CHAPTER I

INTRODUCTION

1.1 Background

Distillation column is one of the most important unit operations in chemical industries especially in refinery and petrochemical processes. It is used for separation of feed streams and for purification of final and intermediate product streams. When a feed material is introduced at one or more points along the column, liquid runs down the column, cascading from tray to tray, while vapour flows up the column, contacting liquid at each tray. Liquid reaching the bottom of the column is partially vapourized in a heated reboiler to provide boil-up, which is sent back up the column. The remainder of the bottom liquid is withdrawn as bottoms, or bottom product. Vapour reaching the top of the column is cooled and condensed to liquid in the overhead condenser. Part of this liquid is returned to the column as reflux to provide liquid overflow. The remainder of the overhead stream is withdrawn as distillate, or overhead product.

This overall flow pattern in a distillation column provides counter-current contacting of vapour and liquid streams on all the trays through the column. Vapour and liquid phases on a given tray approach thermal, pressure, and composition equilibriums to an extent dependent upon the efficiency of the contacting tray.

Steady-state process simulation is used routinely in the evaluation, selection, and design of new processes. In the past, all the pertinent design factors could be addressed with steady-state programs, however, there are new factors to be considered, and some of these have more to do with the operation and control of the column than with steady-state aspects. For example, the change of feed components, feed flow rate, reflux ratio, or any operating conditions are all important factors that tend to influence column operations. However, the operational aspect of column design is difficult to glean from steady-state simulations, and we must, therefore, consider dynamic simulations for answers. The dynamic calculations can be considered by writing material and energy balances including the accumulation terms for each tray in the column. In principle, the mathematic models describing distillation, especially for muticomponent distillation, are complex and have a large number of equations to be solved. Consequently, solution procedures are relatively difficult and tedious even are programmed for a high-speed digital computer.

By this reason, various mathematical procedures can be used to solve these equations with high accuracy, in this research, compartmental technique is selected in order to reduce the order of equations. The accuracy is compared with full-order model and simulation of the existing steady state program (PRO II).

1.2 Objectives

1.2.1 To understand the basic principles and behaviour of multicomponent distillation.

1.2.2 To develop the equations describing a multicomponent distillation using compartmental technique.

1.2.3 To compare the compartmental model with full-order model and actual ones.

1.2.4 To suggest guidelines for selection of a compartmental model structure to obtain a high degree of accuracy.

1.3 Scopes of Work

1.3.1 Create a computer program to determine promptly a dynamic distillation using mathematical model.

1.3.2 Select a large-scale petrochemical or refinery plant to be used as case study.

1.3.3 Find out actual data, i.e., feeds composition, operating condition, product composition, heat duty for reboiler and condenser existing in actual plant.

1.3.4 Compare the computer program in step (1) with an existing steady state simulation program, PRO II, to confirm the correction.

1.3.5 Determine the dynamic distillation with a step change of the selected plant by using full-order model.

1.3.6 Determine the dynamic distillation with a step change of the selected plant by using compartmental model.

1.3.7 Compare the results obtained in step (3), (4), (5) and (6) and then gain ideas on the magnitudes of each model.

1.3.8 Purpose the effects of order reduction on dynamic response accuracy.

1.4 Benefits Expected

1.4.1 To demonstrate how the compartmental technique could be applied to determine a dynamic distillation.

1.4.2 To use a computer program to study the behaviour of dynamic distillation when it needs to change something on operating distillation such as flow rate, composition, temperature or pressure, etc.