Chapter 2

Literature Reviews

2.1 Introduction

This chapter presents a literature review of the topics related to this work. Previous studies of factors affecting drying of rubber sheets are reviewed first as they should be controlled in a suitable range before beginning the experimental works. Computational Fluid Dynamics method in simulation of air flow and case studies using this method for solving the fluid flow problems are then reviewed. Study of temperature distribution and performance of rubber smoking room is also presented. Problems related to the smoking process will subsequently be reviewed. Finally, the chapter presents the literature remarks which conclude with the causes of the problems and also suggests an alternative way for solving the problems which is a goal of this research.

2.2 Studies of the factors affecting the drying of rubber sheets

Pomvisaid [8] studied effects of velocity and temperature on drying of rubber sheets. In the experiment, the temperatures were controlled at 29, 40 and 50°C, and the velocities were set at 0.18, 0.55 and 0.63 m/s for each temperature. It was found that the drying rate at 50°C was highest during the first 12 hours. After that, temperature had slight effect on the drying rate of the rubber sheets. It was concluded that effect of temperature was not clearly shown when less water quantity was presented in the rubber sheets. Furthermore, it was also found that the effect of velocity on drying rate at the same temperature was not significant. The range of velocity in this study could not show clear effect on the drying rate of the rubber sheets.

Tonsattayaleard [9] studied drying characteristic of fresh rubber sheets in a drying room. The parameters studied were temperature and velocity. Temperatures were fixed at 50, 60 and 70°C, while the velocity was controlled at 0.85 m/s. Results showed that the drying time increased with the decrease of temperature. At 70°C, the rubber sheets had highest drying rate, but the quality was unacceptable. It was concluded that temperature affected the quality of the rubber sheets and the drying time. The appropriate temperature of this study for rubber sheet drying was found to be 60°C.

Prasertsan and Kirirat [10] investigated the factors affecting rubber sheet curing. These include airflow rate, humidity, and moisture content of firewood. They divided the study into two main conditions. In the first experiment, the temperature was controlled at 65°C and airflow rate was set at 0.3 m^3/hr. The values of air relative humidity were set at 20, 40, 60, and 80 percent. In the other experiment, the temperature was controlled at 65ฐูC and the relative humidity was set at 40%. The values of airflow rate were set at 0.18, 0.30, 0.60, 1.20, and 2.01 m^3/hr. Results showed that for higher humidity condition, longer time was needed for drying the rubber sheets. Moreover, it was also found that at higher velocity, shorter time was needed for drying of the rubber sheets. After comparing effects between the airflow rate and humidity, it was found that the humidity had more important effect than the airflow rate in the drying of the rubber sheets. Furthermore, the firewood moisture also affected the rubber smoking time because quantity of heat supply from the fresh firewood was lower than from the dry firewood.

2.3 Computational Fluid Dynamics method in air flow simulation

Choudhary and Malkavi [11] employed the Computational Fluid Dynamics (CFD) method for modeling of the controlled temperature room. The simulation study was conducted along with the experiment. To validate results between simulation and experiment, they measured temperature at 27 points in the room. The results showed that an average temperature difference between model and experiment was about 0.4°F. Furthermore, the radiation model was added to a stabilized and calibrated model of the chamber, and an average temperature difference for the radiation model between the CFD results and the measurements was reported to be about 0.3°F. In conclusion of the validation study, the CFD method could be employed to study thermal analysis in the building.

Bartak, et al. [12] studied flow pattern and local mean age (LMA) of air in a room. Supply of air inlet was achieved by using a special nozzle that was designed to supply uniformly distributed air. CFD method (ESP-r program) and experiment were used in this study. In the CFD method, two conditions of grid setting, coarse and fine, were used in calculations. Results showed that fine grid setting gave more accurate results than the coarse grid setting when compared with the experimental results. Moreover, it was found that flow patterns were similar with the local mean age patterns.

Li, et al. [13] studied flow pattern of air in a test room by the CFD method and experiment. In the experimental work, a testing room quantity of air inlet could be controlled and the positions of the inlet and outlet could be changed. There were 2 positions of the inlets and 5 positions the outlets in the testing room. Results show that the positions of inlet and outlet were effected of flow pattern in the room.

