CHAPTER I

INTRODUCTION

An important problem in process control is to develop effective control structures for complex whole plants. In the past, the typical approach for plant-wide control was to design the control system for the individual units first, then combine these units to form an entire plant. This method works well when processes are in cascade form (i.e. without material and energy recycles) or large surge tanks are installed for processes with recycle streams to isolate the individual units. However, there is growing pressure to reduce capital investment, working capital and operating cost, and to respond to safety and environmental concerns. Design engineers have to eliminate many surge tanks, increase recycle streams, and introduce heat integration for both existing and new plants. Hence, the interest in the study of dynamics of chemical plants with recycles and plant-wide control design, has increased significantly in the last decade.

Dynamic simulation has become increasingly important as processes become more complex and are design and operated closer to constraint. The use of intermediate buffer tanks has been greatly reduced because of environmental and safety concerns. Increasing yields and suppressing the formation of undesirable and environmentally unfriendly by-products are often achieved by using complex flowsheets with many recycle streams. Increasing energy cots keep pushing design engineer toward more heat integration. All of these trends make dynamic control more difficult and dynamic simulation more important. Ideally the dynamic of the process should be considered at the very early stage of the development of a process.

Considering that plant-wide control design approaches are of recent origin, their application and evaluation to realistic and large processes with recycle streams, energy integration and non-ideal systems is meaningful and useful. As the computer software needed for plant-wide dynamic simulation is becoming commercially available, this provides the opportunity to study plant-wide control problems based on rigorous nonlinear dynamic models. The main objective of this study is to apply and evaluate a plant-wide control structure to the HDA process using a rigorous model on a commercially available dynamic simulator. The methods is systematic and considers the system dynamic model and controllability in the control structure. Hence, this method is selected for application to the HDA process. The commercial simulator chosen is HYSYS.PLANT.

1.1 Research Objectives

The objectives of this research are:

1. To develop a Hydrodialkylation model plant of toluene to benzene.
2. To develop an performance evaluation criteria of a plant wide control structure for the Hydrodialkylation process.
3. To test the performance evaluation criteria.

1.2 Scope of Research

1. The process is considered to simulate for both steady state and dynamic state.
2. The process follows the Hydrodialkylation process presented in Plantwide Process Control, William L.Luyben , Bjoin D. Tyreus and Michael L.Luyben.
3. Methods for evaluation of the control structures are as followed;
    - 3.1 Steady-State Analysis
    - 3.2 Dynamic Simulation
    - 3.3 Controllability Analysis

1.3 Contribution of Research

1. Hydrodealkylation model can be obtained by using HYSIS simulation program.
2. To evaluate the optimal control structure for Hydrodealkylation processes.
3. Provide guidelines for future control structures development.

1.4 Research Procedures

1. Summary information regarding HDA process and evaluation method for evaluating plantwide control structure are reviewed.
2. Simulation of a steady state hydrodealkylation model is developed and evaluate the control structure with the model.
3. Simulation of a dynamic hydrodealkylation model is developed.
4. Evaluation of control structure with the dynamic state hydro alkylation model is analysed by controllability analysis.
5. Simulation results are analysed and summarized.
6. The complete thesis is prepared.

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 activity plan.

Chapter II reviews the work carried out on plantwide control, Hydrodealkylation process and process controllability analysis.

Chapter III covers some background information of plantwide and theory concerning with evaluation of control structure.

Chapter IV describes Hydrodealkylation process and the simulated results of HDA process by HYSYS simulation. The results obtained by MATLAB are detailed in each section.

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

This is follow by:

References

Appendix A: Relative Gain Array

Appendix B: Data of HDA Process for Simulation

Appendix C: Parameter Tuning of Three Control Structures

NOMENCLATURES

g_{ij}	ijth element of G
G	Steady-state gain matrix
$\tilde{G}$	Matrix consisting of diagonal elements of G
$\tilde{G}_d$	Close Loop Disturbance Gain
u	Manipulated variable
y	Process variable
S	Sensitivity function

Greek symbols

λ_{jk}	Element in the j_{th} row and k_{th} column of relative gain array
Λ	Relative gain array matrix
$\bar{\sigma}$	Maximum singular value
$\underline{\sigma}$	Minimum singular value
γ	Condition number
γ_{ij}	Performance Relative Gain
Γ	Matrix of performance Relative Gain Array