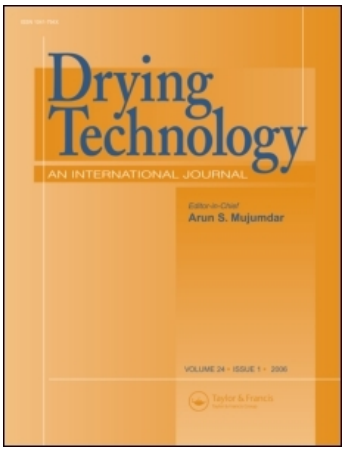

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Some Physical Properties of Heat-Treated Hornbeam (*Carpinus betulus* L.) Wood

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Thermal treatment of wood alters its structure due to degradation of wood polymers (cellulose, hemicellulose, and lignin), so the physical properties of wood are either improved or worsen. In this study, the effect of thermal treatment on density, equilibrium moisture content (EMC), and color of hornbeam wood was investigated. The color and density (air-dry and oven-dry density) were determined for the control and heat-treated samples, as well as their equilibrium moisture content at relative humidities of 35, 50, 65, 80, and 95%. The data showed that thermal treatment resulted mainly in darkening of the wood and the reduction of its density and EMC. It was found that the treatment temperature had a much more significant impact on color changes than the duration of the treatment. Generally, heat-treated wood color becomes darker than nontreated wood, so it can be used as decorative material. Because the EMC is lower, the heat-treated wood can be used in saunas and pool sides. Also, heat-treated wood can be used in outdoor applications because of lower density.

Keywords Color changes; Density; Equilibrium moisture content; Hornbeam wood; Thermal treatment

INTRODUCTION

Heat treatment of wood has been used to dry wood and modify its properties since ancient times. At present, heat-treated wood can be produced by using different thermal processes yet for the same reasons. Heat treatment of wood has an important effect on its chemical composition and its physical and mechanical properties. In addition to better durability, the features of heat-treated wood include reduced hygroscopicity, improved dimensional stability, and desirable changes in its color. The characteristic properties of heat-treated wood are generally different from those of dry but untreated wood. For example, after thermal treatment, wood is less hygroscopic than kiln-dried wood.[1–4] This feature reveals through reduced swelling and shrinkage, which can be as much as 50% for higher temperatures (>200°C) and longer times. In that context, the sorption and desorption characteristics are also altered. The water uptake by heat-treated wood is slower, and the water release is faster than for kiln-dried wood.[5–7] It is furthermore clear that the equilibrium moisture content is reduced by up to 40% compared with untreated wood.[6,8,9] Dimensional stability and durability, which are strongly associated with the reduction of the hygroscopicity, are improved as a result of the improvement of the product essential properties. However, the loss of strength has always been one of the main drawbacks for the commercial utilization of thermally treated wood.

Heat-treated wood has been found to be brittle compared to kiln-dried wood, especially for treatments over 200°C. This brittleness generally increases with increased treatment temperature and time. The impact strength, modulus of rupture (MOR) bending strength and modulus of elasticity (MOE) can be reduced by up to 50%.[10–14] Hardness and abrasion resistance are also affected and significant reductions have been reported.[11,15–17]

Heat-treated wood is often appreciated for its light- to dark-brown appearance.[8] Therefore, heat-treated wood has been suggested as a substitute for some tropical hardwoods. Both treatment time and temperature can be varied to produce a specific, brownish color. Prolonged treatment time and/or raised temperature usually give the wood a darker color. Furthermore, according to heat treatment temperature and duration, wood generally turns into a lighter and darker material and therefore it has been suggested that the color can be used as an indicator of the degree of conversion[18] and losses in mechanical properties.[14] However, the attained brownish color is not stable when exposed to light.[4,7,19–21]

The colored substances in the wood are eventually degraded and washed out if the wood is exposed outdoors, leaving a bleached and grayish appearance. No cost-effective and easy method to prevent this fading has been described. As opposed to other chemical modification methods,[22] in most thermal treatment processes no reacting chemicals are added during wood treatment. In the thermal treatment of wood, chemical transformations are caused principally by autocatalytic reactions of the cell-wall constituents.

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