WATER REPELLENT FOR KILN DRIED LUMBER

L. A. Story
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Most of us have seen photographs of the Klondike Gold Rush. One picture that caught my eye showed two men hand sawing a log into boards. Boards were cut by a two handed saw from a log held on a platform elevated several feet above the ground. This minature headrig has been greatly improved upon, at least in most instances, and with these improvements larger volumes of lumber are produced than what is required by local sales. Lumbermen found that when this green lumber was piled, piece upon piece, it often discolored badly. This discoloration is known in the industry as sap staining. A chemical treatment was born out of necessity to prevent sap stain from forming on green lumber. The industry knows this product as sap stain chemical or sap stain solution.

I would like to talk to you for the next few minutes about another product which was born out of necessity: a water repellent treatment to protect kiln dried lumber from moisture absorption and dimensional change. A little history may be in order.

Many of you remember the change which took place in the early 1960's when the new dimension came into being. The people responsible for this change were very concerned about the possibility of the old and the new dimension becoming mixed on the same building site. Uneven floors and walls was only one of several possible problems. Because of this, it was decided to identify the new dimension in some distinctive manner. This problem caused the introduction of cherry brown lumber to the industry.

Shortly thereafter some Canadian mills began to produce this new dimension in the cherry brown color. The transition was not a difficult step, however, a problem developed when more stock was produced than covered storage could hold. The original cherry brown, which was essentially a thin latex wood stain, had no water repellency and as a result, wood treated with this product reabsorbed water which resulted in the swelling of the wood and the loss of dimension.

About this time the processing superintendent phoned to arrange a meeting to talk about making cherry brown into a water repellent treatment. It was a luncheon meeting and after he described what he wanted, I had indigestion for the rest of the day. Essentially he wanted absolutely no observable change in the new product from the cherry brown material, yet it had to prevent the lumber from picking up moisture. This seemed like a very tall order since it was rather unlikely that a water repellent could be developed with the high water dilution the cherry brown concentrate required and still provide a degree

of water repellency. From a paint man's viewpoint there just were not enough solids deposited at these high dilution ratios to come close to forming a film. 'If you don't want water in the wood you seal it' -- at a few cents material cost per thousand square feet of surface area it appeared an impossible project. This did not deter the processing superintendent. He had a plan all laid out as to how we were going to evaluate the product.

I won't go into the details of the search for and the evaluation of possible water repellents. After we had developed what looked like a good water repellent, the following procedure was used to determine the relative merits:

1. Only standard size, strapped packages of lumber to be used.
2. All testing to be run against a control package.
3. Each piece to be numbered and remain in the same position throughout the test program.
4. Each piece to have three moisture metre readings taken and an average for the piece established.
5. After 30 days exposure to the weather the package to be opened and identical readings taken to establish a new average.
6. Reassemble package with each piece in the same position and continue exposure.
7. Repeat above at 60 days.
8. Repeat above at 90 days.
9. Assemble datum.
   (a) Show plus or minus moisture increase per piece (See Appendix chart)
   (b) Calculate average moisture increase (See Appendix chart)

The results are easier to read and probably more meaningful if they are assembled in a configuration corresponding to the end view of the package. If the difference in the average moisture content is placed in a box corresponding to the position of the piece in the package then the figures, whether they be plus or minus, are added together for each course and carried off to the side, this column of figures when totaled gives the net change in the moisture content of the package. If this figure is then divided by the total number of pieces in the package the average increase or decrease in the individual piece is established. The last two pages of the paper have two of these tables: one headed package number 6 which is the control package and the other package number 1 which has been treated with water repellent. The results of this particular test were chosen since the wood was shipped by both rail and barge arriving at its destination after six weeks of travel. Staff from our company and the lumber company cooperating on the test flew to the mid west States to take both photographs and the moisture level in each board. When you have an opportunity to look over these tables you get an idea what part of the package is most vulnerable to moisture pickup. On the untreated package there is a considerable increase in the moisture level between the fourth and fifth course. There has to be a reason for this, possibly there was a sticker between these two courses. Notice, also, that the untreated package averaged

just under four percent increase in moisture and that 7.5 percent of the pieces in the package increased in moisture content 10 percent or more. The water repellent treated wood had a slight increase in moisture with the average less than one tenth of one percent. Over seventy per cent of the boards either did not pick up moisture or lost weight. Two boards in this test picked up five percent or more moisture.

