Thermo-densification of beech wood pretreated with furfurylation

DAMAY Jérémie[1], ETIENNEY Bertille[1], OBOUNOU AKONG Firmin[1], SEJATI Prabu Satria[12], DWIANTO Wahyu[2], GERARDIN Philippe[1]

[1]LERMAB, EA 4370, Université de Lorraine, Faculté des Sciences et Technologies, BP 70 239, F-54506 Vandoeuvre-lès-Nancy, France
[2]Research Center for Biomaterials, National Research and Innovation Agency (BRIN), Jl. Raya Bogor Km. 46, Bogor 16911, West Java, Indonesia
prabu-satria.sejati@univ-lorraine.fr

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Context and objectives

Wood is natural polymer that easily degraded by biotic as well as abiotic factors. Therefore its utilization as a building material is not quite optimal. Furthermore, competition with other building materials utilization forced the supply of high quality wood based products. In this regards, wood modification including furfurylation, has been developed to obtained high dimensional stability and durability of wood as well as to replace the conventional preservation method that potentially pollute the environment. In other side, wood densification seems to be interesting way to increase mechanical properties of wood. European beech (*Fagus sylvatica* L.) is a major tree species of European forest that is underexploited because of its low dimensional stability and durability. The purpose of this study is to combine these two methods to enhance beech wood dimensional stability and hardness especially (Pfriem et al. 2012).

Materials and method

Samples were impregnated under vacuum with a furfuryl alcohol solution containing tartaric acid as catalyst and water (Sejati et al. 2017). Solutions used in this study were furfuryl alcohol solution varying from 50%-90% and tartaric acid 5% and the rest being water. A diffusion step and a drying step at room temperature were applied. Afterwards, samples were thermo-densified using a heating press, inside which compression and curing took place (Han 2019). Diffusion time and air-drying duration were ranged 15h to 24h. Samples were maintained compressed during the whole curing duration (Westin et al. 2009). Temperature of compression was 120°C, range of time was from 5h to 8h. Compression ratio was set to 15% and 30% in tangential direction. The modified wood than characterized by the weight percentage gain (WPG), density, dimensional stability, set recovery or linear swelling in the compression direction, and the Brinell hardness.

Results and discussion

Weight percentage gain (WPG) represent the furfuryl alcohol polymerized to the wood. Table 1 showed that higher concentration of FA resulted higher WPG after pressed with 15% compression ratio. Furfurylated wood pressed with 15% compression ratio resulted higher WPG than those pressed with 30% ratio. Wood densification increased the density of water impregnated wood from about 0,7 g/cm³ to 0,78 g/cm³, meanwhile the densification of furfurylated wood with 15% compression ratio increase 40-48% its density. Even though 30% compression ratio treatment resulted lower WPG, the density was increase 68% than the native beech wood.

Tab. 1: WPG and density of thermo-densified wood pretreated with furfurylation in different condition of impregnation solution and pressing

Solution	Compression parameters	WPG (%)	Density (g.cm^{-3})
H_2O	t=15h, c=15%	-0,42±0,04	0,78±0,01
50% FA + 5% TA	t=5h, c=15%	35,31±0,68	0,98±0,01
60% FA + 5% TA	t=5h, c=15%	36,10±1,24	1,04±0,01
85% FA + 5% TA	t=8h, c=15%	38,81±0,70	1,03±0,01
90% FA + 5% TA	t=8h, c=15%	41,07±3,02	1,04±0,01
85% FA + 5% TA	t=8h, c=30%	31,67±1,66	1,17±0,03
90% FA + 5% TA	t=8h, c=30%	30,70±0,67	1,16±0,01

FA: Furfuryl Alcohol, TA: Tartaric Acid, t: duration, c: compression ratio, WPG: Weight Percent Gain

Figure 1 showed that furfuryl alcohol polymerization play important role in the dimensional stability of densified furfurylated wood. Wood swelling of 30% compression ratio treatment ranged from 13,45 to 16,42%, while sample treated with 15% compression ratio show better swelling between 11,58 to 12,78%. These results were better than that for the sample impregnated with water alone, which resulted in 33,69% of swelling. Without any pretreatment, wood will recover to part of its initial thickness after the densification. Set recovery was measure in the direction of wood compressed. In line with the swelling result, furfurylation pretreatment seems resulted permanent fixation than water impregnated densified wood.

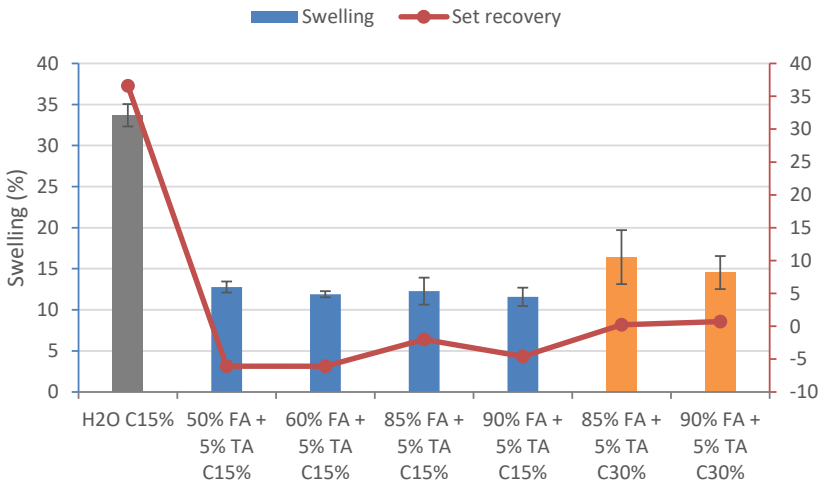

Fig. 1 : Swelling and set recovery of thermo-densified wood pretreated with furfurylation in different condition of impregnation solution and pressing

Conclusion and perspectives

Modification of beech wood by combination of thermo-densification pretreated with furfurylation showed promising alternative method that could increase its density, dimensional stability, fixation, and mechanical properties, thus offering new non-biocidal alternatives the use of some toxic preservatives and use of endangered exotic species. These improved properties might lead to new uses for modified beech wood.

Reference

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