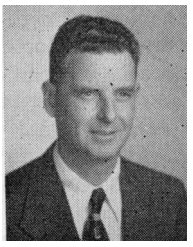
1953 PREPRINT FOREST PRODUCTS RESEARCH SOCIETY **240**

Preliminary copy of a report to be presented at the Seventh Annual National Meeting to be held at Memphis, Tenn., June 15, 16, 17, 1953. Not to be republished except upon release by FPRS Exec. Secy., Box 2010, Univ. Sta., Madison 5, Wis. The Society is not responsible for the views expressed.



Kiln Drying Water and Swamp Tupelo

JOHN M. McMILLEN

Technologist,[1] Forest Products Laboratory: Forest Service, U. S. Department of Agriculture

Describes tests run to determine proper kiln schedules for drying of sap and heartwood of swamp and water tupelo. Schedules determined as practical are given. Various separations by species and by sap and heartwood are suggested for best results. Control of warping and case-hardening-relief and final moisture content are also discussed.

Introduction

AMONG THE MORE common trees of the South are the tupelos. The name "tupelo" includes four species of the genus *Nyssa:* namely *Nyssa sylvatica,* black tupelo; *N. sylvatica* var. *biflora,* swamp tupelo; *N. aquatica,* water tupelo; and *N. ogeche,* ogeechee tupelo. The lumber from the black tupelo is commonly called blackgum, and that from water tupelo is called simply tupelo. The lumber from the swamp and ogeechee tupelos may be mixed in with that from either of the other species because there is no way of distinguishing the species by wood structure or general lumber characteristics.

Black tupelo grows in most of the territory east of the Mississippi and southwest to central Texas. In the North it occurs in wet locations as well as on high ground, but in the South it is generally restricted to relatively well-drained sites. The other species grow in fresh-water swamps and along the edges of streams and ponds in the South and Southeast. Water tupelo is the most prevalent and grows in a belt about 100 miles wide along the Atlantic coast from Virginia to northern Florida, westward through the Gulf States to southern Texas, and northward up the Mississippi Valley to southern Illinois. The range of swamp tupelo is approximately the same as that of water tupelo, except that it rarely grows north of Baton Rouge, La. Ogeechee tupelo is rare and of little commercial importance.

Blackgum lumber has long been used commercially, and its seasoning characteristics are well known. Specific kiln schedules were reported by Torgeson,[4] and standard kiln schedules T12-E5 and T11-D3 are listed for the 4/4 to 6/4 and 8/4 lumber, respec-

[1] Experimental kiln runs made by collaborators Ole Karlsen, Institute of Woodworkin and Wood Technology, Oslo, Norway, and Sixto J. Pericchi, University de Los Andes, Merida, Venezuela, under the direction of the author.

[2] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

[4] Accelerated Type of Kiln-Drying Schedules for 1- and 2-inch Blackgum. O. W. Torgeson. South. Lbrmn. Dec. 15, 1946.

ABOUT THE AUTHOR: McMILLEN, JOHN M. Has conducted research in the field of seasoning including chemical seasoning, special seasoning methods, kiln-schedule development and analysis of internal stresses in wood during drying. Received BS degree in forestry in '33 and MS in '38 from the University of Minnesota. Early experience included general forestry the Superior National Forest, FPL logging and milling studies in the Southeast and seasoning and preservative treatment of cross ties and poles and development of water repellents and end coatings in the wood preserving industry. Joined the staff of the FPL in '42.

