

Leachability of boron from wood treated with natural and semi-synthetic polymers and calcium precipitating agent

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Introduction Several fixation systems to limit or decrease boron leachability from treated wood have been developed. Some attempts have relied on limiting of water penetration of treated wood using water repellents, monomer and polymer systems. On the other hand, non-toxic polymers such as proteins were tried to reduce amount of boron leached from wood (Thevenon et al. 1997, 1998). Their results showed that protein borates such as albumin and soja protein borates greatly retarded the leaching of boron from treated wood via formation of salt. In addition, precipitation of boron in wood via a calcium precipitating agent NHA (N'-naphthaloylhydroxylamine) also has potential to reduce boron leachability (Kartal and Green 2002). This paper presents results from a preliminary study to reduce the leachability of boron using natural polymers including naturally occurring polysaccharides, carboxy methylcellulose as a synthetic polymer, and NHA.

Materials and methods Wood blocks, 19 by 19 by 19 mm, were cut from sapwood portions of southern yellow pine logs. Before treatment, all wood blocks were conditioned at 20±2°C and 65±5% relative humidity (RH) for two weeks. Wood blocks were vacuum-treated (88 kPa for 30 min) with 3% BAE (boric acid equivalent) disodium octaborate tetrahydrate (DOT) ($\text{Na}_2\text{B}_8\text{O}_{13}\cdot 4\text{H}_2\text{O}$) (Solubor, U.S. Borax Inc. Valencia, CA). After treatments, all samples were blotted dry and reweighed to determine uptake boron retention. The blocks were conditioned at 20±2°C and 65±5% RH for two weeks before treatments with polysaccharides and carboxymethyl cellulose (CMC) as cellulose. After conditioning period, wood blocks treated with DOT previously were then treated with 1% pectin, guar gum (GG), starch, or sucrose solutions as natural polymers or 1% CMC as a semi-synthetic polymer or 1% NHA solution in a desiccator. In the treatments, pressure cycle consisted of a 30-minute vacuum (88 kPa). Treated wood blocks were dried at 40°C for 24 h and all treated wood blocks were then reconditioned at 20±2°C and 65±5% RH for two weeks before leaching test.

The leaching test was similar to AWP Standard Method Ell-97 (AWPA 1999a, b). After the conditioning period, 2 replicate sets of 6 blocks for each treatment were removed from the conditioning room, and reweighed. Each set of 6 blocks was placed into a 500 ml bottle, submerged in 300 ml of deionized water, and subjected to a vacuum to impregnate the blocks with deionized water. The sample bottles were subjected to mild agitation and the water was replaced after 6 hours, 1 day, 2 days, and every 2 days thereafter for a total of 14 days. Leachates were collected after each water replacement and analyzed for boron content.

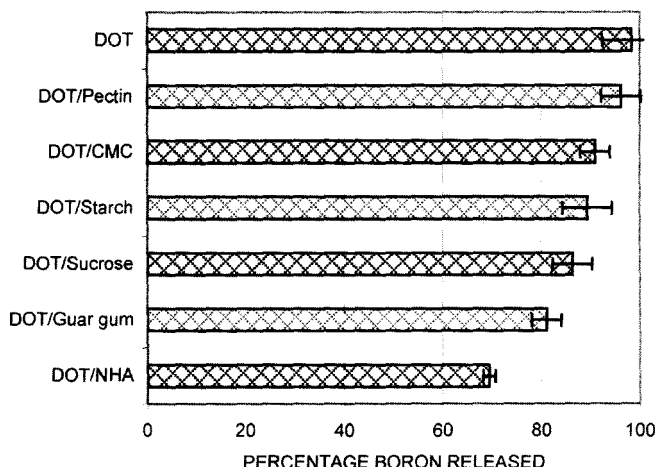


Fig. 1. Percentage boron released from wood blocks treated with DOT, natural and semi-synthetic polymers and NHA

Abb. 1. Anteil der Borfreisetzung aus Holzklötzchen, die mit DOT, Natur- und synthetischen Polymeres und NHA behandelt waren

A microassay based on colorimetry has been developed for estimation of boron content in wood and leachates (Kartal and Green 2002). Microassay determination of boron in wood and leachates was done according to AWP A2-98 method (AWPA 1999a, b). The results were expressed as percentage of boron released, relative to the amounts retained in the unleached wood blocks.

Results and discussion Boron retention levels were found to be 3.38, 3.41, 3.39, 3.38, 3.40, 3.39, and 3.68 kg/m³ in wood blocks treated with DOT only, DOT/pectin, DOT/CMC, DOT/starch, DOT/sucrose, DOT/GG, and DOT/NHA, respectively. Figure 1 shows percentages boron released from treated wood blocks. After a 14-day leaching course, the average percentage boron remaining in wood blocks treated with DOT plus NHA solutions was about 30%. The existence of boron and NHA in wood together would be expected to have a synergistic effect against wood decay since NHA has been found to have protection ability in southern yellow pine from fungal decay and termite damage at several concentrations (Green et al. 1996, 1997). The 14-day leaching test indicated that the combination of GG in DOT-treated wood blocks also helps to fix boron at least retard boron leaching compared to other treatments. Percentage boron leaching followed the order NHA<GG<sucrose<starch<CMC<pectin<DOT only. Percentage boron released from wood blocks treated with DOT only was 98.4% whilst 81.1% from DOT/GG treated blocks. GG is a cold water soluble polysaccharide. GG hydrates may have the property of interfacial binding and thereby act as true emulsifiers. GG is also a non-ionic polymer compatible with most plant hydrocolloids and modified water soluble polymers.

Since some multivalent salts, such as borate ions, forms cross-link with hydrated guar gum to form cohesive structural

gels, guar gum in our study may form a cross-link in DOT-treated wood resulting in less boron leaching compared to DOT only treatment. NHA has also the capacity to reduce DOT leaching by 30% using distilled water by physically blocking tracheids and ray parenchyma lumens or by co-precipitating with DOT at a 1:8 ratio (unpublished data). Leaching of DOT and NHA would likely be further reduced if leaching were done in tap water due to calcium precipitation (Kartal et al, in press). On the other hand, percentage boron released from wood blocks treated with DOT and sucrose, a disaccharide used in the study, was 86.4%. Further research on fixation of boron on wood via poly- and disaccharides using various fixation conditions and fungal resistance of treated wood is needed to attain a better understanding of this relationship.

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