Laboratory and Field Evaluation of Wax Emulsion Water Repellents for the Protection of Lumber

By Tony Byrne,
Scientist
Forintek Canada Corp.,
Western Laboratory, Vancouver B.C.

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A large portion of Canadian lumber (both kiln-dried and green) exported overseas is given a fungicide/water repellent treatment. The role of the fungicide is to prevent growth of fungi causing stain, mould, and decay on wood. The water repellent (wax) treatment ideally retards wetting of dry lumber, and enhances drying of green lumber while limiting its rewetting. It also gives lumber a bright, clean appearance, an aspect of wax treatment which was not examined in these studies. While the efficacy of fungicide treatments has been well documented, data on effects of water repellents are limited. Although wax/fungicide treatments are routinely used on export lumber, the optimal levels of these two constituents have not been established.

Forintek has recently done both laboratory and field evaluations of wax water repellents.

A. Laboratory Evaluation

Approach

A series of laboratory experiments was done in two general areas: (1) examining the growth of fungi on wax emulsion treated wood, and (2) assessing the water repellent effects of wax treatment.

Wood samples treated with various formulations of wax emulsion were examined under the scanning electron microscope. Selected fungi were grown on wax-treated samples and the electron microscope was again used to study the growth of fungi on the surface. An experiment was done to investigate whether wax treatment combined with a fungicide increased or decreased the efficacy of the formulation and whether separate application of the fungicide and wax was more effective than a mixture.

A laboratory test to determine the optimum fungicide/wax ratio was also done. Small wood beams were treated with combinations of five levels of fungicide (sodium tetrachlorophenate or 2-(thiocyanomethylthio) benzothiazole (TCMTB) and six of wax emulsion, giving 30 mixtures for each fungicide. The beams were inoculated with fungi, incubated for four weeks and fungal growth was assessed.

A simple colour indicator test was developed to detect wax on treated wood. The wettability of small samples treated with different concentrations of wax emulsion was assessed by two methods - using a surface tension analyzer, and by submerging small treated beams and weighing them at intervals to measure the uptake of water. The vapour uptake of dry samples and loss from wet samples was also determined.

Results

Under the microscope the wax appears as a relatively even coating with many smooth, rounded globules and occasional crystal-like particles. The pits in the woody cell walls were generally not blocked by the wax. The wax alone did not impede the growth of fungi on and in the wood.

With mixtures of fungicide and wax emulsion fungal growth was not significantly retarded or accelerated by the presence of the wax. Mixtures of the fungicide and wax emulsion generally gave the same protection as when the fungicide was applied first and wax second or when the wax was applied first and the fungicide second. The optimum ratio of fungicide/wax could not be determined since the inclusion of wax in mixture with either NaTCP or TCMTB had no effect. These experiments indicated that no fungicidal advantage would be gained by including wax in mixtures for the protection of lumber.

Wax emulsion treatment, even with low concentrations of wax solids (e.g. 0.25 percent) imparted short-term water repellency to small wood samples but there was little, if any, gain in water repellency with increased levels of treatment. Wax treatment retarded in the rate of wetting of small beams, especially of western hemlock, submerged in water. In pine, just over one hour was required to wet untreated samples to 40 percent moisture content while wax treatment delayed the time required to about seven hours. Wax treatment had only a slight retardation effect on the uptake of water vapour by dry pine but not hemlock. The loss of water vapour from wet wood of both types was unaffected by wax treatment. Use of the colour indicator showed that dip treatments in the laboratory gave somewhat patchy coverage with wax while an industrial spray system could give very even coverage.

Implications

Although it has been proposed that wax/fungicide mixtures, rather than formulations of fungicide alone, might be more effective in controlling fungal growth, laboratory experiments indicated that this was not the case. No fungicidal advantage would therefore be gained by including wax in mixtures for the protection of lumber.

In the laboratory, wax treatment retarded wetting of dry wood samples. The wax slowed down the rate at which the wood absorbed moisture but did not affect the eventual moisture content. Low levels of wax treatment are able to do this and treatment with higher concentrations of wax solids does not appear to be required to control pick-up of moisture.

The even distribution of wax is probably more important than the quantity used.

The colour indicator developed can be used to qualitatively determine the extent of wax treatment on commercial lumber.

B. Field Trial

This test was done to establish the optimum wax/sodium tetrachlorophenate (NaTCP) ration in a water repellent formulation and the concentration required for treating both unseasoned and kiln-dried lumber to prevent degradation, and to examine the capabilities of such treatments to promote drying of unseasoned wood during outdoor storage.

Approach

In mid-summer of 1984, kiln-dried spruce-pine-fir (SPF) and green hem-fir lumber were purchased and delivered to a B.C. lower mainland sawmill which uses an on-line spray box. Twenty combination solutions were prepared using four levels of wax and five of NaTCP. Lumber in 110-piece sets was spray treated, one set of each lumber type for each wax/NaTCP combination. The lumber was packaged and the packages left, individually and equally exposed to weather, at a test site. At zero, seven, and 12 months moisture changes in the lumber were determined by both moisture meter readings and by weights of the packages. At the 12 month inspection fungal degradation was also noted.

Results

The m.c. of hem-fir lumber packages rose from about 65 percent to about 80 percent during the winter and the lumber then dried out during the summer to about 55 percent m.c. There was an indication that the lowest concentration (0.7 percent) of wax treatment reduced the wetting of the green hem-fir; at the winter inspection the average m.c. of untreated hem-fir was 18 percent higher than the average m.c. of the wax-treated lumber. At the summer inspection the corresponding difference was 22 percent higher. There was no indication that increasing concentrations of wax above the 0.7 percent level further reduced the m.c. of hem-fir.

Wax treatment at all levels tested (0, 0.7, 1.4 and 2.8 percent) had no detectable effect on the moisture content of the packages of SPF in this test. The m.c. of all the SPF lumber rose from an initial 12 percent to about 35 percent by late winter and to just less than 20 percent by the summer following.

The addition of wax had no effect on the fungicidal efficacy of NaTCP. Control of fungal growth was achieved by spray treatment with two percent NaTCP on SPF lumber but this level did not control growth of sapstain fungi on the hem-fir.

Implications

Although experience has shown that wax treatments have benefits in maintaining the appearance, and limiting the water uptake, of kiln-dried lumber, this test was unable to prove water repellency effects, possibly because of the severity of the test or irregularities in the treatment. However, there was an indication that wax treatment reduced, but did not prevent, wetting of green hem-fir. The fact that wax treatment slightly reduces the weight of the lumber is a possible reason for its use. Wax alone did not prevent fungal deterioration of lumber and wax added to a fungicide neither enhanced nor reduced its efficacy in protecting lumber.