The Kilndrying of Southern Pine

By

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Madison, Wis.

THE subject of kilndrying lumber is one of great interest to every lumberman, because it is a phase of his operation which he has not been able to work out to his satisfaction. So great is his interest that each year large sums of money are expended in developing methods whereby lumber may be dried with a greater saving in quality.

That the United States Forest Service recognizes the achievement of good kilndrying as a forward step in the conservation of our forest resources is shown by the fact that for thirteen years it has carried on experiments at the Forest Products Laboratory at Madison, Wis., on the kilndrying of wood. These experiments have given us an intimate knowledge of the physical structure of wood and of its behavior and action during the drying process, and have succeeded in removing much of the "mystery" element so commonly attributed to the seasoning of wood.

The application of the information resulting from these experiments has already done much to improve the art of kilndrying lumber and it was with the view of bringing in a greater measure into the field of the kilndrying of Southern Pine such information which would lead to a reduction in kilndrying losses that your Directors arranged last fall with the Forest Products Laboratory to make a survey of the kilndrying practice at Southern Pine mills.

From a list of representative mills named by your association, I visited during last September, October and November the following plants:

Wisconsin-Arkansas Lumber Co., Malvern, Ark.
Fordyce Lumber Co., Fordyce, Ark.

Lufkin Land & Lumber Co., Lufkin, Tex.
Delta Land & Timber Co., Conroe, Tex.
Calcasieu Longleaf Lumber Co., Lake Charles, La.
Forest Lumber Co., Oakdale, La.
Industrial Lumber Co., Elizabeth, La.
J. J. Newman Lumber Co., Hattiesburg, Miss.
Marathon Lumber Co., Laurel, Miss.
Wausau Southern Lumber Co., Laurel, Miss.
Eastman Gardiner & Co., Laurel, Miss.
Kaul Lumber Co., Tuscaloosa, Ala.
Alger-Sullivan Lumber Co., Century, Fla.
Foster Creek Lumber Co., Stephenson, Miss.

It would be an injustice to you to attempt to tell you after making such a survey that I could tell each of you exactly what to do in order to eliminate your kilndrying losses. But I do want to state some facts which I hope you will find of interest and which may be of benefit to you.

Progressive Kiln Generally Used.

The mills which I visited covered practically the entire longleaf and shortleaf pine area and I believe are typical and representative of the progressive manufacturer of Southern Pine. At all of these mills I found lumber being dried in ventilated progressive kilns, such as National, Standard, Moore or others operating on similar principles. I believe that there are a few mills drying Southern Pine in compartment kilns, but the greater percentage of pine is being dried at the present time in progressive kilns.

The practice at all of these mills was to kilndry all B&B stock. The drying time ranged from 72 to 96 hours. The kiln operation in most cases consisted of loading the kiln, turning on the heat and leaving the operation to itself, the temperature and relative humidity during drying depending on the design and construction of the kiln.

Only in a few cases was there any attempt to control the temperature and humidity during the drying operation. In some cases a reducing valve gave a uniform steam pressure at the kiln but in most cases the kilns were supplied with steam direct from the boilers. In a few cases the steam was shut off over Sundays and holidays.

At practically all of the mills I measured the temperature and humidity at various places in the kiln to determine what effect these conditions had on the quality of dried lumber; several trucks of lumber were graded rough before and after kilndrying and again after

manufacture. Since much of the degrade due to kilndrying does not show up in the rough lumber, we will concern ourselves only with the degrade behind the planer.

1″ B&B stock was kilndried and graded at 4 plants. At mill No. 1, cutting longleaf pine, 1x4 to 1x12 mill run 16' stock was dried at a temperature of 200° to 220° and a relative humidity of about 10% at the dry end of the kiln. 77.8% of this stock came out on grade, 15.1:% having fallen to No. 1C, 4.2% to No. 2C, 1.2% to No. 3C, and .7 of 1% being waste. 22.2% of the stock which had entered the kiln as B&B stock was reduced one or more grades on account of defects which developed during kilndrying. Using the average mill price given in your association report of March 10, the average loss per thousand feet of stock in this test was $6.15. In making these tests, I followed mill practice in keeping stock on grade where possible by trimming the ends. Defects due to mismanufacture were not considered as degrade.