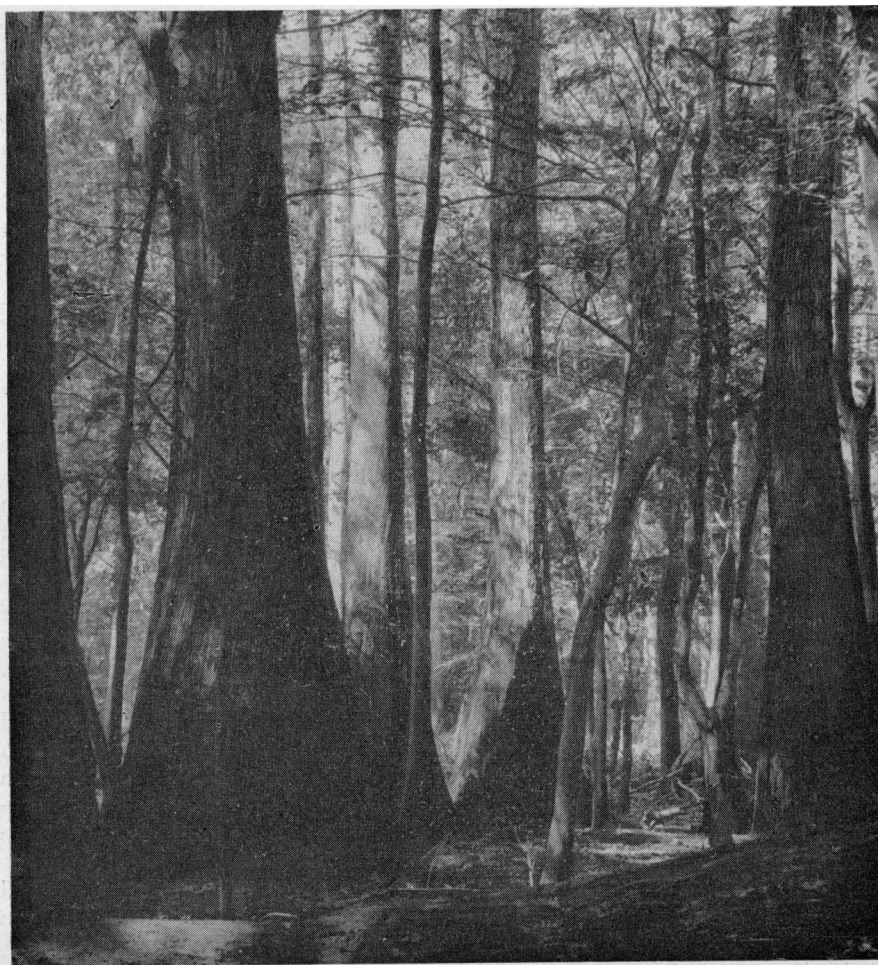


Figure 1.—Water tupelo *(Nyssa aquatica)* growing in typical site in Louisiana.

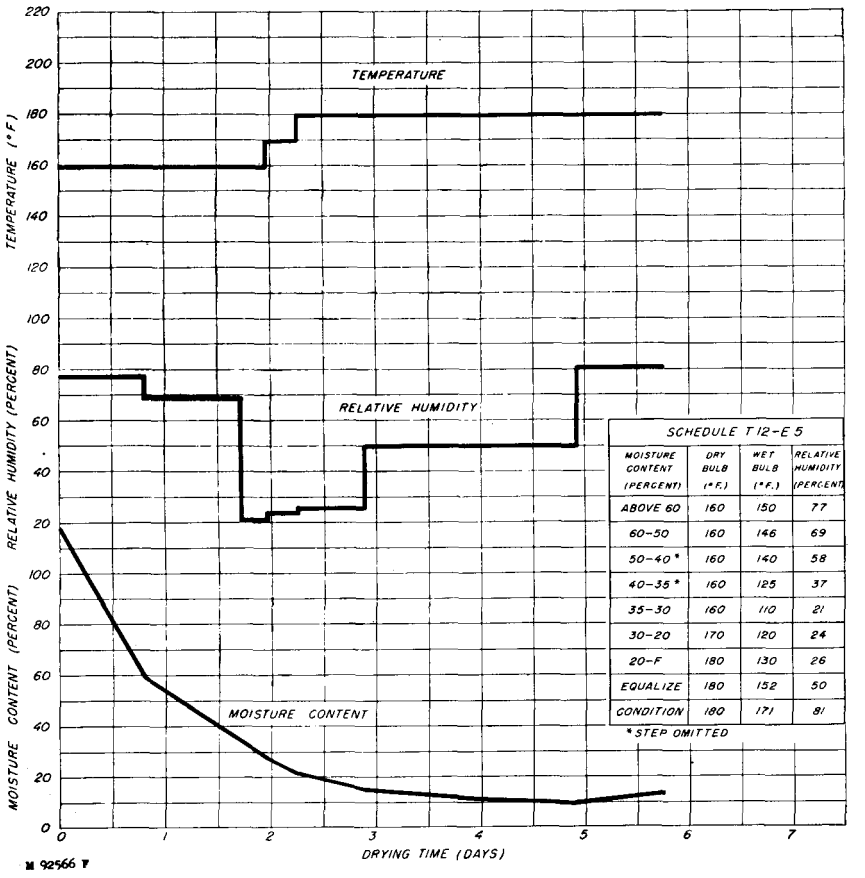


Figure 2. Kiln conditions and drying curve for 1-inch sapwood of water tupelo and swamp tupelo dried together using schedule T12-E5.

tively, in the Forest Products Laboratory report, No. D1791,[5] on its new schedules for the kiln drying of wood.

