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TREATABILITY OF CANADIAN SPECIES WITH ALTERNATIVE PRESERVATIVES

By

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Summary

Over the past decade Forintek has produced data on a variety of Canadian species treated with alternative preservatives compared to the mainstream preservative Chromated Copper Arsenate (CCA). Preservatives evaluated to date are Ammoniacal Copper Citrate, Disodium Octaborate Tetrahydrate(Borate) + Additives, Alkaline Copper Quat, Amine Copper Quat, and Amine/ammoniacal Copper Quat. Without exception, these alternative preservatives have shown better initial penetration than CCA for Canadian species. For some preservatives, i.e. borate, continued penetration after pressure process has been shown to improve penetration. Also incising is not required for some species/preservative systems to meet CSA standards for penetration.

Introduction

Over the past decade Forintek has produced data on a variety of Canadian species treated with alternative preservatives compared to the mainstream preservative Chromated Copper Arsenate (CCA). The data presented here is collected from experiments conducted under project work, funded by the Canadian Forest Service, and contract work, for various chemical suppliers. Much of this data has been used to support submissions to either the Canadian Standards Association (CSA) or the American Wood Preservation Association (AWPA) for the listing of Canadian species in wood preservation standards. With the phasing out of CCA for use in residential areas by December 31st 2003, data on the penetration of alternative preservatives into Canadian species will be required to help define treatment cycles for the treating industry. This paper summarises the work performed at Forintek in laboratory and plant (commercial) trials on five alternatives to CCA.

Some of the advantages of these new preservatives over CCA are that working solutions can be heated which can increase initial preservative penetration. A wider variety of compatible additives can be used to aid with preservative penetration. Also in some cases, particularly borates, the preservatives are diffusible after pressure treatment.

Materials

Preservatives Evaluated to Date

Forintek tested the following preservatives in laboratory and plant trials:

- Ammoniacal Copper Citrate - ACcit
- Borate (Disodium Octaborate Tetrahydrate) + Additives
- Alkaline Copper Quat (ACQ)
- Amine Copper Quat: ACQ – Type D
- Amine/ammoniacal Copper Quat: ACQ – Type D+

Canadian Species Tested

- Western hemlock (*Tsuga heterophylla*)
- Pacific silver fir (*Abies amabilis*)
- Douglas fir (*Pseudosuga menziesii*)
- Subalpine fir (*Abies lasiocarpa*)
- Balsam fir (*Abies balsamea*)
- White spruce (*Picea glauca*)
- Black spruce (*Picea mariana*)
- Red spruce (*Picea rubens*)
- Engelmann spruce (*Picea engelmannii*)
- Jack pine (*Pinus banksiana*)
- Red pine (*Pinus resinosa*)
- Lodgepole pine (*Pinus contorta* var. *latifolia*)

Methods, Results and Discussion

Plant Trial Using Ammoniacal Copper Quat and Ammoniacal Copper Citrate – Western Spruce

Trials were conducted on kiln-dried single and double density incised western spruce. Pressure cycles ranges from 6-10 hrs @ 830 to1035 kPa using 2.1-2.7% active treating solutions. Both the copper citrate and ACQ samples, either single or double density incised, met the CSA 080.2 standard for ground contact (Table 1). There were no differences in penetration shown between single and double density incised material (Morris 1990; Morris and Ingram 1993).

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Table 1: Penetration Data for Ammoniacal Copper Quat and Ammoniacal Copper Citrate – Western Spruce

Preservative	Incising Pattern	Penetration % ≥ 10 mm	Penetration % ≥ 13 mm
Ammoniacal Copper Citrate	Single	100	85
Ammoniacal Copper Citrate	Double	100	85
Ammoniacal Copper Quat	Single	100	100
Ammoniacal Copper Quat	Double	100	100

Laboratory Trial using Borate at Ambient Temperature

Kiln-dried Eastern SPF and white pine were treated at 1035 kPa for 2 hours using a 9% Boric Acid Equivalent (BAE) treating solution at ambient temperature. The lumber was un-incised and allowed to diffuse for 4 weeks after pressure treatment (Table 2). White pine met the CSA 080.34 penetration requirement immediately after treatment. Jack pine and balsam fir after 2 and 4 weeks diffusion respectively met the CSA 080.34 penetration standard. Kiln-dried black spruce failed to meet the standard (Morris *et al*. 1996).

