Chapter 7

Conclusions and Recommendations

7.1 Conclusions

The main objective of this research is to improve uniformity of temperature and velocity distributions in the rubber smoking room by CFD simulation in order to reduce fuel consumption and improve quality of the ribbed smoked sheets (RSS). In the simulation, the flow was assumed to be steady. In general, the flow in the smoking room is difficult to control and unsteady effect dominates. However, the steady-flow assumption helps facilitate the calculation and the results should be applicable to the actual process by regarding the flow as quasi-steady.

The study of the velocity and temperature distributions in the empty present original rubber smoking room by CFD simulation along with experimental verification was carried out in the Chapter 4. Results show that temperature difference at 15 positions in the smoking room between simulation and experiment is about 0.12-4.46°C. Differences between simulated and experimental results of average velocities at burner inlet and at the ventilating lids outlet are about 0.22 and 0.02 m/s, respectively. The agreement of results between the experiment and simulation is quite good. Therefore, it is possible to use the CFD technique for simulation of the flow in the present rubber smoking room containing rubber sheets and improvement of the flow in the model room as well.

CFD study of velocity and temperature distributions of the model of the present rubber smoking room containing rubber sheets hung on 3 carts was presented in Chapter 5. Results show that the temperature and velocity distributions in the room are highly non-uniform. Temperature variation in the smoking room is 51-66°C, and the velocity variation is quite large as well. Most of hot gas flows out of the model room through the rear ventilating lid, while the air from outside flows back into the smoking room through the front ventilating lid. Moreover, distribution of hot gas inlet at the gas supply ducts is highly uneven. High heat loss of the hot gas takes place at the gas exhaust (draft) tube. Results indicate that the size and positions of the gas supply ducts and ventilating lids are not suitable. In order to improve uniformity of temperature and velocity distributions, adjustment of these parameters are needed.

In Chapter 6, a new model of the rubber smoking room was obtained. Simulation results of various models to improve the rubber smoking room indicated that the sizes,

positions and number of the gas supply ducts and the ventilating lids significantly affected the temperature and velocity distributions. The optimal rubber sheet smoking room with the size of 2.6 m × 6.2 m × 3.6 m contains 154 hot gas supply ducts (2-inch-diameter), and four 25 cm × 25 cm, and four 25 cm × 20 cm ventilating lids as shown in case study 7-9. The suitable heat source input is 11,000 W which is equivalent to feeding of 15.3 kg of firewood (60.5% per dry basis) in 2 hrs. The reason for choosing this size of the smoking room is that it is suitable for general rubber smoking cooperatives located throughout the country. This improved model should help the rubber smoking cooperatives to achieve 27% saving in energy.

7.2 Recommendations

To improve accuracy of the simulation, it is suggested that the drying characteristics of the rubber sheet should be taken into account in the CFD simulation. This means moisture transport should be considered along with momentum and energy transports. Moreover, the unsteady nature of flow should also be included in the study.

In order to obtain good operation of the new model of the rubber smoking room, the heat source should be controlled at a nearly constant rate. This can be attained by controlling the feeding of firewood. A feeding mechanism is then necessary. The advantage of this equipment is not only the temperature variation control but it can also reduce the firewood consumption. Moreover, it is convenient for the workers who have to wake up at night to feed the firewood in order to maintain temperature in the smoking room.