Until comparatively recent times, the lowland species of tupelo were bypassed as of low value. Lately, however, commercial interest has increased in water tupelo, and the lumber has appeared on the market under the name "tupelo," or sometimes as "bay poplar."

At the time of publication of Report No. D1791, satisfactory data were lacking on kiln schedules for water tupelo; so it was assigned the same schedules as blackgum. Information reached the Laboratory, however, that these schedules were not always satisfactory and that difficulties were encountered in drying water tupelo heartwood by any schedule without excessive degrade. As a part of its program of research, the Forest Products Laboratory decided to obtain a considerable quantity of water tupelo and determine which of the schedules listed in Report No. D1791 are most suitable for it.

Discussion with members of the staff of the Southern Forest Experiment Station, New Orleans, La., brought out that swamp tupelo or swamp blackgum (*N. sylvatica* var. *biflora*) grows quite generally in association with water tupelo; so the study was extended to this species. Because of the necessity of distinguishing between these two species, the terms "water tupelo" and "swamp tupelo," instead of the simple term "tupelo," are used for the lumber throughout this report. A photograph of water tupelo is shown in figure 1.

The sizes covered by this report are 4/4 and 6/4 lumber.

Material and Experimental Procedure

The material consisted of eight 16-foot water tupelo logs ranging from 18 to 28 inches and seven 16-foot swamp tupelo logs ranging from 16 to 25 inches in diameter inside the bark at top end. It came from the vicinity of Pontchatula, La., and was donated by Mississippi Products, Inc., Jackson, Miss. The logs were generally classified as good sawlog and veneer grade. No low-density swollen butts were included. An 8-foot length of five logs from each of the two species was used as material for veneer-cutting studies reported elsewhere.[6]

Soon after the logs were received at the Laboratory, a variety of items proposed for study were marked out on the end of each log. Those in the dark-colored central portion were designated as heartwood, and those in the lighter outer zone as sapwood. The items were sawed out according to the marking in considerably oversize boards, which were then stored in the green condition at a temperature of 35° F. Immediately prior to each series of experiments, the material needed was rough-dressed to the slightly oversize dimension common to green hardwood lumber.

The dressed boards were cut into short specimens 28 inches long, using the general procedures described in Forest Products Laboratory Report No. R1607.[7] There was considerable variation in the green moisture content of individual specimens. Water tupelo varied from 102 to 184 percent for heartwood and 80 to 163 percent for sapwood. Swamp tupelo varied from 63 to 140 percent for heartwood and 84 to 135 percent for sapwood. Average specific gravities were 0.42 for water tupelo and 0.48 for swamp tupelo.

For the purpose of the experiments, one end of each specimen was end coated to help the specimen approximate the drying rate of full-length material, while the other end was left uncoated to show the effect of the kiln conditions on the control of end

Fourteen kiln runs were made in all, the first ones attempting to check the suitability of the blackgum schedules for these woods, the others attempting to apply various principles of acceleration to speed up the drying after it was discovered that milder initial conditions were necessary for the water and swamp tupelos. The schedules and drying times for the different items are shown in table 1. Since it was found that there was a very great difference in drying characteristics of the sapwood and the heartwood of both species and that the swamp tupelo or swamp blackgum withstood more severe schedules than the water tupelo and dried faster, the separate items are arranged in the table and in the text in progressive order from the easiest to the hardest drying job. Also, wherever a numb-red schedule, such as T12-E5, is shown, it refers to the standard schedules published in Forest Products Laboratory Report No. D1791.[5]

Results With 4/4 Lumber

Sapwood, Both Species: The first run was made on the sapwood of both species, using the schedule given for blackgum, T12-E5. This schedule

[5] Schedules for the Kiln Drying of Wood. O. W. Torgeson. U. S. Forest Products Laboratory Report No. D1791. Feb. 1951.

[6] The Rotary Veneer Cutting and Drying Properties of Tupelo. John Lutz. Unpublished report of U. S. Forest Products Laboratory.

