CHAPTER I

INTRODUCTION

In chemical process operations, energy should be conserved with an aim to minimizing total operating costs. If energy usage is reduced without considering its effect on the total operating cost or product quality, such as by arbitrarily reducing the reflux rate in a distillation column, the total operating cost may instead increase. For example, the use of products from a distillation column that are not pure enough could result in producing off-grade material that would require more energy for recovery or command a lower selling price. Optimization of a process operation leads to evaluating various trade-offs that result in minimum operating costs, and usually reduces energy consumption. The emphasis here is placed on optimizing existing chemical process operations.

An existing atmospheric crude oil distillation column, which for simplicity, is commonly called a " topping column " in an oil refinery plant and the petroleum industry, is considered for optimizing its operation. To do this, the performance of the column at a given crude oil and feed rate is simulated using a steady state mathematical model.

In the field of chemical engineering, the advent of fast electronic computing machines has stimulated the development of process simulators. Although they were primarily devised as a tool for process design, their use has been extended to simulation, optimization, performance and equipment rating. The present day simulator hardly resembles its forerunners in size or complexity. However, it is generally recognized that the core of a simulator centers on the modeling of distillation equipment. Previous research efforts have dwelt on the development of accurate and reliable mathematical models for most types of distillation columns including the topping column in refinery plant.

The topping column is normally classified as a type of absorber-type columns because the main column has a condenser but no reboiler and all of the sidestrippers are of the conventional type. Simulation of a system of distillation columns may be based on a system modular approach or a column modular approach. In the system modular approach, the complete set of material balance equations are solved simultaneously. In the column modular approach, each of the units (columns) in the system is solved sequentially in a predetermined order. At present, with respect to systems of distillation columns, the column modular approach, is more popular than the system modular approach. One possible exception is the topping column, since each sidestripper is small in relation to the main column, and it is easier to treat the particular system by the system modular approach rather than the column modular approach.

In this work, the technique adopted to simulate the existing topping column is a new combination of existing methods. It belongs to the " 2N-Newton-Raphson " class of methods or the " multi-Θ method " originated by Holland (1,2) and uses simple vapor-liquid equilibria and enthalpy models for solving the mass- and energy- balance equations. Details of this will be described later.

Operational, rather than design, objective functions for optimization are relatively straight-forward to define. Limitations due to existing equipment sizes, product specifications and operating characteristics can be specified and act as constraints on the optimization problem.

Simulation and optimization of many process operations are now widely practised throughout the chemical industry in a variety of applications.