

The density and bending strength of Turkish red pine wood treated with geothermal waters with different temperature: A case study from Sakarya, Turkey

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Abstract: Geothermal resources waters containing various chemical substances are used in different application areas. In order to make a rational use from these sources, the effects on some important technical properties of wood material in practice need also to be determined. The purpose of this study is to investigate the properties of density and bending strength of pine wood treated with geothermal resource water with different temperatures. The study used the geothermal resource waters of Geyve, Kuzuluk and Taraklı from geothermal fields of Sakarya region of Turkey, hot-cold dipping method (thermal method) and sapwood samples of Turkish red pine (*Pinus brutia* Ten.) as experimental materials and methods. The hot geothermal waters were taken from the geothermal resources, and cooled to normal environmental conditions. For each geothermal resource, the treatment fluids with four different temperature (23°C, 48°C, 69°C, 92°C) were prepared with $\pm 2^\circ\text{C}$ degrees of precision. The density and bending strength tests were carried out separately on wood samples impregnated with treatment liquids according to thermal method technique. Findings obtained from tests were analyzed and evaluated statistically. According to this, in treatment with different temperature geothermal water, for sapwood samples of Turkish red pine, the values of density varied between 0.53 g/cm³ and 0.57 g/cm³ while the values of bending strength ranged from 76.82 N/mm² to 118.94 N/mm². For three geothermal resources, the geothermal water temperature affected significantly the bending strength, but did not important effect on density. In this treatment, according to untreated control wood specimens, the density values of test wood specimens increased while the bending strength values decreased. Statistically, the density value increasements were found insignificant while the bending strength value decreases were found significant. However, due to the increase in temperature of geothermal resource water, the density values of wood samples increased while their bending strength values decreased. For density value, while the highest increment was found to be 0.57 g/cm³ in treatment with Kuzuluk geothermal water at 92°C, the lowest increment was found to be 0.53 g/cm³ in treatment with Taraklı geothermal water at 48°C. For bending strength value, the lowest reduction was 76.82 N/mm² in treatment with Geyve geothermal resource water at 92°C, while the highest reduction was 122.87 N/mm² in treatment with Taraklı geothermal resource water at 48°C.

Keywords: Geothermal, Wood impregnation, Density, Bending strength, Sakarya