Water repellents have served the lumber industry for about ten years and hundreds of millions of feet of kiln dried lumber have been treated. It was a product born out of need and has served its purpose well.

Wood which is under 19 percent by meter reading does not normally support sap stain. I think we all know how difficult it is to dry every piece in each kiln charge below this level. Since kiln dried lumber does not contain enough moisture to sustain mildew or fungus growth it was never considered necessary to treat this stock with Sap Stain Solutions. The specifications for kiln dried lumber allow a small percentage of the total number of pieces to exceed the nineteen percent level. These pieces do contain enough moisture to support biological growth. This combination of facts indicated that a new or modified product was needed by the industry, a product which would prevent sap stain from developing and at the same time protect the lumber from absorbing excessive moisture. The evaluation of this product is covered in the report VP-X-146 which was an extensive test conducted under the control of the Western Forest Products Laboratory. Aside from its trade name the product can be described as a colored, water repellent, sap stain control product. Although the product covered in the test was of a cherry brown color it can be made in a clear or some other shade if necessary.

One last word before we leave water repellents. These products will protect lumber against rain or water but they are of a breathing type which means the protection allows gases or air to move freely back and forth. This allows moisture in the form of vapor to continue to leave the wood after the treatment and, by the same token, allows water vapor to re-enter the wood if certain conditions are reversed. This can present a problem in the hold of a ship if both green and kiln dried lumber are stored in the same hold, or if the relative humidity is allowed to reach the saturation point because of bilge water or some other conditions. Although we have done no tests on the amount of moisture lumber will pick up when it is stored at 100 percent relative humidity and the dew point is exceeded on a daily basis, it is our opinion that most of the wood will move to an average level of moisture whether it is green or kiln dried. This could be avoided by segregating green from kiln dried by a continuous film such as polyethylene. The same precautions followed in the past when green and kiln dried were shipped together should continue to be used. Water repellents protect lumber from the liquid phase of water; fortunately the gaseous phase of water is a possible problem only occasionally and then under man-made conditions for which corrective actions can be taken.

We have done some checking with shipping companies to find out how they treat cargo in the same hold when it is made up of both green and dry lumber. For the most part no precautions are taken to prevent the movement of air borne moisture into the dry lumber. We are not sure that this happens but in our opinion it bears looking into. We are presently running tests at Walker Brothers to determine the degree of moisture transfer under conditions of 100 percent relative humidity in a closed system. We think the test will approximate what happens in the hold of a ship. At least it should give an indication whether more extensive testing is required in this field. Our preliminary tests should be completed sometime in June of this year.

Let's flash back for a moment to the point where the manufacturer of the new dimension had decided to color the entire piece of lumber. The problem that arose at this time had long been with the industry. How do you apply a uniform coating on the lumber other than by dipping it? I think we are all aware of the spray boxes used to apply sap stain chemicals to lumber back in the 50's. The big problem in spray application was the continual plugging of spray tips. Also if the plugging was eliminated by using large tips then the lumber was so wet that it became miserable to handle.

Notwithstanding the problems of spray application it was decided that this method offered the best choice of the alternatives. Since a relatively abrasive compound was to be used to give the wood its distinctive color it was decided to use the then comparatively new airless spray tips. These tips are made of tungsten carbide and resist abrasion very well. In order to make them perform satisfactorily the liquid fed into them must be at relatively high pressures. Pressures of between 400 and 600 psi were necessary for proper spray patterns and fine atomization.

The problem of continual plugged tips was solved by a much more elaborate filtration system than had ever been used in the industry up to this time. The spraying unit was much more complicated than any unit up to this point, yet, it was in reality, a fairly simple piece of equipment.

Each unit had two large storage tanks. These tanks were of the order of 1,000 gallons in size and had an agitator either top or side mounted so that the solution was kept in continuous movement while it was being used. This was necessary because of the tendency of the colored component to settle out. When the level dropped in one tank the second was mixed. This was generally accomplished by pumping a forty-five gallon drum of concentrate into the correct amount of water. Some mills had a third tank if they were using this same equipment to apply sap stain chemicals to green lumber.

