CHAPTER 5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This work is concerned to the safe operation as well as long life time of proton exchange membrane fuel cell. Therefore, an effective control manner using the passivity concept is presented to regulate the stability of the stack temperature, the relative humidity and the cell voltage at the optimal level. PEMFC system is equipped with three control loops for control the hydrogen and oxygen pressure in anode and cathode channel, and the stack temperature by manipulation of the hydrogen and oxygen flowrate, and the cooling water flowrate.

The proton exchange membrane fuel cell (PEMFC) is non-passive system. Therefore, the weighting function is added to make PEMFC become strictly passive system. After PEMFC is strictly passive, the passive controllers are designed to make PEMFC system to be stable.

In this work, the control system can be divided into two scenarios, temperature-voltage control and temperature-voltage-humidity control. The cell voltage is controlled by manipulation of hydrogen and oxygen flowrate. The best control loop system is temperature-voltage-humidity control because it can achieve not only the membrane humidity but the stack temperature also. It should be note that although the PEMFC is operated at low temperature (75°C), the PEMFC still gives high performance due to the optimal level of membrane humidity (70%).

In addition, the passive controller works better than the simple PI-controller because the results of stack temperature, relative humidity and cell voltage with PI-controller are more oscillate than passive controller. Moreover, the rising time of system with PI-controller is more than passive controller which obviously seen in the cell voltage when the load current is changed. In view of failure-tolerant control system, the fuel cell system can be driven to stable state under disturbance even failure of one loop. However, the stability of fuel cell system is limited to two loops control failed.

5.2 Recommendations

5.2.1 The proton exchange membrane fuel cell (PEMFC) should be extended to be used in larger automotive due to its high power density by adding more cells to give the higher fuel cell power.

5.2.2 PEMFC pilot plant should be set up to verify the results with this developed model by using the same parameters, process gain and integral time of each loop control.

5.2.3 The others plant-wide processes need to be investigated with passivity concept due to its advantages.