SOCIETY OF WOOD SCIENCE & TECHNOLOGY

Mendel University in Brno

Faculty of Forestry and Wood Technology

MASS LOSS KINETICS OF THERMALLY MODIFIED WOOD SPECIES AS A TIME-TEMPERATURE FUNCTION

INTRODUCTION

There has been a great scientific effort aimed at obtaining wood-based material that maintain its advantages over time and at the same time reduce its natural disadvantages such as natural variability, dimensional instability or biological degradability. Heat treatment considerable allows reduction some of these natural disadvantages in order to obtain enhanced products performance over the service life. Severity of the heat treatment process is commonly expressed as a mass loss. The mass loss as a consequence of the thermal degradation of wood is highly dependent on the initial wood characteristics such as wood species and its density as well as process parameters, such as drying level, heating medium, and treatment intensity. The knowledge about the mass loss kinetics of various wood species under different process parameters has therefore a high importance, not only to optimize the heat treatment process and control the product quality, but also to potentially predict required material properties of heat treated wood. Therefore, the main motivation of this study was to analyze mass loss and equilibrium moisture content kinetics for selected softwood and hardwood species as a function of time and temperature.

MATERIAL & METHODS

The mass loss kinetics during heat treatment of selected wood species was experimentally analyzed. European beech (*Fagus sylvatica* L.), English oak (*Quercus robur* L.), Norwegian spruce (*Picea abies* L. Karst.) and Scots pine (*Pinus sylvestris* L.) wood specimens were heat treated at 140°C, 160°C, 180°C, 200°C and 220°C for 1 to 6 hours in thermal modification chamber (Fig. 1) using atmospheric pressure and superheated steam environment. The process intensity was determined by mass loss (M_L), based on oven-dry mass before and after the heat treatment. Furthermore, the equilibrium moisture content (EMC) was determined before and after heat treatment to analyze the effect of mass loss on the sorption properties.

Figure 1 Laboratory thermal modification chamber

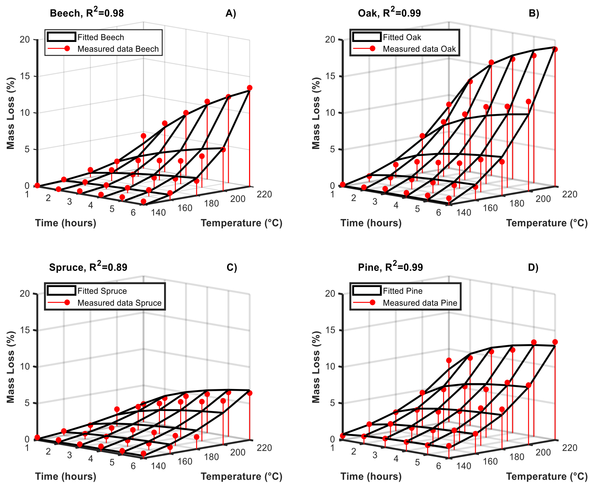

Figure 2 Mass loss results of selected wood species rendered as a time-temperature function

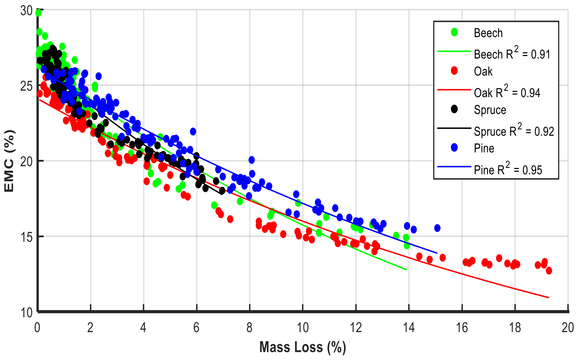

Figure 3 Exponential correlation between EMC (20°C, 99% RH) and mass loss of various thermally modified wood species

RESULTS AND DISCUSSION

The M_L (Fig. 2) was found to be less than 1–1.5% when temperature of 140°C and 160°C was applied. Differences between studied species were more significant at temperatures higher than 160°C. At higher temperature (220°C) a mass loss attained of 13.5% (beech), 18.8% (oak), 6.7% (spruce) and 13.5% (pine). The EMC was reduced after heat treatment within the range of 4 – 48%, 0.4 – 47%, 1 – 32% and 0.7 – 40% for beech, oak, spruce and pine, respectively. The reason for the decrease of the EMC is that less water is absorbed by the cell wall after the heat treatment as a result of chemical compounds degradation with a decrease of hydroxyl groups. Further, the EMC correlates exponentially (R^2=0.91–0.95) with the decrease of specimen's mass depending on the used wood species and modification temperature applied (Fig. 3).

CONCLUSIONS

The thermal degradation reaction is strongly influenced by the nature of studied wood species.

The nature of the wood species becomes more important at higher temperature (>160°C) due to the differences in thermal degradability between softwood and hardwood chemical compounds.

EMC was considerably reduced after the thermal modification depending on the temperature and time conditions used during the process.

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