The tanks were connected to a pump which forced the solution through a very fine filter. The filter removed everything larger than a quarter of the diameter of the orifice in the spray tip. With routine cleaning these filters performed relatively well.

The spray box was fed directly from the filter. All four sides of the piece were sprayed and the uniformity of the color over the entire piece allayed the doubts of many who had maintained that it was not possible to apply uniform coatings by spray. The ends of each board had to be sprayed separately after the lumber was strapped.

The over spray was collected in the spray box and accumulated in a sump which was pumped back to the original storage tank after some preliminary filtering.

Although the applicating unit performed satisfactorily, improvements were bound to be made as more mills adopted the equipment and tedious or troublesome points developed under continuous use. It was a nuisance to have to dilute a concentrate into a large tank. Workmen could easily let the tank overflow when adding the water which led in some cases to improper concentrations. Not all pumps performed satisfactorily, some seized while others were so turbulent the emulsion was destroyed. The filters performed only if they were well maintained and since they were somewhat on the small side they occasionally plugged solid before they were serviced.

The spray tips were adjustable and the uniformity of the color was dependent upon the ability of the operator. Most of the weaknesses would fall into the class of the human element.

The latest applicating equipment was designed to eliminate human error as much as possible. Each piece of equipment is designed and calibrated for the varied production of a single planer.

The large storage tanks were eliminated and replaced by a metering pump. This is a rugged little pump used extensively by sewage plants to uniformly meter chemicals in a continuous and reliable manner. This pump maintains a small quantity of premixed material and feeds the main pump.

The main filter was changed to a much larger model and motorized. The filter is self cleaning and is manually flushed periodically to remove accumulated wood flour and other impurities. Flushing the filter is a simple operation of opening and closing a valve.

Many changes were incorporated into the spray box. I won't go into detail on these since the boxes vary with each installation depending upon what product is being used and the dimension cut.

The overspray is accumulated under a coarse filter in the bottom of the spray box and then is either pumped or flows under gravity into a finer secondary filter and from there into the main sump for recirculation.

In conclusion I would like to emphasize the effectiveness of water repellents in keeping kiln dried lumber dry. Treated, packaged lumber will show an average plus or minus change of 1 percent when stored exposed to the elements over a 90 day period. It is not difficult to apply and is cheaper than alternate means of protection.

PACKAGE #1 - WATER REPELLENT ONLY

								TOTAL
+ 3	+ 4	+ 6	+ 4	+ 5	+ 4	+ 4	+ 4	+34
+ 2	+ 1	+ 3	+ 1	+ 1	+ 2	+ 2	+ 2	+14
+ 1	+ 1	- 1	+ 2	+ 1	+ 2	---	+ 2	+ 8
---	---	---	---	---	---	- 1	---	- 1
- 1	- 1	- 1	- 1	+ 1	---	- 1	- 2	- 6
- 1	---	- 1	+ 1	+ 1	---	---	- 4	- 4
- 1	---	---	---	- 2	---	---	- 2	- 5
- 1	- 1	- 2	- 2	- 1	- 1	---	---	- 8
---	---	+ 1	---	+ 1	+ 1	+ 2	---	+ 5
---	---	---	---	- 1	---	---	---	- 1
- 2	---	- 1	---	- 1	---	- 1	---	- 5
---	---	- 2	- 4	---	---	---	- 1	- 7
---	- 1	+ 1	+ 1	+ 1	- 1	---	+ 1	+ 2
---	- 1	- 1	- 2	---	---	- 3	---	- 7
+ 1	+ 1	- 3	---	+ 1	+ 1	+ 1	---	+ 2
---	---	+ 1	---	---	---	- 2	- 1	- 2
---	- 1	- 1	+ 1	+ 1	---	---	---	0
- 1	---	- 2	- 2	+ 1	---	- 1	+ 1	- 4
---	---	- 1	+ 2	---	+ 1	---	---	+ 2
---	- 3	---	- 1	---	---	+ 1	---	- 3
								+14