[7] Use of Kiln Samples in Operating a Lumber Dry Kiln, H. H. Smith. U. S. Forest Products Laboratory Report No. R1607. 1948.

proved to be generally satisfactory. There was very little surface checking, associated with defects in the wood. End-check penetration was limited to 2 inches. In this thickness, the wettest swamp tupelo did not dry much faster than the water tupelo. The total kiln time, including 2 days of equalization and 3/4 day of conditioning, was 5 3/4 days. The kiln schedule, the kiln conditions actually used, and the drying curve of the wettest half of the kiln samples of both species are shown in figure 2. The actual kiln conditions departed from the kiln schedule for two reasons. First, the drying rate was so fast that steps Nos. 3 and 4 of the schedule were bypassed. Second, equalization had to be started at the end of 3 days of drying because the driest samples were down to the minimum moisture content value, while the average moisture content of the wettest samples was still comparatively high. The swamp tupelo probably could have 'been dried by itself in 4 days, but segregation may not be practical for 4/4 stock. The final average moisture content in this run was high because of the slow drying of the wetter samples during equalization. In later runs equalization was not started until "wild" kiln samples that seemed to dry at an unusually fast rate had dried to 2 or 3 percent below the set minimum moisture content value, and in some runs the equalizing E. M. C.[5] was set 1 percent lower than the standard recommendations.

Heartwood, Water Tupelo: The first run on 4/4 heartwood included both the water and the swamp tupelo and followed schedule T12-E5. Both species end checked excessively and honeycombed under these severe conditions. As an expedient, both species were dried together again with a schedule derived from a sweetgum heartwood schedule, as far as temperature and humidity numbers were concerned.[5] The humidity letter was modified so as to allow for the extremely high moisture content of the tupelos in the green condition. The resultant schedule was T8-F4. The kiln schedule, actual kiln conditions, and the drying curve of the wettest half of the water tupelo specimens are shown in figure 3. The moisture content values of these water tupelo specimens at the time kiln changes were made were higher than the schedule called for because actual operation was based on specimens of both species.

Figure 3 also indicates the extremely fast drying rate of 'sapwood included in the run. It shows the disadvantage of including sapwood in a heartwood kiln charge because of the necessity

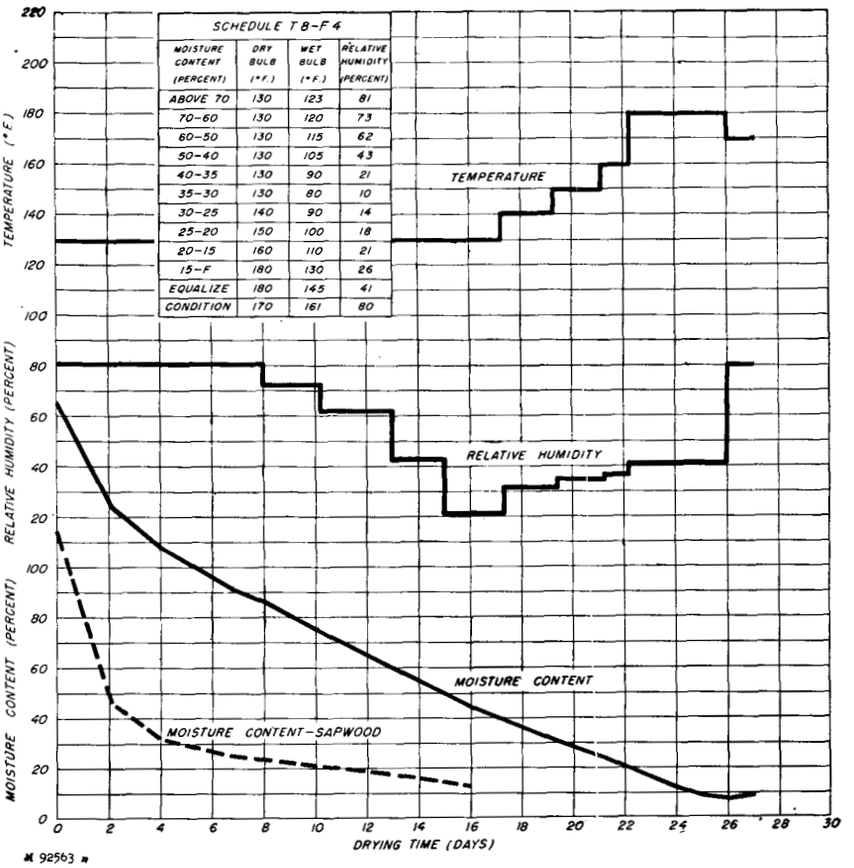


Figure 3. Kiln conditions and drying curve for 1-inch water tupelo heartwood using schedule T8-F4.

of starting the equalizing while the charge still is at the lower temperatures. This probably increased drying time 2 days or more.

The water tupelo heartwood showed a slight amount of surface checking and end checking with penetrations up to 6 inches. Also, the slowest-drying specimen showed very slight honeycombing. It is believed that drying defects would not have been excessive if temperature changes had not been made until the moisture content was down to 30 percent.