At mill No. 2 a load of 1x8 to 1x12 B&B shortleaf pine showed a degrade of 28.9%, an average loss per thousand feet of $11.64. At mill No. 3 a lot of 1x4 to 1x12 B&B shortleaf pine mill run showed a degrade of 13.3%, an average loss per thousand of $4.55. At mill No. 4, the degrade in B&B shortleaf pine mill run was 25.3%, an average loss per thousand of $588.

Last year your inspection department made similar degrade studies at 10 representative pine mills. They found that in 1″ B&B stock the degrade ranged from 14% to 55%, with an average for all the mills of 36.3%. This is somewhat higher than the tests I made and shows that due to degrade a loss of $4.00 to $1090 per thousand mill run is not uncommon in kilndrying B&B pine. The chief cause of degrade in B&B was checking, endsplitting and planersplitting.

Variation in Common Lumber Drying.

In the kilndrying of common lumber there is a greater variation in kilndrying practice. In many cases the common stock is kilndried with the B&B stock, requiring 72 to 96 hours of drying and becoming quite dry. In other cases an attempt is made to prevent the common stock from getting as dry as the B&B and it is piled separately and is left in the kiln from 12 to 24 hours less than B&B.

The mills at which I dried common stock were drying it with their B&B. At mill No. 1 the degrade in No. 1C was 45.1%, an average loss of $7.30 per thousand mill run. At mill No. 2 the degrade in No. 1C was 49.7%, an average loss of $9.51 per thousand.

At mill No. 3 the No. 1C degraded 16.2%, an average loss of $3.14 per thousand. At mill No. 4 the degrade in No. 1C was 27.7%, an average loss of $4.64 per thousand. Your inspection department in its tests found degrades in No. 1C from 16½% to 63¼%, with an average of 32.6% for all mills. The chief source of loss in this stock was loose and checked knots, and planersplitting,

The degrade in kilndrying No. 2C also runs quite high, but does not represent such a large loss in value. At mill No. 1 the degrade in No. 2C was 26.4%, a loss of $1.70 per thousand. At mill No. 3 the degrade was 35.3%, a loss of $1.88 per thousand, and at mill No. 4 the degrade was 28.1%, a loss of $1.23 per thousand. Your inspection department found degrades in No. 2C ranging from 8½% to 55¼%, with an average for all mills of 23.7%. Loose and broken knots and some planersplitting caused these degrades.

It is evident therefore, that throughout the whole pine industry kilndrying is developing defects, which reduce the value of lumber per thousand by $4.00 to $10.00 in B&B, by $3.00 to $10.00 in No. 1C and by $1.00 to $2.00 per thousand in the lower grades.

Causes of Degrades.

What are the principal factors to which this degrade in kilndrying is due? Me can roughly classify the drying defects which cause degrade, in pine under three heads:

1. Splits and checks.
2. Loose and broken knots.
3. Warp, cup and crook.

Splitting of the ends of boards and checking of the faces of boards are the principal causes of degrades in B&B stock, and result from the peculiar shrinkage properties of wood. Pine sapwood which makes up most of the B&B stock, contains anywhere from 2/3 to twice as much water as wood. I have found sections of pine which, weighing nearly 3 pounds when cut green, weigh only 1 pound upon becoming dry. The structure of this pine wood is much like honey comb and a part of the water goes to soak up the wood tissue, while the rest of the water simply stands in the openings as free water. The amount of water which goes to soak up the wood tissue is equal to about 1/3 of the weight of the dry wood itself. So in this sample there is only 1/3 of a pound of water soaked in the wood tissue and the nearly 1-2/3 pounds of water is free water. Wood does not begin to shrink until the free water is all evaporated and the water

begins to dry out of the tissue. So this sample of wood, if uniformly dried, would lose nearly 1-2/3 pounds of water before it would begin to shrink. If green pine lumber is exposed to dry hot air, the surface and ends of the board dry very rapidly and soon are dry enough to shrink. The center of the board, however, still contains free water and therefore cannot shrink. As a result the face and ends of the board crack open causing a drop in grade. The thicker the stock. the more the center of the board lags behind the surface in drying and the checking is worse. At mill No. 1, where the 1″ B&B stock degraded 22.2%, the 2″ B&B degraded 73.6% on account of checking and splitting.

The only practical method we know of reducing checking and splitting is to carry a relative humidity high enough to prevent the surface and ends of the board from drying very far below the point at which shrinkage begins until the center of the stock has also dried to the shrinkage point. Then the humidity may be lowered so that the lumber will become dry.

Preventing Loose and Checked Knots.

