 541.2 mA/cm^2 which it better performance about 10.03% and 14.91 %, respectively. In others operate conditions, it found at 70 ^{o}C cell temperature gave best current density therefore it can develop fuel cell in region for replacement old energy source.

6.2 Recommendations

3 D numerical modeling of PEMFC for analysis gas flow in channel and electro-chemical in fuel cell and experiment has improves it follow;

6.2.1 In electro-chemical reaction in this research is describe to concentration in gas phase only. It can not calculate in liquid phase for product but it has a major problem in operating fuel cell. Next, it should be use liquid phase model which it is found characteristic and location of liquid water in flow fields channel for a guide in good water management.

6.2.2 The research was used steady state in modeling. There is improved modeling to transient state for study to the electro-chemical reaction in gas consumption, gas transport and boring product of reaction and power density in begin until steady.

6.2.3 Numerical modeling predict to single cell. It can be improve modeling to stack cell for study to characteristic of gas flow in each flow field of stack cell and observe electro-chemical reaction, heat and power density of stack cell for large power source.

6.2.4 Performance of fuel cell has influent of heat problem therefore it should be study in heat management in electro-chemical reaction for observe to heat product in cell which in this thesis is isothermal.