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Hydroxyl accessibility and dimensional changes of Scots pine sapwood affected by alterations in the cell wall ultrastructure during heat-treatment

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Abstract

There is a complex link between the water sorption behavior and the presence of accessible hydroxyl groups in the wood cell wall, which can be altered by heat-treatment (HT). This study analyses the effect of changes in the cell wall ultrastructure caused by two HT techniques on the hydroxyl accessibility, water vapor sorption and dimensional changes of Scots pine (*Pinus sylvestris* L.) sapwood. HT of wood in pressurized hot water at 120-170 °C was applied to cause the preferential bond cleavage, whereas HT of wood in oven-dry state in superheated steam at 180-240 °C was performed to create additional covalent cross-links within the cell wall matrix. Removal of cell wall polymers by HT and water leaching reduced the oven-dry dimensions of wood and enhanced the cellulose aggregation during drying. Cellulose aggregation restricted the cell wall shrinkage in circumferential direction, resulting in inhomogeneous shrinkage of the cell wall with only little changes in lumen volume by HT. Cellulose aggregation also reduced the water-saturated dimensions, but a decrease in swelling was only achieved when additional cross-links were formed by HT in dry state. Additional cross-links in the cell wall matrix also resulted in an additional reduction in water sorption at 25 °C and 93 % RH. However, this was not caused by a further reduction in the hydroxyl accessibility. Instead, cross-linking was shown to reduce the amount of accessible OH groups that are simultaneously active in sorption, which was explained based on the concept of sorption of water dimers at hydroxyl group pairs at high RH levels.

Keywords: Elemental analysis; Hydrogen-deuterium exchange; Mercury intrusion porosimetry; Thermal degradation; Water interactions; Wood