The second class of defects, namely loose and checked knots is a principal source of degrade in common lumber and is largely due to the shrinkage of the knot away from the board, When the pine board is dried in comparatively dry air, the knot becomes loose for two reasons. In the first place, the exposed surface of the knot is end grain and therefore dried rapidly. Consequently the knot shrinks while the board is still too wet to shrink. In the second place, wood shrinks very little along the grain, but quite appreciably across the grain. Consequently, the knots shrink in all directions on the face of the board but none at all in thickness, while the board shrinks in width and thickness but not in length. In the dry board then the knot is thicker than the board but not as large as the hole in the board and therefore becomes loose or checks. It is well known that in airdrying fewer knots fall out of the lumber than in kilndrying. The chief reason for this is that airdried lumber does not get as dry as kilndried lumber, and consequently, the knots do not shrink as much. The Forest Products Laboratory has recently kilndried some No. 1C Douglas Fir Lumber and by using a relative humidity of 70% throughout the entire drying, which prevented the lumber from becoming drier than airdried stock, the degrade was held down to 10%.

The third class of defects, namely, cupping, warping and crook are due to variations in shrinkage properties within the same board

These defects cannot be so greatly influenced by the conditions of drying but must be overcome by stickering so that the board will be held flat and in place during the drying process.

Another source of degrade which takes place in kilndrying pine under a low humidity, is casehardening. By casehardening I do not mean that the surface of the board is harder than the rest of the board. When the surface of a board first dries and tends to shrink, It is prevented from shrinking by the wet interior. Consequently, the surface becomes dry, without receiving all the shrinkage it should. When the center of the board becomes dry enough to shrink, it is in turn partially held back by the dry surface and the board comes out of the kiln with its center pulling, at the stretched surface. Such lumber is said to be casehardened. If you re-saw such a board the two sections will cup, the re-sawn faces becoming shorter due to this pull.

Machine Splitting Causes Degrade.

By the use of a low humidity in the kiln, such lumber also becomes very dry, waiting for the slow drying boards in the upper part of the pile, and often dries to a moisture content of 1 or 2%. This low moisture content makes the lumber brittle. When such lumber, if slightly cupped, is put through the planer where it is flattened out on the bed of the machine, the brittleness of the board, together with the casehardening stresses, causes a splitting of the board known as machine or planer splitting. This defect in many cases caused as much degrade as all other sources of degrade.

It is customary at many mills to bulkpile the kilndried stock for 30 to 60 days before sending it to the planing mill. Two changes take place during this period. In the first place, the casehardening stress becomes less, that is, they die out to some extent, so that when re-sawn, such lumber will not cup as badly as when first drawn from the kiln. In the second place, there is a redistribution of moisture between boards and some absorbtion of moisture from the atmosphere, so that the board is not as brittle as formerly. There may also be a gradual flattening out in the cupped board. The result is that bulkpiled lumber goes through the planing mill with much less degrade than stock direct from the kilns. At mill No. 2, we graded a lot of 1x10 No. 1C direct from the kiln, which showed a degrade of 49.7%. A similar lot, but bulkpiled, for a month, gave a degrade of less than 9%.

At some mills it is customary to open a steam jet in the dry end of the kiln for about two hours before pulling the lumber from the

kiln. This of course increases the relative humidity in the kiln and the overdry lumber will pick up some moisture and it will come out of the kiln with a little less casehardening and a somewhat higher moisture content, and will therefore, go through the planers with a smaller degrade.

Greater Humidity Beneficial.

The fact that all the degrade tests which your association made last year and the observations which I made last fall showed a high degrade due to checking, endsplitting, loosening of knots and planer-splitting was evidence that pine must be dried in more humid air if the degrade is to be reduced. I found that in practically all of the kilns where the humidity was not controlled, the relative humidity at the dry end of the kiln was between 10 and 20% at temperatures of 190° to 225° in a natural circulation kiln, the relative humidity varies inversely as the temperature, the higher temperature causing a low relative humidity and the low temperature a higher relative humidity. At the green end of the kiln the relative humidity often was as low as 35%. These readings were taken outside the piles but showed that in most kilns even inside the piles, the air was not really moist. I could go into most of the kilns and close the door behind me, without being scalded; any kiln with which you can do that when the temperature is 180° and above does not have a high humidity.

Now the humidity in these kilns comes from the moisture evaporated from the lumber. But there was so much fresh air entering the kiln, not only through the air ducts, but through openings and cracks at the doors that the moisture escaped from the kilns as fast as it evaporated from the lumber. The result was that the air in the kiln was quite dry instead of being laden with moisture.