Heartwood, Swamp Tupelo: In the matter of seasoning defects, the schedule shown in figure 3 was entirely satisfactory for swamp tupelo. It showed only minor end checks, surface checks in defective areas, and maximum penetration of end checks of 1 1/2 inches. Subsequent research, however, showed that the 6/4 could be dried by a more severe kiln schedule, so the more severe schedule is also recommended for the 4/4.

Results With 6/4 Lumber

Because of the results obtained with the 4/4 stock, all experimental runs on the 6/4 stock were separate as to sapwood and heartwood, also species.

Sapwood, Swamp Tupelo: The most satisfactory kiln schedule for 6/4 swamp tupelo sapwood is shown in figure 4, along with the actual kiln conditions and the drying curve of the wettest samples. The schedule, T12-E5, is the same as the schedule for 4/4 sapwood. Drying time was 5 1/4 days. This is slightly less than the drying time for the 4/4 stock, but, in the run illustrated in figure 2, the drying of swamp tupelo was delayed because of the water tupelo in the run. In the 6/4 run shown in figure 4, the swamp tupelo was down to about 12 percent moisture content and able to stand a temperature of 180° F. when equalization was started at the end of 3 days. One day of equalization followed by 1 1/4 days of conditioning resulted in a fina1 moisture content of approximately 10 percent.

When another run was made at a slightly less severe schedule, T11-E5, equally satisfactory results were obtained except that drying time was longer, 6 3/4 days.

Sapwood, Water Tupelo: The most satisfactory kiln schedule for 6/4 water tupelo sapwood was T10-F4. This schedule, along with the actual kiln conditions and drying curve, are shown in figure 5. Drying time was 10 1/4 days, approximately twice as long as the drying time, with the slightly more severe schedule for the swamp tupelo sapwood in this size. The run

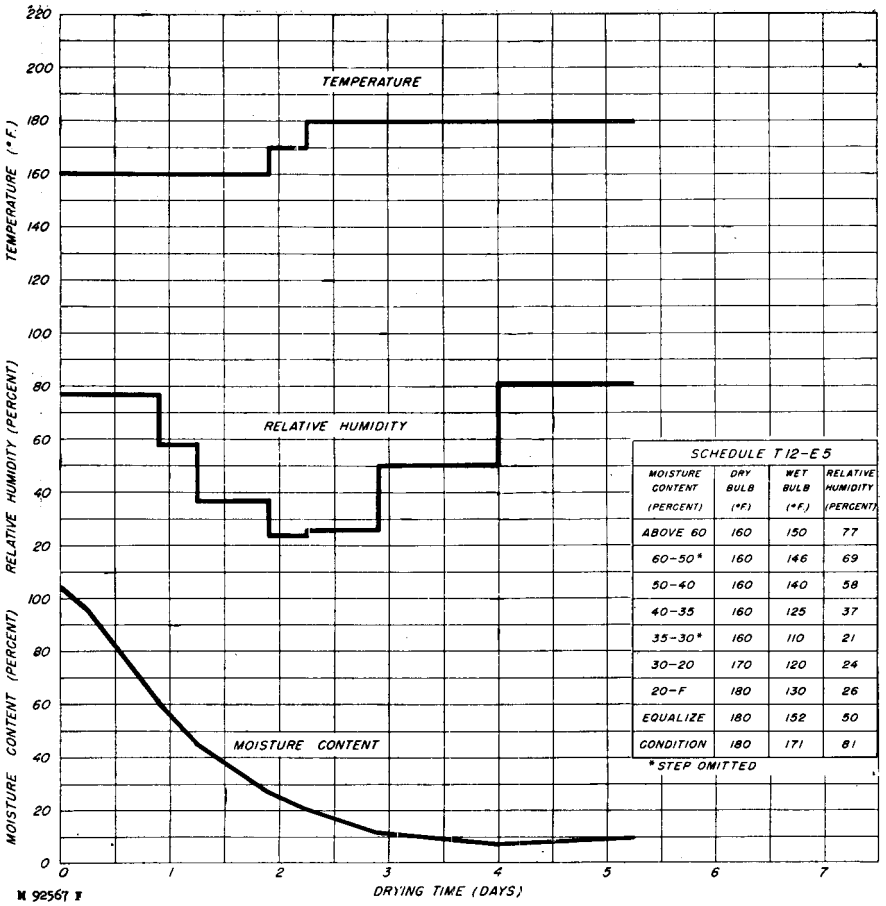


Figure 4. Kiln conditions and dying curve for 1½-inch swamp tupelo sapwood using schedule T12-E5.

was entirely satisfactory for the material that was really sapwood. Maximum end-check penetration was about 2½ inches. When the green specimens had been prepared, however, some of the outer heartwood, which had the same general appearance as the sapwood on the end of the log, was included as sapwood. The drying curve of this type of material is shown by the dotted line in figure 5. In view of the fact that changes in kiln conditions were made when these specimens were still at a high moisture content, considerable damage was done to the wood. It end checked and honeycombed severely.

