Chapter I

INTRODUCTION

1.1 Evaporator

The vaporization of a liquid for the purpose of concentrating a solution is a common step in chemical processing and is done in many ways. Basically an evaporator consists of a heat exchanger, capable of boiling the solution, and a device to seperate the vapor phase from the boiling liquid. In its most simple form it might be a pan of liquid sitting on a hot plate. The surface of the hot plate is a simple heat exchanger, and vapor disengaging is obtained by the large area for vapor flow and its consequent slow rate of flow. In industrial operation the equipment is usually arranged for continuous operation, the heat exchange surface is vastly increased, boiling is much more violent, and vapor evolution is rapid. Such problem as foaming, scaling, heat sensitivity, corrosion, and space limitations are met. These problems have resulted in variations and refinements in evaporator design to meet different combinations of solution properties and economic conditions.

Today many types of evaporator are used in a wide variety of applications. The important types are open kettle pan, vaccumn evaporator, single or multiple-effect

evaporator, drum evaporator, thin film evaporator. The thin film evaporators have lately become very popular because these evaporators have high heat transfer coefficients at low temperature differences, and because of their small hold up. It was first introduced in the 1950's and employed successfully in the sugar industry, and further recommended for fruit juices. Thailand is an agricultural country. Lots of fruits and vegetables remain surplus, and often, are left rotten before being consumed during their peak seasons. Methods and techniques have been introduced to preserve these fruits and vegetables. Evaporation is the easiest method of removing the water from fruit juices which contain more water than is required in the final product which was storaged and transported. This type of the evaporator was expected to be suitable for this purpose.

1.2 Vertical Film Evaporator

For certain special application of evaporation, the falling film exchanger presents features that can not be matched by other types. These are inherent in the characteristics of film flow. They are: (1) lack of static head, which makes it possible to evaporate without elevation of the boiling temperature of the liquid, of crucial importance in evaporation at high vacumn; (2) short time of contact with the heating surface, a necessity

of heat-sensitive materials.

In this type of service, the entering process fluid is introduced at the top of the exchanger and is put in film flow inside the tubes by a distribution system which suitable for the quantities and properties of the fluid to be processed. The fluid flows under gravity through the tubes from top to bottom. There is no static liquid height in the tube, but only an accere-lation of the downward flow of the liquid film by the force of gravity. As the film of liquid is heated in its downward flow by the heating medium in the shell, usually steam, vapor bubbles formed in the tubes pass in the same downward direction at very high speeds and thus greatly accelerate the downward flow of the liquid film. The high speed of both vapour and liquid results in shorter exposure of the product to heat, usually less than a minute Vapor can be with drawn either from the top of the tubes or from the bottom. If bottom withdrawal is prefered, the vapour and the hot liquid in equilibrium with it air seperated in the bottom head. If vapor exit from the top is desired, the distributor must be of a type that allows the vapors to go through to the top.

In the present study, a vertical film evaporator was designed and constructed. The evaporator had the vapor removed from the top. The liquid formed a liquid head above the distributor, and was preheated in the preheater

to the desired temperature before introduced to the evaporator. By means of a distributor, the liquid was allowed to flow from the top of the vertical double pipe heat exchanger, as a thin film on the inside surface of the tube. The liquid film flowed downward by gravity, adhering and wetting all the tube surface.

1.3 Objective and Scope of Study

Evaporators are found the most commonly unit employed in chemical process industries. Effectiveness in evaporator design, which makes the process economical, required on understanding of the basic theories of heat transfer and methods of evaporation. Many investigators have found that the efficiency of the evaporator was improved when the liquid was spread in the form of a thin layer over the heating surface. The technical literature of this evaporator is quite limited in terms of experimental data or theoretically analysis. The objective of the present work was intended to study the effectiveness of an evaporator design.

To study the principal factors affecting the magnitude of the increase in evaporative film heat transfer coefficient, a vertical film evaporator, which supposedly has high heat transfer coefficient, was designed and constructed. These principal factors are feed rates, feed

temperature, temperature of heating surface, length of heated tubes, and physical properties of feeds. The effects of these factors on the film heat transfer coefficient have been investigated using sucrose solutions as an evaporating liquid. The results have been summarized, and are expected to be applicable to similar solutions such as fruit juice.