With the survey completed and the results showing that a considerable portion of pine lumber was being reduced in value through degrade during kilndrying, it was felt desirable to make demonstration runs at some commercial kiln on kilndrying pine at higher humidities. Arrangements were made by your association to fit up a kiln at the Lufkin Land & Lumber Co., Lufkin, Tex., for this purpose.

The kiln used for the demonstration runs was a Standard two track, ventilating progressive kiln, 110 feet long and adapted for flat and endpiling. The first object sought was control of humidity. A series of steam sprays was put in at the dry end of the kiln and were operated and controlled by a wet bulb thermostat placed between the trucks of lumber at the dry end of the kiln. This thermo-

stat could be set to give any wet bulb temperature desired. In operating kilns of any kind at a high humidity, however, moisture will condense on the cool ceiling and so we put in several lines of heating pipe along the ceiling to keep it warm enough to prevent condensation and drip.

Rapid Circulation Sought.

The second object sought was to secure as rapid circulation of air through the lumber pile as possible. Now any natural circulation kiln is designed with the idea that heated air should rise through the pile and dry the lumber. But if heated air is to rise, the cool air must have a place to fall. I had noticed that in most kilns with heating coils between trucks, the heated air rose between the trucks to the top of the kiln and if there was a chimney in the roof of the kiln, it went out that chimney. In fact, I failed to find a single chimney at any kiln where the exhausting air had a high humidity. The heated air rising between the trucks of lumber therefore, did not dry any lumber.

The tendency of the cool air in the pile is to fall, and I think the most rapid circulation I found in the lumber at any kiln was at a plant where edgestacking was used. Although the heating coils were directly beneath the lumber, the air in the pile was cool enough and heavy enough to cause a downward circulation through the pile and through the heating coils and the circulation of heated air was upward between trucks and the wall. This condition prevailed for over 48 hours out of the 72 hours the lumber was in the kiln. In other words, the circulation in the pile did not turn upward until @he stock was nearly dry.

Now, if the heated air is to rise through the lumber pile, the cool air must also be given a chance to fall. In this demonstration run we accomplished this by removing all the heating coils which were not directly underneath the loads of lumber and placed part of the coils removed underneath the lumber pile at the green end of the kiln. New the heated air could rise through the pile, evaporate moisture, and become cool, tending to fall. thus moving to the side of the load and dropping to the bottom of the kiln. In this way we were able to secure a circulation of air across the face of the boards, and outside the loads secured a rapid downward circulation. Obtaining this circulation, we closed the entering air duct at the bottom of the kiln, making it easier to maintain a humidity at the dry end of the kiln. There was also a strong longitudinal circulation in the

kiln from the green end toward the dry end at the bottom of the kiln, and in the opposite direction at the top of the kiln between the top of the loads and the ceiling. This longitudinal circulation did not increase the circulation of air through the pile, but served to distribute the humidity between the two ends of the kiln, making the relative humidity dependent on the variation in temperature.

With the kiln thus remodeled for controlling conditions, and with numerous recording thermometers placed at various points in the kiln, the kiln was put into operation. The first test load consisted of about 12,000 feet of 1″ stock, mill run all widths and grades No. 2C and better. With a wet bulb reading of 150°, the relative humidity at the dry end of the kiln was held around 30% at a temperature of 200° and about 60% at the green end at 170° to 180°. Even with these humidities much of the stock dried to 3 and 4 per cent moisture content, but with very little checking and splitting. The B&B stock showed a degrade of less than 6 per cent, which was an average loss per M. of $1.70, as compared with losses of $4 to $10 per M. in B&B on previous tests. The drying time on this test was 84 hours.

The common lumber, however, being dried with the B&B stock, became so dry that the knots loosened and the degrade was practically as high as in previous tests, showing 24 and 25% degrade. Drying common lumber down to a moisture content of 3 and 4 per cent, even under a humidity high enough to prevent checking did not materially reduce the degrade, so a second test was made on common stock. This time the stock was pulled from the kiln at 55 hours, to prevent overdrying. While it was found that the lumber in general was not as dry as before, and the knots were tighter, the upper part of the load was hardly dry enough for common. So in grading these loads, the lumber which was not dry enough to finish smoothly was laid out. The degrade in the No. 1C which was dry enough to finish well was 11.6%, an average loss of $2.01 per M. as compared with losses of $3 to $10 per M, in previous tests. No. 2C showed a degrade of 12.170, an average loss of $0.62 per M. as compared with a loss of $1 to $2 per M. in previous tests.

