Preservative treatment of Scots pine and Norway spruce

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Abstract

The ability to treat Scots pine (*Pinus sylvestris)* and Norway spruce (*Picea abies*) with oilborne copper-8-quinolinolate or with waterborne chromated copper arsenate, ammoniacal copper zinc arsenate, or ammoniacal copper quaternary was assessed using commercial treatment facilities in the Pacific Northwest. In general, Scots pine was more easily treated than was Norway spruce, although neither species could be treated to the standards of the American Wood-Preservers' Association for dimension lumber without incising. Treatment was better with ammonia-based solutions, reflecting the ability of these systems to overcome the effects of pit aspiration and encrustation, and their ability to swell the wood to improve permeability. The results indicate that successful treatment of both species will require the use of incising. In addition, further research will be required to identify suitable schedules for successfully treating Norway spruce with oilborne copper-8-quinolinolate.

The past decade has witnessed dramatic changes in the patterns of world timber trade. Countries that formerly were net exporters of timber now find themselves importing an ever-increasing variety of wood species to meet domestic timber demand. An important, but often overlooked, component in this process is ensuring that the imported species meet the appropriate national standards of the importing countries. Although these requirements are often viewed as obstructionist by importers, it is important to remember that national standards are generally promulgated with the ultimate goal of protecting the consumer. An excellent example of the need for the evaluation of imported species is the recent effort to import Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* Karst.) from central Europe into North America. Because these species may find their way into the decking market or other applications where preservative treatment will be essential for achieving adequate performance, it is important to ensure that they meet treatability standards, in addition to the more obvious code requirements for strength.

Scots pine and Norway spruce are both commercially treated across Europe (2-5). European treatment standards (4), however, differ somewhat from those employed in North America (1). In addition, several chemical systems commonly employed in the United States are not as widely used in Europe. As a result, the use of these imported species in structural applications will require the development of treatability data for inclusion in the appropriate American Wood-Preservers' Association Standards (AWPA) (1). This report describes an evaluation of commercial treatment of Scots pine and Norway spruce with four different preservatives.

Materials and methods

Scots pine and Norway spruce lumber (of various lengths) was sorted for the absence of visible cracks and defects. The wood was obtained from Austria as part of a program to establish allowable properties for international species from specific geographic regions through the American Lumber Standards Committee. This defect-free material was first ripped lengthwise to create two nominal

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*Table 1. — Penetration and retention of CU-8, CCA, ACZA, and ACQ in **Austrian** pine and spruce.*[a]

Wood species	Chemical	Incising	Preservative penetration Average	% ≥10 mm[b]	Preservative retention 0 to 5 mm	5 to 10 mm	10 to 15 mm	15 to 25 mm	0 to15 mm
		(+/-)	(mm)	(%)	(kg/m^3)				
Scots pine	CU-8	-	17.6 (15.7)	53	0.22	0.14	0.13	0.11	0.16
		+	17.6 (15.5)	60	0.20	0.15	0.12	0.10	0.16
	CCA	-	22.2 (17.2)	65	11.37	7.38	6.83	6.35	8.53
		+	23.9 (13.2)	98	13.71	12.37	8.05	5.64	11.38
	ACZA	-	29.2 (17.2)	78	10.90	6.34	5.39	4.84	7.54
		+	34.1 (14.2)	98	12.41	9.56	7.78	5.49	9.92
	ACQ	-	29.3 (19.7)	70	20.56	10.33	8.14	6.92	13.01
		+	30.5 (15.8)	97	22.25	15.23	10.22	6.44	15.90
Norway spruce	CU-8	-	1.8 (2.2)	0	0.08	0.05	0.05	0.05	0.06
		+	11.2 (5.3)	63	0.14	0.09	0.06	0.05	0.10
	CCA	-	3.5 (3.5)	5	4.02	0.70	0.39	0.10	1.70
		+	13.8 (7.1)	85	10.09	6.34	2.38	0.74	6.27
	ACZA	-	13.9 (10.2)	53	8.86	3.82	2.23	1.89	4.97
		+	26.3 (10.5)	100	12.20	8.75	5.41	2.98	8.79
	ACQ	-	11.1 (11.0)	38	12.56	3.43	1.55	1.22	5.85
		+	28.4 (13.0)	100	21.45	13.96	7.53	3.19	14.31

[a] Values in parentheses are standard deviations.
[b] The AWPA Standard C2 requires 10 mm of penetration in 80 percent of a 20-core sample.

