Chapter 1

Introduction

1.1 Background and Rationale

Thailand is the largest natural rubber (NR) producing and exporting country in the world. Total amount of NR products in year 2004 was about 3.0 million metric ton (more than one-third of the world total) as shown in Figure 1.1. About ninety percent of the NR produced was exported. Their value was about 137,000 million bahts [1]. Generally, most of the natural rubber products are used in the vehicle tire production; hence, direction of NR production follows consumption in the world market. Amount of NR export from Thailand in the last three year has increased about 0.2 million ton per year. However, the increasing quantity is still not sufficient for the growth of the tire industry. In the coming years, it is expected that NR production will increase twice. To meet the expectation, improvement of NR production of 7 million Thai farmers in the community (particularly the Southern Thailand) must be carefully implemented.

In Thailand, NR has been produced in four types; ribbed smoked sheet (RSS), block rubber, rubber concentrated latex, and others [2]. The proportion of each type is 35%, 35%, 28% and 2%, respectively. Responding production of each type depends on the NR consumption in the world rubber market. The main consuming NR countries in the world are United States of America, Japan, China and India. The largest exporting markets of Thailand are Japan and China. At present, the consumption of rubber concentrated latex of the world rubber market is nearly constant. In contrast, both RSS and block rubber consumption is increasing. This follows the growth of the rubber tire industry.

In general, RSS is preferred in the NR market to the block rubber [3]. This is because RSS is produced directly from the rubber latex. Therefore, it is cleaner than the block rubber which is produced from the rubber scrap. Currently, production of RSS has been shifted to the community level entrepreneur groups, while the Block rubber is produced at large-scale industries. Finally, RSS production is supported by the government as now Thailand is the largest RSS exporting country accounting for 90% of the world total.

The Thailand government supported RSS production in the community level during the years 1993-1995 because of the declining price of rubber latex in the world market [4]. To keep the rubber price stable, the government supported establishment of rubber smoking cooperatives to produce RSS. Each cooperative received the support of around 3.2

million bahts for rubber smoking/drying factory construction. Many advantages of the organized cooperatives are quality control of the RSS, and price negotiation. Moreover, the benefit from the rubber sheet production will return to the communities.

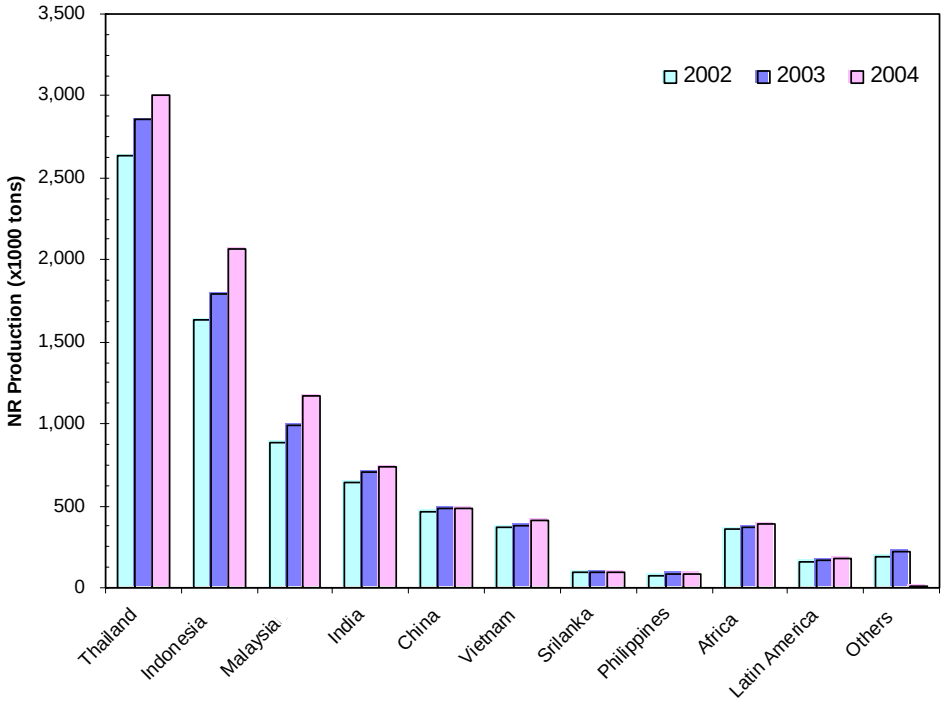

Figure 1.1 Data of NR production in the world.

At present, there are about 700 rubber smoking cooperatives throughout Thailand. More than a half of them are undergoing the RSS production, particularly in the South. The smoke drying or smoking procedure of RSS production is shown in the diagram in Fig. 1.2. Smoke drying is an important process which affects the quality and the price of the RSS.

