# CHAPTER I

# INTRODUCTION

This Chapter is an introduction of this research. It consists of importance and reasons for research, research objective, scope of research, contribution of research and research contents.

## 1.1 Importance and Reasons for Research

At present, the tendency of energy demands is rapidly increasing. With high fuel prices and the possibility of supplies in the years ahead, the importance of developing systems to use energy more efficiently is apparent. One of the major components in the chemical processing is the heat exchanger network, because it determines to a large extent the net energy consumption of the process. Tremendous efforts have been expanded to establish a series of systematic approaches toward conserving energy and also minimizing losses in the process industries.

Modern industrial processes contain a complex flow sheet with several recycle streams, heat integration, and many different unit operations. The main goal of the plantwide process control is how to develop the control loops that need to operate a process and achieve its design objectives. Normally, the problem is quite large and complex. It involves a large number of theoretical considerations such as a quality of controlled response, stability of the system, the safety of the operating plant, the reliability of control system, the ease of operation etc. Besides, it is very much open-ended problem. There are a number of possible choices and alternative strategies. So there is no unique "correct" solution because the "best" control structure for a plant depends on the design and control criteria established.

Terrill and Douglas (1987) proposed six different energy-saving alternatives of HDA process. The simplest of these designs (Alternative 1) recovers an additional 29 percent of the base case heat consumption by making the reactor preheater larger and the furnace smaller. The most complicated of the designs (Alternative 6) recovers 43 percent of the base case heat consumption. To control such a complex heat integration scheme (Alternative 6), design modifications to process is needed to ensure controllability and operability. Luyben (1999) solves some of the control diffculties associated with Alternative 6 by adding auxiliary utility coolers and reboilers to the process. The modified HDA process (Alternative 6) needs three new reboilers and three utility coolers to improved controllability. The coolers are located in bypass streams around the process-to-process reboilers so that disturbances in the heat balance can be dissipated quickly to utilities without propagating through the entire plant. For this structure, disturbances are rejected to the auxiliary coolers when the column temperature controllers divert excess heat around the main reboilers. The auxiliary reboilers are used to provide a quick source of energy for the columns. So, heat deficiencies in the process are not propagated to the next downstream unit operation. However, some of extra equipments and control valves added made this design less attractive economically, besides some equipment design issues are needed to be solved (Luyben, 1998).

In this work, the goal of this study is to use plantwide control strategies to develop the new control structures for the hydrodealkylation process with energy integration schemes that are designed to achieve the control objective and reduce the cost of production. The commercial software HYSYS is chosen to carry out both steady state and dynamic simulations.

## 1.2 Research Objectives

1. To design heat exchanger networks of Hydrodealkylation plant using load propagation method.
2. To design control structures for energy-integrated Hydrodealkylation plant.
3. To assess performance of the designed control structures for energy-integrated Hydrodealkylation plant.

## 1.3 Scopes of Research

1. The design control structures for energy-integrated Hydrodealkylation process are design using luyben's heuristics method.
2. The Hydrodealkylation process with energy integration schemes (Alternative 6 which given by Terrill and Douglas, 1987) is chosen for the case study.
3. The description of Hydrodealkylation process is given by Douglas (1988) and Luyben et al.,(1999).
4. Simulation of the Hydrodealkylation process (Alternative 6) is performed by using a commercial process simulator – HYSYS
5. The number of control structure design is 2 alternatives
6. To design 3 heat exchanger networks of HDA process (Alternative 6)

## 1.4 Contributions of Research

1. The new control structures of the Hydrodealkylation process with heat integration are designed and compared with the earlier work given by Douglas and Luyben.
2. New energy integrated designs of the Hydrodealkylation process

## 1.5 Research Procedures

The procedures of this research are as follows:

1. Study plantwide process control theory.
2. Study HDA process and concerned information.
3. Steady state simulation of Alternative 6 of HDA process.
4. Study of dynamic simulation of the HDA process.
5. Design of control structures for the energy-integrated HDA process.
6. Dynamic simulation for the energy-integrated HDA process with control structures design.
7. Assessment of the dynamic performance of the control structure.
8. Analysis of the design and simulation results.
9. Conclusion of the thesis.

## 1.6 Research Framework

This thesis matter is classified into 7 chapters as follows:

**Chapter I** provides reasons for objective, contribution, objective, scope, benefit and thesis outline.

**Chapter II** presents literature reviews related to control and design of heat exchanger network.

**Chapter III** presents background information of plantwide control, plantwide control design procedure; plantwide energy management and heat exchanger network are presented.

**Chapter IV** shows the description of the HDA process and the steady state simulation of highly heat integrated HDA process alternative 6 modeling.

**Chapter V** presents a design of workable complex heat-integrated HDA process and results of a steady state simulation.

**Chapter VI** shows the four new plantwide control structures and the three resilient heat exchanger networks for the highly heat integrated HDA process alternative 6 are present.

The overall conclusions and recommendations of this thesis are discussed in **Chapter VII**.