A NEW FUNGICIDE COMBINATION FOR PREVENTION OF KILN BROWN STAIN OF WHITE PINE

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ABSTRACT

Eastern white pine often develops a surface brown non-microbial stain when kiln-dried. Such staindowngrades high quality lumber and is likely to occur when fresh, unseasoned lumber is stacked during warm weather prior to kiln-drying. Use of chemical reducing agents or pH alteration have been successful control agents, but may have some practical limitations for general use. A new combination of fungicides (chlorothalonil and methylene bis[thiocynate]) was tested for ability to also control brown stain in pine lumber by a short dip treatment of green lumber. The results from two independent laboratories indicated that the new formulation was more effective than sodium thiosulfate, and similar in performance to sodium azide. This co-biocide system should provide the white pine lumber industry with both sapstain and brown stain protection.

A variety of pines grown in the United States (including sugar [*Pinus lambertiana* Dougl.] eastern white [*P. strobus* L.], and ponderosa [*P. ponderosa* Laws.] as well as western hemlock [*Tsuga heterophylla* (Raf.) Sarg.]) and some firs develop a brown oxidative stain on the surface of lumber during kiln-drying. The problem is thought to be most severe in lumber that is stored during warm weather prior to drying or cut from logs that have been held in storage some time. This stain is not removed by normal planing and may result in substantial decrease in value by downgrading of high quality lumber. This non-microbial stain is thought to occur as a result of an enzymatic reaction involving a peroxidase and subsequent oxidation or polymerization of a leuco product in a two-step chemical process (Stutz 1959). High kiln temperatures then cause polymerization and oxidation producing colored compounds. Several chemicals applied to freshly cut lumber have reportedly controlled this stain, including sodium azide (Stutz 1959), and more environmentally friendly compounds such as alkaline salts (Hulme 1975), sodium thiosulfate (Hulme and Thomas 1983), and phosphoric acid (Oldham and Wilcox 1981). However, certain of these chemicals can cause problems in mill applications by reaction with iron or mild steel and/or failing to control mold and stain fungi on lumber stored in the green condition.

This experiment used a new combination of fungicides (one of which is also a reducing agent) to control brown stain in eastern white pine lumber from logs felled either 1 month earlier (Minnesota) or aged at least 1 year (Wisconsin). In addition, the influence of kiln schedule (normal vs. mild) on treatment performance was studied in the Wisconsin trial. Results were compared to chemical agents known to control brown stain (sodium thiosulfate in Minnesota; sodium azide in Wisconsin).

METHODS

MINNESOTA TRIAL

Two white pine trees were felled in north-central Minnesota during August and cut into 2-m-long bolts (20 to 40 cm diameter). Bolts were aged for 30 days in the forest prior to sawing into lumber (2.5 cm thick by 1 m long, random

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TABLE 1. — Average brown stain ratings [a] of eastern white pine lumber in Minnesota (and measured percentage areas of surface coverage).

Treatment	Tree #1	Tree #2	Average (n = 16)
Controls (water dip)	3.0 (64.5)	3.0 (72.0)	3.0 (68.3)
Sodium thiosulfate (5% a.i.)	1.1 (15.9)	1.0 (14.5)	1.0 (15.2)
Chlorothalonil/MBT (0.3% total a.i.)	0.3 (2.0)	0.6 (3.7)	0.3 (2.8)

[a] Rating scale: 0 = no stain; 1 = less than 25 percent of surface stained; 2 = 25 to 50 percent of surface stained; 3 = more than 50 percent of surface stained.; MBT = methylene bis(thiocyanate).

TABLE 2. — Rating of brown stain in lumber from aged eastern white pine logs in Wisconsin.

Treatment	Kiln schedule	Avg. rating (n = 10)
Controls	Normal	2.1 ± 0.6
	Mild	2.1 ± 1.2
Sodium azide (0.06% a.i.)	Normal	0.8 ± 1.2
	Mild	0.9 ± 1.2
Chlorothalonil/MBT[a] (0.3% total a.i.)	Normal	2.0 ± 0.8
	Mild	0.3 ± 0.6
Chlorothalonil/MBT (0.6% total a.i.)	Normal	1.0 ± 1.2
	Mild	1.1 ± 0.8

[a] MBT = methylene bis(thiocyanate)

width) using a horizontal bandsaw. Sixteen boards (eight from each tree source) were given a 1-minute dip in either water (controls), sodium thiosulfate (5% active ingredient), or the experimental fungicide combination (equal amounts of chlorothalonil and methylene bis-[thiocyanate]) to provide 0.3% total active ingredient) diluted in water. Lumber was dead-stacked in warm, humid conditions (26°C, 85% + relative humidity [RH]) for 5 days prior to endcoating, stickering, and kiln-drying according to the normal schedule for white pine (Boone et al. 1993). Brown stain was evaluated on the planed lumber using a subjective scale: 0 = no stain; 1 = less than 25 percent of board surface stained; 2 = 25 to 50 percent of surface stained; and 3 = over 50 percent of surface stained. In addition, the actual stained areas of both faces of lumber were measured using a grid system.

WISCONSIN TRIAL

Two logs stored for at least 1 year were cut into nominal 2.5 by 10 by 30 cm boards and dipped for 10 seconds in either water, 0.06 percent sodium azide, or the co-biocide formulation at 0.3 or 0.6 percent active ingredient level. Lumber was dead-stacked and stored for 1 week at 26°C and 95 percent RH to encourage stain development. The boards were then kiln-dried using both normal and "anti-brown stain" schedules (which begin at lower temperatures and humidities [Rasmussen 1961]). Stain was rated on 10 boards randomly selected from each treatment combination using the same rating scale as noted for the Minnesota study.

RESULTS AND DISCUSSION

MINNESOTA TRIAL

The average brown stain ratings on white pine lumber after drying and planing (and measurement of surface areas stained) are in Table 1. The control material was severely stained, with most stain in the heartwood areas or near the sapwood boundary (68% of surface discolored). The thiosulfate dip was quite effective in reducing brown stain to an average of 15 percent of the board surface. However, the fungicide combination was superior in allowing only an average of 3 percent surface discoloration by brown stain. It was also noted that some surface mold had developed in the dead-stacked lumber after 5 days in both controls and thiosulfate treatment, but not with the fungicide combination. Both of the active ingredients in this co-biocide combination are known to be effective against mold and stain fungi (Woods and Bell 1990, Schmidt et al. 2001).

WISCONSIN TRIAL

The brown stain ratings (with standard deviations) for lumber from aged logs are noted in Table 2. The best control of brown stain in this trial was noted with the fungicide combination at the 0.3 percent active ingredient level using the mild kiln schedule. The efficacy at this level was essentially equal to control by sodium azide. Substantial stain reduction was noted for the normal kiln schedule when using the higher dose of 0.6 percent active (an average of less than 25% of board surface stained). The milder kiln schedule did not further reduce stain at this treatment level.

The fungicide combination was overall more effective for the normal kiln schedule trial in Minnesota presumably due to the increased dip time (1 min. vs. the 10 sec. dip in Wisconsin). Also, the logs in the Minnesota study were aged only 1 month as compared to 1 year or more in Wisconsin. Larger scale trials need to be done to confirm control in a mill situation of white pine brown stain. Use of this new fungicide combination (Freeman et al. 1997) should have the added benefit of providing fungal control on lumber prior to kiln-drying while allowing use of the shorter normal kiln schedule.

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