The Influence of Thermal Treatment on Color Response of Wood Materials

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Abstract: In this study, the influence of thermal treatment on color changes of six different wood materials was investigated. Test specimens were subjected to three different temperatures (160, 180, and 200°C) and durations (3, 5, and 7 h). The data obtained were analyzed using variance analysis, and then the statistical analysis of Tukey's test was conducted. After this treatment, the results showed that the color values of the six wood materials changed significantly. It was determined that L (lightness) values decreased; the minimum change in L* was ~4% for Juniper wood, and the maximum change in L* was ~64% for Beech wood. The values of a* (red coordinate) and b* (yellow coordinate) showed varying levels of increase when the heat treatment conditions were 160°C for 3 to 7 h (not including Cherry wood), but the values began to decrease slowly after treatment at 160°C for 5 h. The ratios of the minimum and maximum color change in a* and b* were determined at 180°C for 3 h in Plane wood, 200°C for 5 h in Hazelnut wood, and 160°C for 3 h and 200°C for 7 h in Beech wood. As temperature and duration were increased, the minimum total color change (ΔE^*_{ab}) was ~3.5% for 160°C at 3 h in Cypress wood, and the maximum total color change (ΔE^*_{ab}) was ~50% for 200°C at 7 h in Cypress wood.* © 2010 Wiley Periodicals, Inc. Col Res Appl, 37, 148–153, 2012; Published online 2 December 2010 in Wiley Online Library (wileyonlinelibrary.com). DOI 10.1002/col.20655

Key words: thermal treatment; wood; color change; colored substances

INTRODUCTION

Wood is a complex and natural material that consists basically of cellulose (40–45%), hemicelluloses (20–30%), and lignin (25–35%). Cellulose represents the crystalline area of the wood, whereas the structures of hemicelluloses and lignin make up the amorphous area. The main mechanical function of hemicelluloses and lignin is to buttress the cellulose fibrils.[1]

Wood materials can be degraded by attacks by numerous biological species and by environmental conditions, so they are protected by the use of various treatment processes. One of these processes is the thermal treatment of wood materials.[2] The thermal treatment of wood is an environmentally-friendly method that is used for protecting wood. The thermal treatment process only uses steam and heat, and no chemicals or agents are applied to the material during the process. Testing of the wood after such treatment has shown that the treatment results in no harmful emissions when the wood is used in various applications.[3]

When thermal treatment is applied, the cell wall components of wood (cellulose, hemicellulose, and lignin) are modified, and this modification changes the physical, mechanical, chemical, and biological properties of wood materials. Heat treatment has important effects on the color and chemical composition of the wood. Thermally-treated wood has better durability, reduced hygroscopicity, improved dimensional stability, lower density than control samples, and darker color. The darker color has led some investigators to suggest that the color can be used as an indicator of the degree of conversion.[2]

The consistency of the color varies due to the normal variations of the density of softwoods, and color also depends on whether earlywood or latewood is used. The color of wood characterizes the appearance of wood, and it is determined by chemical compounds, including cellulose (which is white and makes up the highest percentage of the wood structure), hemicelluloses, lignin, and extractives. After thermal treatment, the color of the wood is affected mostly by the color of the extractives, which make up a very small percentage of the wood's structure.[3] When wood is exposed to high temperatures, aldehydes and phenols are formed, leading to the formation of colored compounds as a result of the chemical reactions[4] that

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