CHAPTER V

CONCLUSIONS AND RECCOMMENDATIONS

5.1 Conclusion

In this thesis, HDA process with different energy integration schemes (i.e. alternative 1, 2 and 5) were studied, since six HEN alternative can be improved by introducing recycle streams and energy integration into the process. However, the recycle streams and energy integration introduce a feedback of material and energy among unit upstream and downstream. This work presents three plantwide designed control structures with three different energy integration schemes. The commercial software HYSYS was utilized to carry out both the steady state and dynamic simulations.

5.1.1 Steady State Simulation Results of HDA process

The steady state simulation results of HDA process alternative 1 have been compared with the earlier study by Luyben et al. (1998 and 2002), and the results are found consistent with those in the earlier study. Then, considering the consistency of the simulation results of the HDA process alternative 1 with respect to the previous work, the other alternatives considered in this work, i.e. alternative 2 and 5 are also developed in the HYSYS software environment. However, there are also some differences: for example, in the current study the flowrates of the reflux streams in the product and the recycle columns are larger and the reactor effluent temperature is lower than Luyben's work. The reasons for these differences may be in current study vapor-liquid equilibrium behavior is base on the Peng-Robinson equation of state and the stabilizer column is modeled rigorously, whereas in Luyben's work vapor-liquid equilibrium behavior was assumed to be ideal and stabilizer column was modeled as a component splitter and tank.

5.1.2 Dynamic Simulation Results of HDA process

In order to illustrate the dynamic behaviors of the control structures in HDA plant alternatives 1, 2 and 5 change in the heat load disturbance of cold stream and change in the recycle toluene flowrates were made. The dynamic simulation results have been compared with three difference control structure.

As can be seen in change in the heat load disturbance of cold stream case, when the cold inlet temperature of FEHE1 decreases, CS1 has better responses of the furnace and cooler utility consumptions are achieved here compared to CS2 and CS1. For CS3 control system can handle more disturbance and faster than other. In CS3 control system the tray temperature of column has a large deviation and it takes long time to return to it nominal value.

On the other case, a disturbance in the production rate is also made for this study. In this case has more oscillations occur in the most of temperature control loop are compare with change in the heat load disturbance of cold stream case .As can be seen that, the dynamic response of HDA process alternative 5 are slowest compare with those in HDA process alternative 2 and 1 . Those results indicate that the implementation of complex energy integration to the process deteriorates the dynamic performance of the process.

5.1.3 Evaluation of the dynamic performance

In this study, IAE method is used to evaluate the dynamic performance of the control system. For the change in the disturbance loads of cold steam on HDA process case the control system of HDA process alternative 1 for case is the most effective on compared with those in HDA process alternatives 2 and 5 i.e. the value of IAE in HDA process alternative 1 is smaller than those in alternatives 2 and 5.

As can be seen the similarity result between the change in the total toluene feed flowrates on HDA process case and change in the disturbance loads of cold steam on HDA process case, the value of IAE in HDA process alternative 1 is smaller than another alternatives. Therefore, those results indicate that the implementation of complex energy integration to the process deteriorates the dynamic performance of the process.

The IAE results for CS3 control structure look just the same as CS2 and CS1 control structure results. The performance of these control structures can be arranged from the best to lowest performance (error of controllability point of view) as the following sequences: CS3, CS2, and CS1.

5.1.4 Economic analysis for HDA process

In this study, we concentrate on the evaluation of the economics of a HDA process. From steady state pointview the benefit obtained from energy integration with the alternatives 1 to the others is given the energy cost savings from the energy integration fall between 4.68 and 18.53 %, but the capital cost rising are in the range from 2.20 to 18.32%.

In order to evaluation of operating cost the result show that the improved energy integration has allowed us to increase the recycle flows. The increased recycle flows actually decrease the utilities consumption.Economics of these control structures can be arranged from the best to lowest as the following sequences : CS1, CS3, CS2.

5.2 Recommendations

1. Improve the methodology to accelerate the dynamic performance of complex chemical process.

2. Study and improve the methodology of MPC plantwide control of HDA process.