Average Moisture Increase Per Piece

$\frac{14}{160}$ pieces = 0.09%

PACKAGE #6 - CONTROL PACKAGE - NO TREATMENT

								TOTAL
+ 4	+ 2	+ 4	+ 4	+ 8	+ 2	+ 3	+ 6	+33
+ 5	+ 8	+ 5	+ 4	+ 7	+ 4	+ 6	+ 8	+47
+ 1	+ 1	---	+ 1	+ 3	+ 3	+ 2	+ 2	+13
-10	+ 9	+ 7	+ 2	+ 5	+ 5	+ 3	+ 9	+50
+10	+ 1	+11	+ 1	+ 1	+10	+20	+10	+64
+10	+ 1	---	+ 1	+ 1	+ 3	+ 7	+ 2	+25
+ 7	+ 2	+ 2	+ 2	+ 2	+ 7	+ 5	+ 5	+32
+ 7	+ 1	+ 2	+ 8	+ 1	+ 1	+ 1	+ 5	+26
+ 6	+ 5	+ 3	+ 2	+ 2	+ 3	+ 3	+ 5	+29
+ 6	+ 4	+ 3	+ 1	+ 6	+ 5	+ 5	+10	+40
+ 4	+ 2	+ 7	+ 6	+ 1	+ 9	+23	+ 7	+59
+ 5	+ 3	+ 5	+ 3	+ 1	+ 6	+ 8	+ 2	+33
+ 9	+ 6	+ 1	+ 5	+ 6	+ 9	+ 8	+10	+54
+ 3	+ 5	+ 1	---	+ 3	---	+ 1	+ 2	+15
+ 1	+ 1	+ 1	---	---	+ 1	+ 1	+ 1	+ 6
+ 3	+ 1	+ 3	+ 2	---	+ 3	+ 2	+ 3	+17
+ 3	+ 3	---	+ 1	+ 5	+ 1	---	+ 5	+18
+13	+ 1	+ 3	+ 1	+ 6	+ 2	+ 2	+ 7	+35
+14	---	+ 2	+ 1	+ 3	---	+ 1	+ 2	+23
+ 2	---	+ 1	---	+ 1	+ 1	+ 2	+ 3	+10
								+629

Average Moisture Increase Per Piece.

$$\frac{629}{160} \text{ pieces} = 3.92\%$$

Q. Does a water repellent protect rough lumber?

A. We have never treated rough lumber with a water repellent. I think it might be difficult to treat rough lumber since a water repellent depends on a very fine coating over a continuous smooth surface.

Q. How do these stains affect the use of colored stains, Olympic type stains for decoration?

A. When looking at cherry browns or water repellents you are primarily in the dimension market, not the siding market. The majority of mills that are doing it are in the dimension market. It has been shown that certain wood preservatives, such as salts, do not penetrate the water repellents too well.

Q. In your tests, how long has the water repellent lasted on the lumber?

A. About 10 or 15 tests have been conducted over a period of 90 days of exterior exposure. At certain mills, the amounts and time of rainfall have been recorded. We have been using the weather office statistics for the amount of rain. In reference to the test I think from the time of the treatment with the water repellent on the lumber until received at the market in Minnesota, was something like 70 days with 31 days of rain. I don't know the amount of rainfall on the lumber in transit.

Q. Was your chemical still fairly strong after 70 days?

A. The water repellents are effective on the overall package since application is a minute amount. You are basically taking a product and mixing it with water, a 10, 15, 20 to 1 ratio and putting it on the board at a ratio of half a gallon per thousand feet, so the amount on the surface is very minute. Test results indicate a moisture pickup on top course depending on weather.

Q. What is the cost per thousand?

A. This depends on what you put on basically. The cost of clear water repellents, is about 18.2¢ a gallon, colored water repellents are about, varying with size, 35¢ per thousand. Colored water repellents with sap stain control, 50 to 55¢ per thousand. Anti-travel stain treatment about 35¢ per thousand.

Q. You mentioned that mill in Saskatchewan, was it heated?

A. The mill in Saskatchewan is heated. We are presently spraying in three mills operating continuously through the winter. In B.C. two mills have initiated heat into their planer. The third one has no heat at all around their spraying area, but they have housed a spray unit and the application equipment in a heated room. Lumber coming into these mills have thermometers in the load ranging from a low -45F and we were still able to spray without causing popsicling which is the main problem.