Table 2: Penetration Data for Eastern SPF

Species	Penetration (0 Weeks) % ≥ 10 mm	Penetration (2 Weeks) % ≥ 10 mm	Penetration (4 Weeks) % ≥ 10 mm
White Pine	80	95	95
Balsam Fir	20	35	80
Jack Pine	25	80	85
Black Spruce	0	20	5

Laboratory Trial using Borate plus Additives at Ambient Temperature on Douglas fir

Kiln-dried Douglas fir, non-incised, was air-dried at approximately 25% moisture content prior to treating. The samples that were pre-steamed reached a maximum temperature at the core of 95°C after 4 hours exposure to live steam in a kiln. The lumber was then subjected to a 2 hour pressure cycle at 1035 kPa using a 12% BAE treating solution with or without the additive didecyldimethyl ammonium chloride (DDAC). The addition of DDAC more than doubled initial penetration, although presteaming had less of an effect (Table 3). All treatments, expect the 0.5% DDAC/non-presteamed, showed similar penetration increases over time. The combination of presteaming and 0.5% DDAC had the greatest effect on penetration with 65% of samples meeting the CSA standard after 4 weeks storage (Morris *et al*. 1996).

Table 3: Penetration Data for Borate plus Additives - Douglas fir

Presteamed	% DDAC*	Penetration (0 Weeks) % ≥ 10 mm	Penetration (1 Week) % ≥ 10 mm	Penetration (4 Weeks) % ≥ 10 mm
No	0	5	5	10
No	0.5	25	5	20
Yes	0	10	15	30
Yes	0.5	35	45	65

*- didecyldimethyl ammonium chloride

Laboratory Trial using Borate plus Additives at Ambient Temperature on Western Hemlock

Green, non-incised, western hemlock was pressure treated for 2 hours at 1035 kPa using a 1.8 % BAE solution with or without increasing amounts of the additive DDAC. Results showed (Table 4) that immediately after treatment the additive DDAC increased the penetration of borates into western hemlock, meeting the CSA 080.34 penetration requirement, compared to no additive. Also when comparing increasing amounts of DDAC in the treating solution there appeared to be no significant effects on penetration. DDAC was also shown to increase penetration during storage after treatment (Morris and Byrne 1997).

Table 4: Penetration Data for Borate plus Additives - Western Hemlock

% DDAC*	Penetration (0 Weeks) % ≥ 10 mm	Penetration (2 Weeks) % ≥ 10 mm
0	65	85
0.1	80	100
0.2	80	100
0.5	80	100

*- didecyldimethyl ammonium chloride

Commercial Trial Using Borate at Elevated Temperature

A commercial trial was carried out on 1000,000 FBM of lumber in 12 charges. Kiln-dried, non-incised, lumber for the trial was supplied from across Canada. A 6.5% BAE treating solution was heated to a temperature of 60-65°C. The lumber was treated for 4-10 hours at 1035 kPa. Eight out of twelve charges met the CSA 080.34 penetration standard immediately after treatment (Table 5). After a one-week storage period all but one SPF-South charge had met the standard. Following 2 weeks storage all charges had met the CSA 080.34 standard for penetration. This trial demonstrated that heating the treating solution dramatically increases borate penetration into kiln-dried SPF, using a combination of pressure treatment and wrapped storage (Baker *et al.* 2000).

