CHAPTER I

INTRODUCTION

This chapter introduces the importance and reasons for research, research objectives, scope of research, procedure and method, expected result, and the research contents.

1.1 Importance and reasons for research

Most industrial process contain a complex flowsheet with several recycle streams, energy integration, and many different unit operations. The economic 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.

Many controls of heat-integrated systems have been studied by several workers. Terrill and Douglas (1987a, 1987b, 1987c) have proposed six HEN alternatives for the hydrodelakylation of toluene (HDA) process, in which their energy saving ranges between 29 % and 43 %. Further, study of plantwide process control has also been done by several authors. Luyben et al. (1997) presented a general heuristic presented a general heuristic design procedure for plantwide process control. Their nine steps of the proposed procedure center around the fundamental principles of plantwide control were energy management, production rate, product quality, operational, environmental and safety constraints, liquid-level and gas-pressure inventories, make-up of reactants, component balances, and economic or process optimization. In Luyben et al. (1999), the HDA process alternative 1 of Terrill and Douglas was used as one of four cases to apply their nine steps plantwide control design procedure.Wongsri and Kietawarin (2002) apply Luyben nine steps plantwide control design procedure to presented and

comparison among 4 control structures designed for HDA process alternative 1 withstanding disturbances that cause production rate change, the control structures was compared with reference on Luyben (1998) plantwide process control book. In 2004, Wongsri and Thaicharoen presented the new control structures for the hydrodealkylation of toluene (HDA) process with energy integration schemes alternative 3. Five control structures have been designed, tested and compared the performance with Luyben's structure. In the same year Wongsri and Hermawan Y.D. studied the control strategies for energy-integrated HDA plant (i.e. alternatives 1 and 6) based on the heat pathway heuristics (HPH). The study reveals that, by selecting an appropriate heat pathway through the network, the utility consumptions can be reduced according to the input heat load disturbances; hence the dynamic MER can be achieved.

Although several authors have studied the general design and control strategies for energy-integrated HDA plant but there is no report on study of the effect of energy integration on control performance for six HEN alternatives HDA plant, so in this research, it will focus on heuristic-based plantwide control procedure applied to HDA process for hydrodealkylation of toluene to form benzene that consists of a reactor, furnace, vapor-liquid separator, recycle compressor, heat exchangers and distillations. This plant is a realistically complex chemical process. It is considering that the energy integration for realistic and large processes is meaningful, useful and essential to design a control strategy for process associate with energy integration, so it can be operated well. So the main objective of this study is to evaluate performance of the control structures for the HDA process with energy integration schemes that are designed by Terrill and Douglas (i.e. alternative 1, 2, 3, 4, 5 and 6). In this work, the commercial software HYSYS is chosen to carry out both steady state and dynamic simulations.

1.2 Research objectives

1. To study the effect of heat-integration on hydrodealkylation (HDA) process.

2. To evaluate the performance of the control structures alternative 1, 2 and 5.

1.3 Scope of research

1. Simulation of the hydrodealkylation (HDA) of toluene process is performed by using a commercial process simulator -HYSYS.

2. Description and data of hydrodealkylation (HDA) of toluene process are obtained from Douglas, J. M. (1988), William L. Luyben, Bjorn D. Tyreus, and Michael L. Luyben (1998), and William L. Luyben(2002). The energy integrated hydrodealkylation (HDA) process is obtained from Terrill and Douglas 1987 (alternative 1, 2, 3, 4, 5 and 6).

1.4 Procedure Plan

1. Summary information regarding HDA process and evaluation method for evaluating plantwide control structure are reviewed.

2. Simulation of the HDA process with control structures.

3. Evaluation of the dynamics performance of the control structures.

4. Analysis of the simulation results.

5. Evaluation of the economics of the control structures.

6. Conclusion of the thesis.

This thesis is divided into five chapters.

Chapter I is an introduction to this research. This chapter consists of research objective, scope of research, contribution of research, and procedure plan.

Chapter II reviews the work carried out on plantwide control, Control Structure Design and heat integrated processes.

Chapter III covers some background information of plantwide and theory concerning with plantwide control fundamentals, plantwide control design procedure, control structure evaluation and engineering economic analysis of chemical process.

Chapter IV describes dynamic simulation results and evaluation of the economics of the control structures.

Chapter V presents the conclusion of this research and makes the recommendations for future work.

This is follow by:

References

- Appendix A: HDA Process Stream Data
- Appendix B: HDA Process Equipment Data
- Appendix C: Tuning of Control Structures
- Appendix D: Capital Cost and Manufacturing Cost Data