50- by 100-mm-wide (2- by 4-in.) boards. Half of the boards from each species were incised to a depth of 8 mm with a Protomech incisor (RJH Inc., Corvallis, Oegon) at an incision density of approximately 3,500 incisions per square meter. Each board was then cut into four 300-mm-long sections that were segregated into eight groups, one per treatment chemical and incising condition for each species. A total of 120 boards were used per wood species.

The transverse faces of each section were sealed with three coats of a two-part marine grade epoxy, then allowed to condition to a stable weight at 70 percent relative humidity and 23°C. Each section was weighed, then 10 matched incised and non-incised sections from each species were placed into 1 of 24 permeable burlap bags. The bags were wired shut and transported to local treatment plants, where they were commercially treated with copper-8-quinolinolate (oxine copper, CU-8) in light organic sol- vent to the aboveground target retention level of 0.32 kg/m^3 (as Cu), chromated copper arsenate Type C (CCA), ammoniacal copper zinc arsenate (ACZA), or ammoniacal copper quaternary, Type B (ACQ) to the ground-contact retention level of 6.4 kg/m^3. One bag was treated per charge; there were 24 charges total.

After treatment, the bags were stored on the drip pad as specified by the individual treater (48 to 72 hr.). The sections were removed from the bags, then weighed to determine net solution absorption, then stickered and air-dried.

Preservative penetration was assessed by removing a 9.88-mm plug from one site near the center of one narrow and one wide face of each section. The sections were then sawn in half crosswise. The cross sections were sprayed with indicator (chrome azurol) if necessary, then preservative penetration was measured to the nearest mm. The plugs were then segmented into zones corresponding to 0 to 5 mm, 5 to 10 mm, 10 to 15 mm, and 15 to 25 mm from the wood surface. Segments from a given zone and treatment were combined before being ground to pass a 20-mesh screen. The samples were analyzed for preservative retention according to the appropriate AWPA (1). Samples containing CU-8, CCA, ACZA, and ACQ were analyzed by x-ray fluorescence spectroscopy with an ASOMA 8620 Analyzer (Asoma Instruments, Austin, Texas). The ACQ quaternary ammonia component was estimated on a solution component basis to arrive at a final retention for this system. The results for the outer three zones were then averaged for each treatment to arrive at a retention corresponding to the 0 to 15 mm assay zone, as specified for thin sapwood species in AWPA Standard C2 (1).

The results were compared to the recommended retentions and penetration listed in the AWPA Standard C2 (1). At the start of this testing, the importers believed the Scots pine contained high levels of sapwood and therefore should be assessed according to the standards for southern pine. The Norway spruce was considered to be similar to thin sapwood species in the U.S. Standards, which require 10 mm of heartwood penetration in 16 of 20 cores removed per charge. After examination of the boards, it was concluded that the Scots pine samples contained high percentages of heartwood and were more appropriately classified as thin sapwood materials.

Results and discussion

Scots pine

Average preservative penetration in this species ranged from 17.6 mm for both incised and non-incised sections treated with CU-8 to 34.1 mm for incised sections treated with ACZA (**Table 1**). Penetration of ACZA and ACQ was consistently higher that of sections treated with CCA and CU-8, reflecting the benefits of ammonia in terms of dissolving extractives on the pits and swelling the wood to make it more receptive to treatment.