Saving Effected.

This demonstration showed that B&B pine lumber can be commercially dried in progressive kilns using a humidity of at least 30 per cent at the dry end of the kiln without degrading more than 5 to 6 percent of the stock, which is a saving of from $2.50 to $8.50 per M. mill run. For a 200,000 foot mill cutting 35.000 feet of B&B

daily, the daily saving on the basis of last fall's survey would roughly be $85 to $300 on this item alone.

The drying of common stock with a low degrade is a more difficult matter, chiefly on account of the slow circulation of air through the pile in a natural circulation kiln. Due to this slow circulation of air, I found in the demonstration runs that the upper part of the pile would be as much as 30° cooler than the lower part of the pile. This difference in temperature causes a tremendous difference in relative humidity, especially at high relative humidities. To prevent common stock from drying below airdrying conditions, you would have to maintain a relative humidity of about 70 per cent in the lower part of the load. The cooler air at the top would be so moist then that the upper part of the load would scarcely dry. In other words, it is not possible to dry pine lumber in a reasonable length of time in a natural circulation kiln without getting the lower part of the pile quite dry, thereby causing an appreciable degrade in common lumber, or without pulling the stock in such condition that a considerable portion of the load will be too wet to machine well.

The opportunity for drying common lumber with a minimum of degrade lies in using a drykiln where there is a rapid circulation of air through the pile of lumber.

Time For Drying May Be Shortened.

That the length of time required. to dry pine in commercial kilns depends largely on the rate of circulation of air through the pile is shown by the fact that samples placed in the lower part of the pile would dry in 48 hours while samples off the same board but placed in the upper part of the pile would require 84 hours for drying. To determine how fast green pine might be dried if the circulation through the pile were rapid, I took one board from each of 20 logs, whose texture and moisture content was such that they would be the last to become dry in a load of lumber. Four foot pieces were cut from these boards and taken to the Forest Products Laboratory at Madison. The ends of the boards were coated and the stock was then placed in a fast circulation kiln and dried at a temperature of 180° and 80 per cent. At the end of 40 hours all had reached the dryness of airdried stock. The temperature was raised to 200° and the humidity dropped to 44 per cent. In eight hours more, a total drying time of 48 hours, the stock was thoroughly dried.

Consequently both humidity and circulation are important factors not only in kilndrying pine to secure a low degrade but also to

secure a rapid drying rate. While lumber will of course dry more rapidly at higher temperatures, it must be remembered that the higher the temperature the more difficult it is to control the relative humidity.

I said in the beginning that the conditions I have described applied generally to those kilns where there was no regulation of temperature and humidity during the drying process. There are at the present time, however, an increasing number of mills where the humidity and temperature are being more or less controlled and tests have shown that in actual production operation the lumber dried under such conditions has much less degrade than before such regulation was attempted. Sometimes the drying process has been somewhat lengthened, but when the kilns can be brought to the point where a faster circulation of air through the pile can be secured the drying time can be decreased to approach a drying time of 48 hours for 1″ B&B stock, and 40 hours for common lumber. I believe that the possibilities for securing a fast circulation through the lumber pile in ventilated kilns drying yellow pine are by no means exhausted but that it would be of great value to conduct further experiments along this line.

There are many details connected with the kiln drying of yellow pine which I have not touched in this discussion. There is no doubt but what they also have a great influence on the quality of kiln dried stock, but whatever degrade they cause is so largely swallowed up by the degrade due to unfavorable humidity and circulation conditions that it has not been possible to differentiate between them.

More Uniformity Required.

In considering the future possibilities for kiln drying in Southern Pine, it must also be remembered that the demands of the trade are constantly becoming more exacting. They are demanding that the lumber be more uniformly dried and that it be dried to the moisture content which their stock will reach when put into service. Much of the B&B kilndried pine lumber reaches a moisture content of 1 and 2 per cent while the last wet boards in the pile are becoming dry enough. Such stock when put into service absorbs moisture again causing a change in shape and size. The same control of drying conditions which will reduce the degrade in your drying operations will also go a long way toward bringing stock out of the kiln at a more uniform moisture content and with the percentage of moisture which he finds most desirable for his finished product.

In conclusion I wish to point out the principal results of the survey and demonstration runs.