Table 5: Penetration Data for Borate at Elevated Temperature - SPF

Species	Penetration (0 Weeks) 80% ≥ 10 mm	Penetration (1 Week) 80% ≥ 10 mm	Penetration (2 Weeks) 80% ≥ 10 mm
SPF – West (3 Charges)	3 Pass	3 Pass	3 Pass
SPF – East (12 Charges)	8 Pass	12 Pass	12 Pass
SPF – South (8 Charges)	4 Pass	7 pass	8 Pass

Laboratory Trial Using Borate at Elevated Temperature on Western Hemlock

Green and kiln-dried, non-incised, western hemlock were treated using a 4 hour pressure cycle at 1035 kPa. The 6.5% BAE treating solution was heated as in Tables 6 & 7. Immediately after treatment significant increases in penetration were shown when comparing green to kiln-dried groups. After 2 weeks diffusion the green material treated at all temperatures showed definite increases in penetration when compared to initial penetrations. The kiln-dried material treated at 50°C also showed a significant increase in penetration after 2 weeks diffusion. Green and kiln-dried western hemlock treated at 50°C met the CSA 080.34 penetration standard after 2 weeks diffusion. Heating the treating solution was shown to greatly increase borate preservative penetration, particularly when using green material (Morris and McFarling 2001).

Table 6: Penetration Data for Borate Treated Green Western Hemlock

Solution Temperature (°C)	Penetration (0 Weeks) % ≥ 10 mm	Penetration (2 Weeks) % ≥ 10 mm
20	17	43
35	20	77
50	20	100

Table 7: Penetration Data for Borate Treated Kiln-dried Western Hemlock

Solution Temperature (°C)	Penetration (0 Weeks) % ≥ 10 mm	Penetration (2 Weeks) % ≥ 10 mm
20	47	50
35	47	60
50	50	87

Laboratory Trial Using Ammoniacal Copper Quat

Kiln-dried western white spruce and air-dried, approximately 25% M/C, Pacific silver fir, western hemlock and Douglas fir were incised to 6 to 8 mm deep. The Douglas fir samples were selected with high heartwood content. All samples were pressure treated for 2 hours at 1035 kPa using a 1.8% actives treating solution. The treating solutions used are as shown in Table 8. Western hemlock treated with both ACQ formulations showed significantly deeper penetration compared to CCA. The amine/NH_4 ACQ at elevated temperature gave a significant increase in penetration compared to ambient temperature, meeting the CSA 080.34 penetration standard. For Pacific silver fir both ACQ formulations, at elevated and ambient temperature, showed significant increases in penetration compared to CCA with all ACQ group meeting the CSA 080.34 penetration requirement. Neither Douglas fir or white spruce met the penetration standard for ground contact (Morris *et al*. 2002).

Table 8: Penetration Data for Ammoniacal Copper Quat – Ground Contact Standard

Species	Penetration ≥ 10 mm				
	CCA Ambient	Amine Ambient	Amine 60°C	Amine/NH_4 Ambient	Amine/NH_4 60°C
Pacific silver fir	60	85	95	100	100
Western Hemlock	20	60	70	65	90
White Spruce	3	3	13	20	23
Douglas fir	0	3	3	15	8

The CSA 080.32-97 decking standard requires 80% of samples to have equal or greater than 5 mm penetration. Both Pacific silver fir and western hemlock met this standard with the ACQ formulations (Table 9). Only Pacific silver fir treated with CCA met the decking standard. For white spruce and Douglas fir only the material treated with the amine/NH_4 ACQ at elevated temperature met the decking penetration standard. Although white spruce treated with amine ACQ at elevated temperature came close to meeting the standard with 73% of samples having equal to or greater than 5 mm penetration.

Table 9: Penetration Data for Ammoniacal Copper Quat – Decking Standard

Species	Penetration ≥ 5 mm				
	CCA Ambient	Amine Ambient	Amine 60°C	Amine/NH_4 Ambient	Amine/NH_4 60°C
Pacific silver fir	90	95	100	100	100
Western Hemlock	75	100	100	100	100
White Spruce	20	35	73	58	95
Douglas fir	15	20	45	38	85

Conclusions

- Alternative preservatives have shown better initial penetration for Canadian species.
- Some preservatives, particularly borate, show continued penetration after pressure process.
- Incising is not required for some species/preservative systems.

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