There are two important problems arising in the smoking process of the RSS production. The main problem is the large variation of the temperature in the rubber smoking room which results in non-uniform drying of the rubber sheets. The other problem is a low efficiency of fuel usage in the smoking process. However, these two problems are related. The non-uniformity of velocity and temperature is caused by poor design of the smoking room. This also affects the efficiency of fuel consumption.

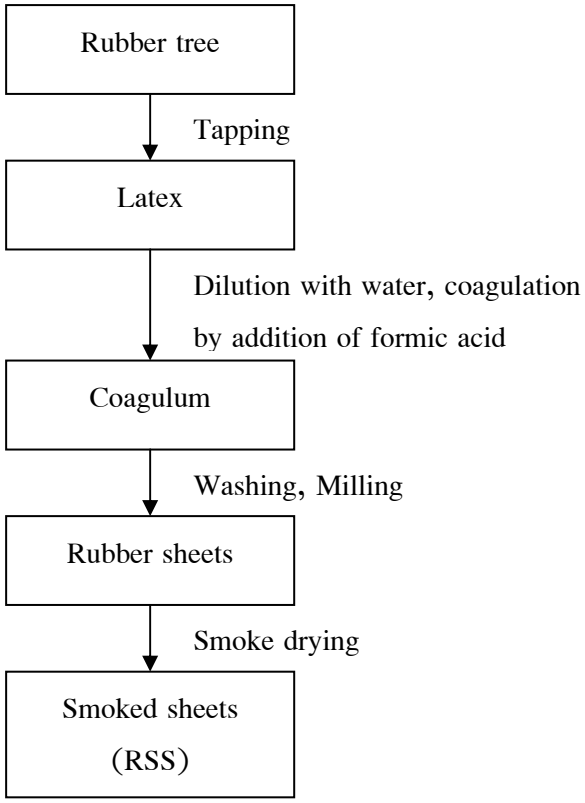

Figure 1.2 Procedure of RSS production.

Generally, there are two models of the present rubber smoking room [5]. These are models 1994 and 1995, named after the years they were built. Differences between two model rooms are the size of the smoking room which is used to contain the hanging rubber sheet carts and the geometries of the hot gas supply to the rooms. The model room year 1994 can contain three carts, but the model room 1995 can contain six carts. Each cart can hang up to about 500 rubber sheets. Therefore, the smoking room model 1994 and model 1995 can contain about 1,500 and 3,000 rubber sheets, respectively. However, at present, capacity of the smoking room model 1994 is generally sufficient for daily rubber smoking in the community level.

From the previous study of the smoking room model 1994 [6], temperature difference in the smoking room is as large as 15°C. This results in a non-uniform drying of the rubber sheets as shown in Fig. 1.3 which, in turn, affects quality of the dry sheets. Moreover, overall thermal efficiency of rubber smoking process is about 30% which is quite low. It was found that consumption of firewood is about 1.2 ton per ton of dried

rubber sheets. Results from investigation show that the non-uniform and low efficiency problems occurred from the uneven distribution of the hot gas from the ducts and high heat loss through the draft tube. This results from geometry of rubber smoking room which is not suitable, particularly, at the gas inlet and at the outlet of the room. The size, position and number of the gas supply ducts and the ventilating lids are not well designed. The rubber smoking room is a crucial component in the rubber smoking process. Improvement of the temperature and velocity distributions in the rubber smoking room is then necessary to increase uniformity of rubber sheet and efficiency of fuel usage.

Figure 1.3 Non-uniform RSS on a cart.

Computational Fluid Dynamics (CFD) has been widely used by many researchers to analyze problems of fluid flow and heat transfers, both for indoor and outdoor environments because it is time and cost saving, and very effective. Hence, this technique will be used to study flow and temperature distributions in the rubber smoking room. A validation study has been routinely carried out to determine the accuracy of the simulation results [7]. Experiment must be conducted to establish the benchmarking of the method prior to using it to improve the model.

In this research, CFD technique will be used to study and improve the temperature and velocity distributions in a present (original) smoking room model 1994. Outcome of this research will enable the rubber cooperatives to build new rubber smoking rooms with better performance.

1.2 Scope of study

1. Study the flow and temperature distributions in a present rubber smoking room model 1994 at steady state by using FloVent V5.2 program. Experimental verification will be performed.

2. Improve uniformity of flow and temperature in the rubber smoking room using FloVent V5.2 program by modifying the size, position and number of the gas supply ducts and the ventilating lids.

1.3 Objectives

The main objectives of this research are:

1. To study the velocity and temperature distributions in the present rubber smoking room model 1994 at steady state by CFD simulation along with experimental verification.

2. To design a prototype model of an improved rubber smoking room by CFD simulation for any entrepreneur who wants to construct a new rubber smoking room.