1. That the degrade in kilndrying upper grades of Southern Yellow Pine can be reduced in the present commercial kilns by proper humidity control to prevent checking, splitting and overdrying, thereby increasing the value per thousand mill run from $2.50 to $8.50, depending on existing conditions.

2. That in order to reduce degrade in common grades the stock must not be permitted to become as dry as B&B and therefore should not be dried with the B&B. The faster the circulation of air through the pile the greater will be the opportunity of reducing the degrade in this class of stock.

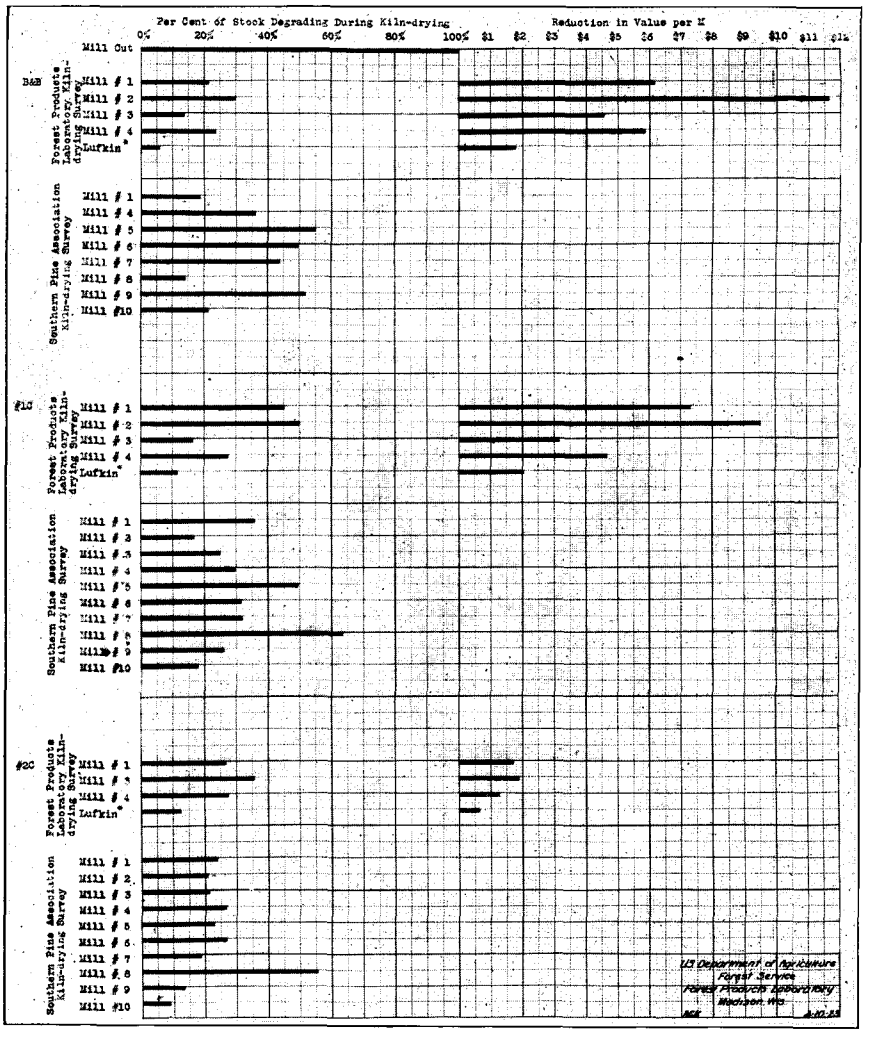
3. That the length of drying time in all grades of yellow pine is dependent on the rate of circulation of air through the pile and that the more the rate of this circulation is increased, the shorter will be the time required to dry the stock. (Applause.)

Results of Southern Yellow Pine Kilndrying Survey

CONDUCTED BY

Forest Products Laboratory and Southern Pine Association

1921 - 1923



* High Humidity Demonstration Run made at Lufkin Land and Lumber Company, Lufkin, Texas by Forest Products Laboratory. All tests on mill run stock (includes both shortleaf and longleaf Southern Yellow Pine). Stock manufactured into finished product immediately after kiln drying. Reduction in value of lumber based on Southern Pine Association Sales Report of March 10. 1923.

RESULTS OF GRADING TESTS

KILNDRYING SURVEY---SOUTHERN YELLOW PINE

—— BY ——

A. C. KNAUSS

FOREST PRODUCTS .LABORATORY---MADISON, WIS.