In another kiln run, use of the somewhat more severe T11-F5 schedule on water tupelo sapwood gave unsatisfactory results. There was extensive honeycombing in two of the five pieces.

Heartwood, Swamp Tupelo: The most satisfactory kiln schedule for swamp tupelo heartwood in 6/4 thickness was the T10-E3 schedule. The schedule, the actual kiln conditions, and the drying curve for this stock are shown in figure 6. Drying time, 40 days, was considerably longer than the 5¼ days for the sapwood of the same species and thickness. This is partly due to schedule difference and partly due to difference in innate drying rate. Drying results were generally satisfactory, end-check penetration going to 2¼ inches on most of the specimens as a maximum. An intermediate moisture content test was made on one of the wet samples at 45 percent moisture content. At this time the temperature was changed to 150° F., and the sample was put back in the kiln without being end coated. Internal tension stresses were at a maximum at this point, and the wood was wet in the core. It was thus especially subject to end checking, and an end check later opened up into a bad honeycomb check. Such end checking and honeycombing should not be expected if changes in temperature were not made until the very wettest sample was not more than 5 percent above the average moisture content of the wettest half of the stock, which average is usually used as a basis for changing kiln conditions.

Another run was made with this item, using the T8-F4 schedule found satisfactory for 4/4 water tupelo heartwood. The run was generally satisfactory as to seasoning defects, but the drying time was considerably longer, 47 days in comparison with 41 days. This is a strong indication that the T10-E3 schedule should be used for 4/4 swamp tupelo to save drying time.

Previous research[5] with sweetgum heartwood showed that a very rapid lowering of relative humidity could be made after the stage of maximum tension stresses in the exterior zones of the wood had been passed. One experimental run was made with 6/4 swamp tupelo heartwood to try out this type of schedule, using 130° F. and a 7° wet-bulb depression as the initial conditions. The first relative humidity drop was made when the moisture content had been reduced to about 0.6 of the original. The pattern of the No. 4 humidity schedules[5] was used to increase the wet-bulb depression, but one change in humidity was made each day regardless of moisture content. Surface checking was entirely absent, and end checking only slight to moderate under initial conditions. No surface checking occurred as a result of the rapid relative humidity drop, but it did cause end checks to lengthen and to develop into honeycombing. In one of the wettest specimens the honeycombing penetrated 14 inches from the end. It thus appears that, for the time being at least, it will not be practical to use a schedule with an extremely rapid relative humidity drop for the heartwood of even this more easily dried swamp tupelo species.

Heartwood, Water Tupelo:—No kiln schedule tried was found entirely satisfactory for 6/4 water tupelo heartwood. The first experiment was the same as the method described above for swamp tupelo, in which initial conditions of 130° F. and 7° F. wet-bulb depression were followed by a rapid humidity drop after approximately one-third of the original moisture content had been removed. This caused bad end checking and honeycombing and was considered entirely unsatisfactory.

The next schedule used was the T8 temperature schedule in combination with one of a newly-designated series of humidity schedules which are called the *H* schedules. These schedules have the same pattern of wet-bulb depressions as the standard Forest Products Laboratory schedules described by Torgeson,[5] but the first drop in relative humidity is made when one-third of the total green moisture content of the wood has been evaporated and subsequent drops are made at 10 percent moisture content intervals until the minimum practical wet-bulb temperature is reached. This principle is not new, in fact it was used by many of the investigators

[6] Accelerating the Kiln Drying of Hardwoods. R. C. Rietz. South. Lbrmn. 181(2262):43-44, 54. July 1, 1950.

whose research was used as the basis of the standard Forest Products Laboratory schedules. The standard schedules themselves follow this principle generally, but for the purpose of standardization, the humidity schedules have been grouped into six series, with the first change in relative humidity for the highest (F) series made at 70 percent moisture content.

