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REDUCTION OF THE SET-RECOVERY OF SURFACE-DENSIFIED SCOTS PINE BY PRE-TREATMENT WITH SODIUM SILICATE OR SODIUM HYDROXIDE

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Surface densification of wood increases its density and hardness. Low-density wood species have a particularly high potential for improved properties, and over the past years the topic has attracted an increased interest within the field of wood modification.

So far, the effects of different densification processes on the properties of the densified wood has been in the focus of research studies [1-3], but industry-related aspects, such as the time consumption or the process costs, have not been considered. In 2016, Neyses *et al.* surface-densified solid wooden boards in a high-speed continuous roller pressing process, which opens up the potential for industrial applications of this technique [4].

However, elimination of the moisture-induced set-recovery in a cost-effective way is still necessary before industrial implementation is viable. It is possible to eliminate the set-recovery, but the existing techniques are rather time-consuming [5, 6]. The aim of this study was therefore to assess the efficacy of a fast pre-treatment of surface-densified Scots pine to achieve a chemical modification of the wood surface.

Sodium silicate and sodium hydroxide were chosen as impregnation agents because they are considered to be both environmentally friendly and cheap. Sodium silicate polymerizes and mechanically stabilizes the wood cells, and sodium hydroxide chemically activates the wood surface.

Scots pine sapwood boards with dimensions of 149x25x17 mm were densified in the radial direction using the approach and equipment described by Rautkari *et al.* [7]. After chemical pretreatment, the specimens were densified on the heated side of the specimen with a compression ratio of 12% and a closing time of 30 s. After a holding time of 60 s at 130°C, the specimens were cooled to below 80°C before being unloaded.

Table 1: Overview of the types of treatment.

Group	Type of treatment	Concentration [volume %]
R	Not pre-treated	-
S20, S50, S80, S100	Na_2SiO_3	20, 50, 80, 100
H0.4, H4, H8	NaOH	0.4, 4, 8

The specimens were pre-treated with aqueous solutions of either sodium silicate (Na_2SiO_3) or sodium hydroxide (NaOH) (Table 1). For each type of treatment 15 specimens were taken. The pre-treatment was carried out by brushing the solutions on the sapwood side of the specimens with a paper towel. The impregnation time until densification was 90 seconds. The set-recovery was determined according to Laine *et al.* [4] after one, two and three wet-dry cycles.

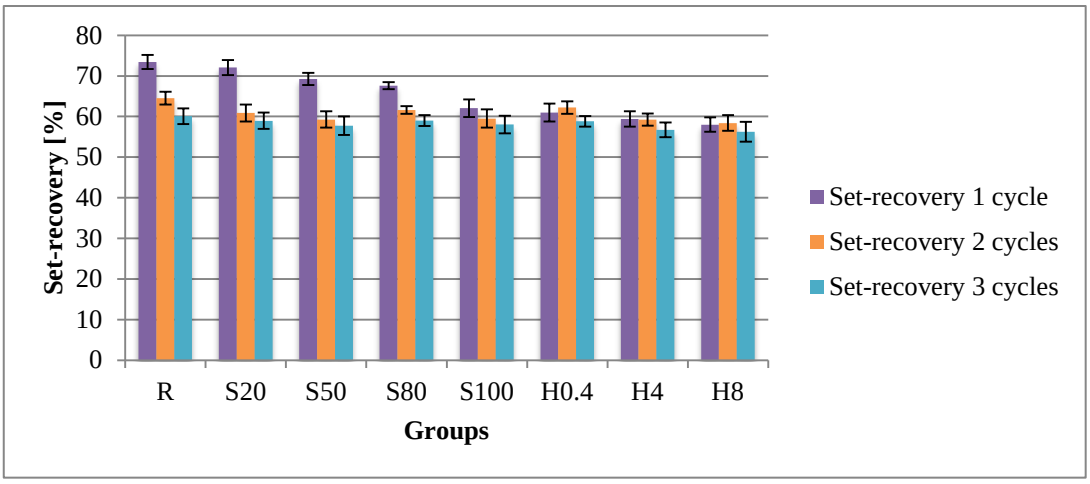

Figure 1: Set-recovery of all groups after one, two and three wet-dry cycles. The colored bars show the average of the 15 specimens in each group. The error bars show the standard deviation.

Figure 1 shows the mean set-recovery after wet-dry cycling. For most groups, the set-recovery decreased between the first and second wet-dry cycle. In general, the effect of the pre-treatment is rather small. The treatment with sodium hydroxide led to a slightly larger reduction in set-recovery than the sodium silicate treatment. In the case of the treatment with sodium hydroxide, a high solution concentration seemed to increase the effect on the set-recovery. In the case of the sodium silicate treatment, there is no clear trend. The higher viscosity of the highly concentrated sodium silicate solutions made it more difficult to wet the surface. As a result, there may be trade-off between the expected effect of the solution and the level of penetration into the wood surface.

The main reason for the rather weak effect of all the tested treatments on the set-recovery could be the short impregnation time. For this reason, further experiments with longer impregnation times will be conducted in the near future.

The verdict about the pretreatment of surface-densified wood with sodium silicate and sodium hydroxide depends on the outcome of further experiments with longer impregnation times. The simplicity of the process and the fact that the treatments are rather harmless from an environmental perspective make the chemicals interesting for further studies.

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