Grade Into Kiln		Mill No. 1	Mill No. 2		Mill No. 3	Mill No. 4	Demonstration Run
B & B..	STOCK.....	Longleaf Pine	Shortleaf Pine		Shortleaf Pine	Shortleaf Pine	Shortleaf Pine
	FEET GRADED	2405	1501		4536	5053	4790
	SIZE.....	1x4 to 1x12 (mill run)	1x8 to 1x12 (mill run)		1x4 to 1x12 (mill run)	1x4 to 1x12 (mill run)	1x4 to 1x12 (mill run)
	Drying time.....	66 hours	72 hours		72 hours	72 hours	84 hours
	Final Grades:						
	On grade.....	78.8%	71.1%		86.7%	76.7%	94.2%
	Degrade to #1C..	15.1%	13.6%		4.7%	17.9%	3.6%
	Degrade to #2C..	4.2%	8.0%		6.7%	5.4%	2.0%
	Degrade to #3C..	1.2%	2.4%		.....	.....	.....
	Waste.....	0.7%	4.9%		1.9%	.....	0.2%
	Loss per M.....	$6.15	$11.64		$4.55	$5.88	$1.76
No. 1C..	FEET GRADED.	3134	2407	627*	4349	5212	4652
	SIZE.....	1x4 to 1x12 (mill run)	1x8 to 1x12 (mill run)	1x10 (mill run)	1x4 to 1x12 (mill run)	1x4 to 1x12 (mill run)	1x4 to 1x12 (mill run)
	Drying time.....	66 hours	72 hours	72 hours	72 hours	72 hours	56 hours
	Final grades:						
	On grade.....	54.9%	50.3%	91.2%	83.8%	72.3%	88.4%
	Drgrade to #2C..	43.9%	22.7%	8.6%	13.8%	24.3%	10.5%
	Degrade io #3C..	0.4%	21.1%	.....	1.2%	3.4%	0.8%
	Degrade to #4C..	0.4%	3.5%	.....	.....	.....	.....
	Waste.....	0.4%	2.4%	1.2%	1.2%	.....	0.3%
	Loss per M.....	$7.30	$9.51	$1.74	$3.14	$4.64	$2.01
No. 2C..	FEET GRADED.	2307			4744	4374	4913
	SIZE.....	1x4 to 1x12 (mill run)			1x4 to 1x12 (mill run)	1x4 to 1x12 (mill run)	1x4 to 1x12 (mill run)
	Drying time.....	66 hours			72 hours	72 hours	56 hours
	Final grades:						
	On grade.....	73.4%			64.7%	72.9%	87.9%
	Degrade to #3C..	24.9%			34.6%	27.1%	11.8%
	Waste.....	1.7%			0.7%	.....	0.3%
	Loss per M.....	$1.70			$1.88	$1.23	$0.62

*Bulk piled for 30 days.

Defects due to mismanufacture not considered as degrade.
All stock manufactured immediately after leaving the kilns.

