# CHAPTER V
# CONCLUSIONS AND RECOMMENDATIONS

In this work, the sequential and simultaneous approaches for multiperiod HEN synthesis have been developed. The three-step sequential method comprises of HEN synthesis, HEN adaptation, and HEN integration. There are three alternative strategies can be used in HEN adaptation step. Each strategy was formulated in each model: model A is an MINLP with fixed process-exchanger area, model B is an NLP with fixed-exchanger topology using least square error of exchanger area as the objective function, and model C is an NLP with fixed-exchanger topology using minimum additional area as the objective function. As they were applied to a case study, it was found that model C could perform more effectively in HEN adaptation procedure when compared to other models because the algorithm of model C is likely to retain the old existing exchanger areas as much as possible. Moreover, there were less exchangers that needed to change area while changing periods. Therefore, it would be less complexity for the process control. For simultaneous approach, it was carried out using simultaneous MINLP multiperiod model which can be solved in one step.

The best sequential approach procedure and the simultaneous approach were compared by adapted case study of VGO hydrotreating process from a literature. It has been shown that the simultaneous approach can perform better than the three-step sequential approach in term of economic concern because it gave the solution with lower TAC. Furthermore, the obtained HEN from simultaneous method was less complex than that from sequential method.

Due to the higher performance of simultaneous approach, it was applied further to the refinery case study of CDU. It illustrated that the simultaneous MINLP multiperiod model could perform well and gave a satisfactory solution for large problem. Moreover, the simultaneous MINLP multiperiod model is quite rigorous since no initial feasible solution is needed for both of two case studies. But, as the problem size increases, the computational time required is also increased substantially. From this problem, an initialization technique was hence developed to find an initial feasible solution for the MINLP model. The average LMTDs

(ALMTDs) of each stream match and each period were calculated with the utilization of composite curves. These values of ALMTD were used in modified MILP model in order to generate rough solution which was entered as the initial value in the MINLP model. In conclusion, the initialization technique was successfully applied to the model. It could help reduce the time resource dramatically; moreover, it could improve the solution of HEN design.

It is suggested that when dealing with large problem that consists of many streams, the sequential approach would be more preferable because of a tendency to use less computational time. Or another way is to use the simultaneous approach with initialization technique.

The simultaneous MINLP mulitperiod model on the other hand is limited due to the fact that the generated superstructure does not include the non-isothermal mixing feature. And a series of heat exchangers in splitted streams could have probably caused some improvement on the solution. Moreover, it should be worthwhile to use GAMS for automated calculation of ALMTDs without any hand calculation.