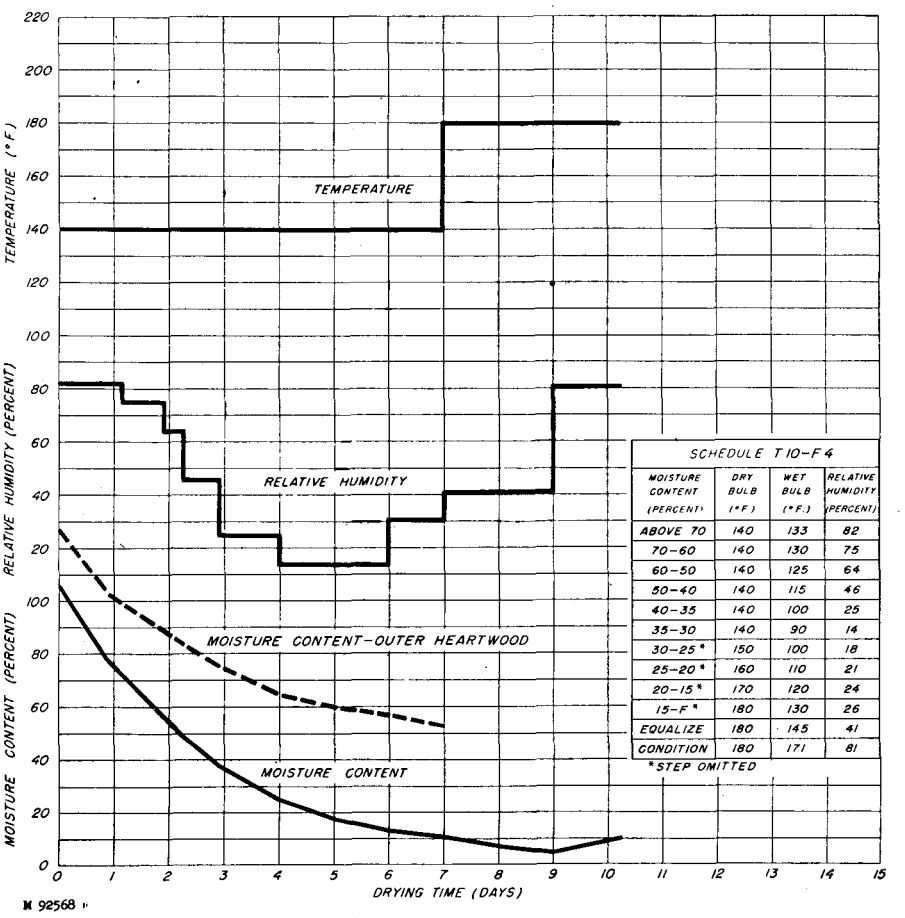
Since the earlier kiln runs had indicated that initial control of drying defects could be achieved by use of a 5° F. wet-bulb depression, the schedule tried was T8-H3. The original moisture content was 168 percent, and two-thirds of that is approximately 110 percent. Results with this schedule were slight to moderate surface checking, moderate end checking, and excessive honeycombing. Since control of honeycombing depends mainly on temperature, and since satisfactory results were obtained with 4/4 water tupelo heartwood at 130° F., it is believed that 120° F. with a proper humidity schedule would be safe for the 6/4 stock. Accordingly, a suggested kiln schedule for 6/4 water tupelo heartwood, T6-H2, is shown in figure 7. The author has no information that this schedule will be entirely satisfactory, but he believes that it would be the most practical if such stock must be kiln dried green from the saw. Drying time is estimated to be in the neighborhood of 60 days.

The drying time with the T8-H3 schedule was about 50 days. A slightly more severe schedule, T10-F3, was tried with this stock and found to be completely unsatisfactory.

General Discussion of Drying

The preceding results indicate quite clearly the desirability of segregating the two species, water tupelo and swamp tupelo, also the sapwood and heartwood within each species. The only sure way to segregate for species is in the tree, using flowers, fruits, or leaves. In some cases the bark may be helpful. Water tupelo bark is usually thinner. In other cases, especially where the two trees are growing in the same habitat, their bark is practically identical. Water tupelo more generally comes from flat flooded lands, and swamp tupelo from the edges of ponds and streams. Just knowing the appearance of the logs from different habitats may make it possible to separate the species at the landing.

If segregation is not made, a large number of kiln samples (10 or 12) should be prepared for each kiln charge, and a water tupelo schedule should be used. As drying progresses, changes in kiln conditions should be based on the average moisture content of the wettest one-fourth of the samples rather than the wettest one-half as ordinarily recommended in Report No. D1791. All the samples would not have to be weighed each time the drying is checked, but the driest sample should be observed regularly to know when to start equalization.