SHOWING

RESULTS OF DRY-KILN TESTS

— BY —

SOUTHERN PINE ASSOCIATION

1921

Mill No.	Amount in Kiln	Grade	Size	Type of Kiln	Time Drying (hrs.)	Avg. Tem.	How Worked	On Grade	Degrade	Percent of Depreciation	Long Leaf	Short Leaf
1	3483	B. & B.	1x4 to 10	Standard	72	180–210	Rough	3401	82	2.35	90%	10%
	4828	No. 1 C	1x4 to 12	"	72	180–210	"	4415	413	8.55	90%	10%
	7888	No. 2 C	1x4 to 12	"	72	180–210	"	7165	723	9.16	90%	10%
	2011	No. 3 C	"	"	"	"	"	2011	000	0.00	90%	10%
	7566	No. 1 C	2x4 to 12	"	"	"	"	7493	73	0.10	90%	10%
	1316	No. 2 C	2x4 to 10	"	"	"	"	1272	44	3.34	90%	10%
10	3562	B. & B.	1x4 to 12	"	72	172–190	Rough	3154	408	11.45		100%
	8451	No. 1 C	"		48-72	"	"	7892	559	6.61		100%
	8862	No. 2 C	"		72	"	"	8500	362	4.08		100%
1	1572	B. & B.	1x6 to 10	Standard	72	180–210	S4S	1183	389	24.74	90%	10%
	2927	"	1x3 and 4	"	"	"	Flg.	2487	440	15.	90%	10%
	4417	No. 1 C	1x4 to 12	"	"	"	S4S	2830	1587	35.93	90%	10%
	7490	"	2x4 to 12	"	"	"	S4S	6746	744	9.93	90%	10%
	7165	No. 2 C	1x4 to 12	"	"	"	S4S	5460	1705	23.80	90%	10%
	1273	"	2x4 to 10	"	"	"	S4S	1202	71	5.58	90%	10%
	2011	No. 3 C	1x4 to 12	"	"	"	S4S	1974	37	1.84	90%	10%
2	4274	No. 1 C	1x6 to 12	"	48	180–198	Various	3562	712	16.67	75%	25%
	4294	No. 2 C	1x6 to 12	"	"	"	"	3400	894	20.82	75%	25%
3	1536	No. 1 C	1x6 and 8	Moore	48	200	"	1153	383	24.94	50%	50%
	3078	No. 2 C	1x6 to 12	"	"	200	"	2428	650	21.11	50%	50%
4	1203	B. & B.	1x6 to 12	Payne-Joubert	72	180–200	S4S	769	434	36.	85%	15%
	3008	No. 1 C	1x6 to 12	"	"	"	"	2120	888	29.52	85%	15%
	3815	No. 2 C	1x6 to 12	"	"	"	"	2809	1006	26.37	85%	15%
5	4777	B. & B.	1x6 to 12	National	96	"	"	2149	2628	55.		100%
	3540	No. 1 C	1x6 to 12	"	72	"	"	1801	1739	49.12		100%
	5330	No. 2 C	1x6 to 12	"	"	"	"	4111	1219	22.87		100%
6	2403	B. & B.	1x6 to 10	Furnace	"	"	"	1209	1194	49.69	100%	
	5125	No. 1 C	1x6 to 12	"	"	"	"	3513	1612	31.45	100%	
	5417	No. 2 C	1x6 to 12	"	"	"	"	3968	1449	26.75	100%	
7	469	B. & B.	1x6	Moore	"	170–190	"	263	206	43.92	100%	
	3322	No. 1 C	1x6 to 12	"	"	"	"	2266	1056	31.79	100%	
	3389	No. 2 C	"	"	"	"	"	2758	631	18.62	100%	
8	509	B. & B.	5/4x6 to 12	National	"	185–200	"	438	71	13.95		100%
	3185	No. 1 C	1x6 to 12	"	"	"	"	1170	2015	63.26		100%
	3645	No. 2 C	"	"	"	"	S2S	1631	2014	55.25		100%
9	4822	B. & B.	1x4 to 12	Standard	84	130–160	"	2321	2501	51.87		100%
	7883	No. 1 C	"	"	48	160–180	"	5836	2047	25.97		100%
	12483	No. 2 C	"	"	60	"	"	10835	1648	13.2		100%
10	4008	B. & B.	1x4 to 12		72	172–190	S4S	3154	854	21.05		100%
	7852	No. 1 C	"		48-72	"	"	6460	1392	17.73		100%
	8378	No. 2 C	"		72	"	"	7655	723	8.63		100%
	Yard				**Days**							
2	4373	No. 1 C	1x6 to 12	Air-Dried	80		S4S	3802	571	13.	75%	25%
	4962	No. 2 C	1x6 to 12	"	"		"	4732	230	4.64	75%	25%
3	1751	No. 1 C	1x6 and 8	"	120		1x6-S2S & C M 1x8 S.L.	1560	191	10.09	100%	
	6521	No. 2 C	1x6 to 12	"	"		Various	5893	628	9.63	100%	
5	4529	No. 1 C	1x6 to 12	"	"		S4S	3988	541	11.95		100%
	5407	No. 2 C	"	"			"	5072	335	6.20		100%
6	4858	No. 1 C	"	"	115		"	3336	1522	31.33	100%	
	5447	No. 2 C	"	"	"		"	5049	398	7.3	100%	
9	8322	No. 1 C	1x4 to 12	"	112		S4S	7345	977	11.74		100%
	10389	No. 2 C	1x4 to 12	"	"		"	10048	341	3.28		100%
10	4171	No. 1 C	1x4 to 12	"	100		"	3679	492	11.8		100%
	4261	No. 2 C	"	"	"		"	4114	147	3.45		100%

Total Kiln Dried and Dressed.....	134600	Degrade	34939	Average	25.95
" Air " " "	64991	"	6373	"	9.08
" Kiln " Inspected Rough ..	47967	"	2664	"	5.55