

Chapter I

INTRODUCTION

1.1 Concentration of Fruit Juices by Evaporation

It has long been known that 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, such as drying, pickling, canning, salting, glacing, etc., depending on the sorts of fruits and vegetables and the consumer acceptability/preference.

Fruit juices are consumed a lot according to their good flavor and taste, as a source of nutritional value, and also as thirst quenchers. However, the fresh taste of fruit juices is a difficult property to preserve over long periods of storage unless it is kept refrigerated at temperatures close to freezing. They may be spoiled through fermentation, molding, or souring caused by the growth of yeasts, molds, and acid tolerant bacteria capable of growing in the fruit juice. The activity of enzymes brings about changes in color and flavor, and it also causes formation of precipitation. They are considered as liquid foodstuffs within the scope of heat sensitive substances.

Evaporation is the easiest method of removing the water from

fruit juices which contain more water than is required in the final product. The finished product known as concentrated fruit juices have been appreciated in terms of reduced storage and transport requirements. Today many types of evaporator are used in a wide variety of applications. The various types have been developed largely to satisfy specific service requirements. Among them, the important types are open kettle pan, vacuum evaporator, single or multiple-effect evaporator, drum evaporator, thin film evaporator and so on. The selection of equipment for a particular purpose is governed by the characteristics of the dilute and concentrated liquids, such as heat sensitiveness, crystallisation, corrosion, and viscosity etc.

The falling film evaporators have lately become very popular. It was first introduced in the 1950's and employed successfully in the sugar industry, and further recommended for fruit juices. In the falling film evaporator, the dilute liquid flows vertically downwards on a heating plate or heating tube in form of a thin film under the influence of gravitational force as well as the influence of the descending vapors created by the evaporation of the liquid. It was realized that the initial concentration of liquid being evaporated was low, and hence the evaporation rate was high. However, due to the low viscosity, the residence time was short. After being concentrated for a period of time, the viscosity of liquid increased, but the evaporation rate decreased. Too long the residence time during this period might harm the product. Inclined-

film evaporator was expected to eliminate this problem.

1.2 Purpose and Scope of Study

The purpose of the present work was intended to study the concentration by evaporation of fruit juice under vacuum in an inclined film evaporator. The evaporator would be based on the principle of the falling film evaporator except that the heating plate would not be vertical but incline to some angle. Only one angle with constant inclination would be studied here.

Juice from Citrus reticulata Blanco (Mandarins) would be used to study the performance of the inclined-film evaporator because of its peak during the experimental period and it could be used in 'cut back' for orange juice processing. Other fruit juice such as pineapple, lime, tomatoes might also be studied.

The vacuum in the evaporator would be maintained as high as possible to reduce the boiling point of the juice and lower deterioration due to loss of flavor and due to development of cooked flavor. Hot water would be used as heating medium. The effects of hot water temperature and the flow rate of fruit juice on the performance of evaporation and on the quality of the concentrated product would be studied.

1.3 Application of the Present Study

It was expected that the present study would provide a new applicable evaporator to the fruit-juice-concentrate industries.

From the basic principle of falling film evaporators and the disadvantages found with them, inclined-film evaporators should serve to avoid the difficulties. The plate or the tube in falling film evaporator would be very long or very high if high concentration would be performed in the evaporators, because both the evaporation rate and the flow rate of liquid were high at the beginning. The evaporation rate and the flow rate decreased progressively as the liquid became more viscous as it flowed downwards. In the inclined-film evaporator, liquid with low concentration would be evaporated on inclined plate. The plate would have little slope in order to allow the liquid to flow less rapidly. The residence time would then be increased while the evaporation rate was high enough. As the more viscous fluid was obtained, the plate would have more slope to allow the liquid to flow under gravitational force. This, with the participation of high vacuum, the concentrated fruit juice would be of high quality.