CHAPTER 1
INTRODUCTION

1.1 Dynamic Distillation Simulation and Control

In recent years there is a dramatic increase in the use of microprocessor-based control systems in the processing industry, but unfortunately problems on the design and operating of complex systems have often occurred because the dynamic properties of the process to be controlled were not quite well understood. Dynamic simulation can be used at the begining of the project to study the steady state behavior of these systems under the influence of various control configurations. It ensures that the process will be operable and meet the product specifications when the process varies from steady state design. During the project, the simulation can also be used to complete the detailed control system design and solve process operability problems. After the project is finished, the same simulation is still useful for training. A product and economic conditions change in years later, such simulation can be used for process improvement programs as well.

Another area which could benefit from a fast dynamic simulation is education, especially on the process dynamic and control. There is no substitute for "hand's on experience" in the teaching of any subject. The lack of ability of the student to apply, in a real life manner, what he has learned from the theory is what sets process control apart from other subject areas in chemical engineering. Process design classes are an excellent attempt to simulation the "real world" for the purposes of the design skills the student has obtained in his various classes on process equipment design (i.e. distillation column, etc.).

1.2 History of Dynamic Distillation Simulation

Since the early 1950's attempts have been made to do dynamic distillation simulation. The advent of analog computers in the early 1950's permitted attempts to model distillation dynamics in a possibly realistic manner, but simplifications were forced by the limitations of the analog equipment. More wide spread availability and use of digital computers in the 1960's promoted a new attack on the dynamics system, but most of the earlier simplifications remained. Since then, these gradually moved from the easy simulation, through extended commercially available problem-oriented simulation. For instance, Huckaba et al.(1963) limited their attention to binary distillation at constant pressure, with liquid holdups and negligible vapor holdups. Varying liquid holdups were treated very effectively by Peiser and Grover (1962), but vapor holdup was again discounted. More recent simulations include a linearized, dynamic model, also the non ideality of contacting stages.

Up to this point the discussion has depended on the problems in modeling the physical system. Therefore the physical model must be addressed. At present, numerical integration is available for incorporation into a general simulation system. The modular approach to integration allows the used of explicit integration algorithms for the non-stiff equations and implicit integration algorithms for the stiff equations

1.3 The significance of this thesis

Dynamic simulation and control for a distillation column has proven to be an insightful and productive process engineering tool. It can be used to design a distillation process that will possibly produce quality products in the most economic fashion, even under undesirable process disturbances. Dynamic models provide a process engineering tool that has a long and useful life. As a result, there are a lot of research activity in dynamic control, both in academy and in industry. The knowledge of the dynamic control simulation is important to predict the start-up period of the process. It can also aid in control process if the process is not completely instrumental controlled. This program written is intended to be used as a tool for distillation dynamic and control studies. Students can study the dynamic of a distillation column and observe the continuous changes of results which make students' interest increse. This is the best substitute for "hand-on" in the teaching of any subject. In addition, there is much interest in distillation control in recent years due to the needs for reducing energy cost and meeting product specification.

1.4 Objectives

The objectives of this research are :

1.4.1 to develop a simulation program of a binary-system distillation column, and

1.4.2 to study dynamic responses of a distillation column for different types of control configurations.

1.5 Scope of Thesis

The scope of this thesis includes of the following concepts :

1.5.1 Dynamic model of a distillation column

The bases for mathematical models are the fundamental physical laws, such as laws of conservation of mass and energy. To study dynamic behavior, such general form of equation with time derivatives are used. Once all the equations of the mathematical model have been written, the thermodynamic property data will be investigated to compute the variable terms in the equations. After the model is completely designed, the numerical methods will be studied and selected to solve the problems.

1.5.2 Distillation column control

The dynamic distillation simulation program with various control configurations is developed. Dynamic responses of a binary-system distillation column for different types of control configurations are studied. The dynamic distillation simulation program with various control configurations is developed. A graphical user interface is also incorporated to the program.

The dynamic model and the control systems of a binary distillation column are translated into a computer program using in C language. There are four control configurations which can be selected to study. A user can change physical dimensions of distillation column and operating conditions. The results of this dynamic simulation are graphically displayed in terms of various controlled variables (i.e. product compositions, levels) versus time. The distillation column can be operated from atmospheric pressure to 150 psia. Physical and thermodynamic property data of at least 10 hydrocarbon substances are stored in the program and more component data can be added to the program.