

## Chapter 5

### CONCLUSIONS AND RECOMMENDATIONS

The superheated steam impingement drying of rubberwood was suggested as an alternative to conventional drying and was experimentally investigated in this study. The results indicated that a combination of superheated steam and air drying that was developed based on the following technique: (1) using saturated steam in the initial hours of drying to prevent stress buildup, (2) using superheated steam at 105°C and 110°C alternatingly with hot air (80°C) during the main stage of drying, and (3) using hot air continuously during the final stages to reduce the relative humidity inside the chamber and to remove the residual bound water during the final stages produced substantially reduced drying time. The drying time for 1 in. thick rubberwood lumber can be reduced from 7 days to less than 2 days.

Even though the high temperature had a significant influence on the mechanical properties of rubberwood when compared to the commercial industry, their properties still compared favorably to the reference values. After being superheated steam dried, the mean values of shear strength, compression parallel to grain, compression perpendicular to grain, modulus of rupture (MOR) and modulus of elasticity (MOE) were 13.46, 37.10, 1.93, 91.40 and 7387.64 MPa, respectively. The mean value hardness was 4259.03 N.

Comparison of mechanical properties between using superheated steam drying and data from reference shows that the mean value of the compression perpendicular to grain, the MOE and the hardness value were lower than the reference values. The mean values of the shear strength and compression parallel to grain and the MOR were higher than the reference values.

Hence, drying wood using superheated steam can deliver huge drying time and cost savings potential to the rubberwood industry, since the products can be dried in a fraction of the time it would if it were dried using hot air.

Some recommendations for further study are:

1. Although superheated steam drying can significantly shorten the drying time, the mechanical properties of the wood must be further investigated and future research is needed to improve the drying process using superheated steam/hot air.
2. In order to have reliable results from the comparison of the two drying methods, the selection of material used for further research should be chosen from the same piece of log to give as analogous a material as possible for the two drying methods.
3. Because a small number of rubberwood lumber was dried per batch in this study, the number needs to be increased from a lab scale operation to a commercial scale operation for potential applications in the industry.
4. Estimation of the energy requirement and the fixed and operating costs using superheated steam drying must be further investigated and determine which is more effective. If superheated steam drying present a huge cost saving and faster money return, recommendations should be made to the industries.