However, there were no existing research works dedicated to the flow simulation in the rubber smoking room.

2.4 Temperature distribution and performance of the present rubber smoking room

Kalasee, et al. [14] experimentally investigated temperature distribution at 13 positions in the rubber smoking room model 1994 of a rubber cooperative in Songkhla province of Thailand. It was found that variation of temperature in the rubber smoking room during 36 hrs of rubber smoking was larger than 15°C as shown in Fig. 2.1. This resulted in a non-uniform drying of the rubber sheets, and hence, the quality of the dry sheets is affected. Moreover, they have improved the temperature distribution in the smoking room by modifying the size and number of the ventilating lids. The experimental results showed that temperature distribution in the smoking room was improved. However, the drying time of the rubber sheets was not affected.

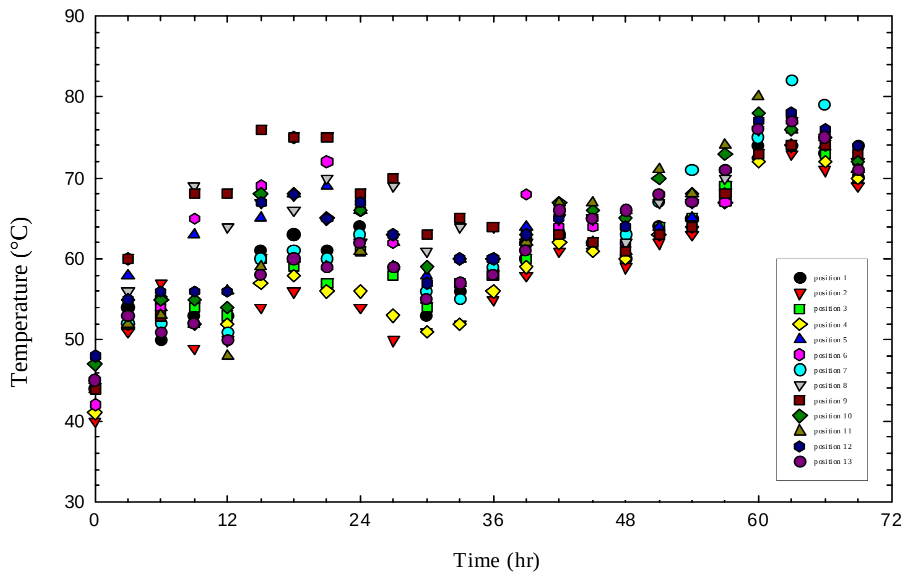

Figure 2.1 Temperature distribution at 13 positions in the rubber smoking room.

Kalasee, et al. [14] also studied performance of a present rubber smoking room (model 1994) by investigating consumption of firewood in a smoking process. It was found that consumption of firewood used to dry rubber sheets was as high as 1.2 ton per 1 ton of dried rubber sheets. It was also found that this high fuel consumption was a result of high heat loss through the exhaust (draft) tube.

In addition, they improved performance of smoking process by constructing a secondary room on the roof to delay an outlet flow of hot air. Moreover, the exhaust tube was not used. After the improvement, the firewood consumption was reduced to about 0.8 ton per ton of dried rubber. Thermal efficiency of the rubber smoking process was enhanced by 13%.

2.5 Literature remarks

The studies of the factors affecting the drying of rubber sheets show that if the air temperature, velocity, humidity, and firewood moisture can be controlled in a suitable range, the drying time can be reduced and quality of the rubber sheets can be improved. The review of Computational Fluid Dynamics method in modeling of air flow shows that CFD technique is effective for study of air flow patterns. Verification of the result shows that results from the CFD technique agree very well with the experimental results. However, no existing study of CFD simulation of air flow in the smoking room was presented. The exist study of temperature distribution in a present rubber smoking room shows that there is a large variation of the temperature during the smoking process. This causes non-uniform drying problem of the rubber sheets. Besides, the efficiency of fuel usage in the rubber smoking process is also quite low. Therefore, the improvement of the rubber smoking room is an alternative way which can increase uniformity of hot air flow and efficiency of fuel usage.