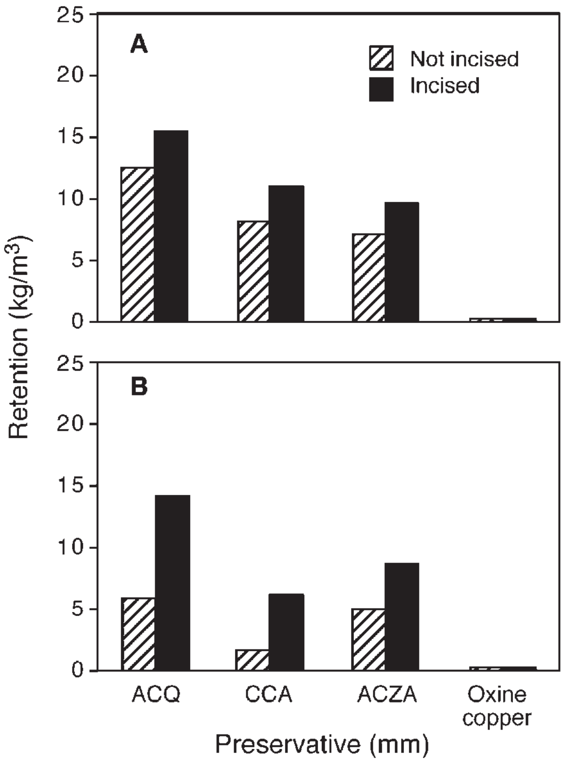

Figure 1. — Average retentions in the 0 to 15 mm zones after pressure treatment with oxine copper (CU-8), CCA, ACZA, or ACQ: A. Scots pine; B. Norway spruce.

An evaluation of the wood based on meeting the AWPA minimum penetration standard (≥ 10 mm) produced similar results (1). The percentage of sections meeting the minimum penetration level ranged from **53** percent for incised boards treated with CU-8 to 98 percent for incised boards treated with ACZA **and CCA?**(**Table 1**).

Incising generally increased the average depth of penetration, although the differences were sometimes slight. Incising improved penetration of CCA, ACZA, and ACQ to the point where they met the current AWPA Standard (1), but the improvement was greatest with CCA. Incising also enhanced CU-8 penetration, but the improvement was slight and was not enough to meet the AWPA standards. Incising increases the percentage of end-grain exposed to potential preservative flow, improving both the depth and uniformity of treatment (6,7). The incision effect is generally confined to a relatively narrow zone around the incision, however, and there is usually little heartwood penetration beneath the incision (8).

Retentions tended to decrease from the surface inward, although the differences beyond the outer 15 mm were sometimes slight. The target retention for ground contact (6.4 kg/m^3) in the outer 15 mm was achieved with CCA, ACZA, and ACQ. There is currently no ground-contact retention specified for CU-8; instead, the wood was treated to the aboveground retention of 0.32 kg/m^3 (as Cu). Neither the incised nor non-incised sections met this retention level. Incising increased retentions in the 0 to 15 mm assay zone: 33, 31.6, 22.9, and 66.7 percent for CCA, ACZA, ACQ, and CU-8, respectively (**Fig. 1**).

Norway spruce

Preservative penetration was consistently lower in Norway spruce than Scots pine, reflecting the well-known difficulty of treating this species (2). Preservative penetration ranged from an average of **1.2?** mm for non-incised boards treated with CU-8 to 28.4 mm for incised boards treated with ACQ (**Table 1**). The percentages of boards with at least 10 mm of preservative penetration ranged from 0 to 100 percent. Penetration was consistently low in non- incised boards. Incising helped improve average penetration by 620, 394, 189, and 256 percent for CU-8, CCA, ACZA, and ACQ, respectively. The less substantial improvements in penetration for ACZA and ACQ reflect the simultaneous benefits of ammonia-based solutions.

Incising also enhanced the percentages of boards with acceptable penetration. This effect was most dramatic with CU-8 and CCA, although only 63 percent of the boards had acceptable penetration with CU-8 (**Table 1**). This percentage would not meet current AWPA Standards (1). Incising improved penetration to acceptable levels for CCA, ACZA, and ACQ.

Preservative retention in the outer 5 mm was generally lower in spruce than in pine, although the differences were slight with some incised treatments. For spruce, retentions in the 0 to 15 mm assay zone were considerably lower than in pine when boards were not incised (**Fig. 1**). None of the retentions on non-incised spruce met the target retentions for ground contact (6.4 kg/m^3), although the ACQ retention was closest. Incising increased retentions to acceptable levels for ACZA and ACQ, while the CCA retention was only 2 percent below the target. As noted earlier, the target retention for CU-8 was the aboveground retention level (0.32 kg/m^3 as Cu). Although, incising did enhance CU-8 retention, neither incised nor non-incised boards met the minimum levels (1).

Conclusions

Scots pine and Norway spruce should both be properly classified as thin sapwood species under the AWPA standards (1). Incising was generally required to meet AWPA penetration standards and also produced substantial improvement in retention with CU-8 and CCA. Ammonia-based treatments enhanced penetration for both species, although generally not enough to achieve the AWPA standard without incising.

The results suggest that both species can be acceptably treated with CCA, ACZA, and ACQ when incising is employed. Acceptable CU-8 treatment was not achieved for either species, even with incising.

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