SCHEDULE T10-F4

MOISTURE CONTENT (PERCENT)	DRY BULB (°F.)	WET BULB (°F.)	RELATIVE HUMIDITY (PERCENT)
ABOVE 70	140	133	82
70-60	140	130	75
60-50	140	125	64
50-40	140	115	46
40-35	140	100	25
35-30	140	90	14
30-25*	150	100	18
25-20*	160	110	21
20-15*	170	120	24
15-F*	180	130	26
EQUALIZE	180	145	41
CONDITION	180	171	81

*STEP OMITTED

Figure 5.—Kiln conditions and drying curve for 1½-inch water tupelo sapwood using schedule T10-F4. (Drying curve of outer heartwood shown by dotted line.)

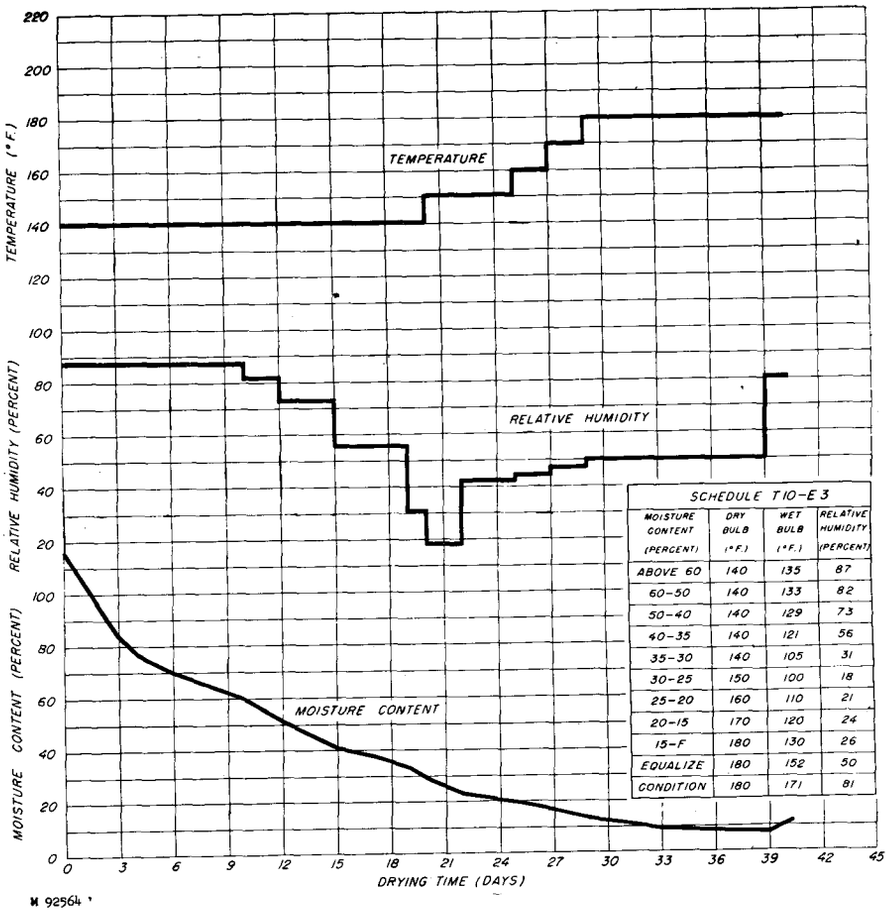
The problem of segregating the sapwood of water tupelo from its heartwood is complicated by the outer heartwood not showing the color of heartwood. It has all the low moisture permeability characteristics of true heartwood. Figure 8 illustrates the condition observed in three specimens of 6/4 water tupelo when cut for intermediate moisture content determinations. Average moisture-content values varied from 26 to 64 percent. When these specimens were in the green condition, they appeared to be 100 percent sapwood. On the intermediate moisture sections, however, there appeared to be a very definite demarcation line between outer, uncolored heartwood and true sapwood. Also, the distance of the inner wet zone from the sapwood-heartwood line in the interior of the piece was approximately the same as the distance between the wet zone and the outer surface in the heartwood portion.

If outer heartwood is included in a charge of sapwood, the use of low humidities and high temperatures must be held up until the heartwood material is down to proper moisture-content values. Otherwise, it would end check and honeycomb badly. The only practical way to avoid getting it

Table 1—KILN SCHEDULES AND DRYING TIMES FOR 1- AND 1½-INCH WATER AND SWAMP TUPELO SAPWOOD AND HEARTWOOD

Class of wood	Species of tupelo	Schedule	Drying time Days
1-Inch			
Sapwood	Both	T12-E5	5¾
Heartwood	Water	T8-F4	27
1½-Inch			
Sapwood	Swamp	T12-E5	5¼
	Water	T10-F4	10¼
Heartwood	Swamp	T10-E3	40½
	Water[1]	T6-H2	60

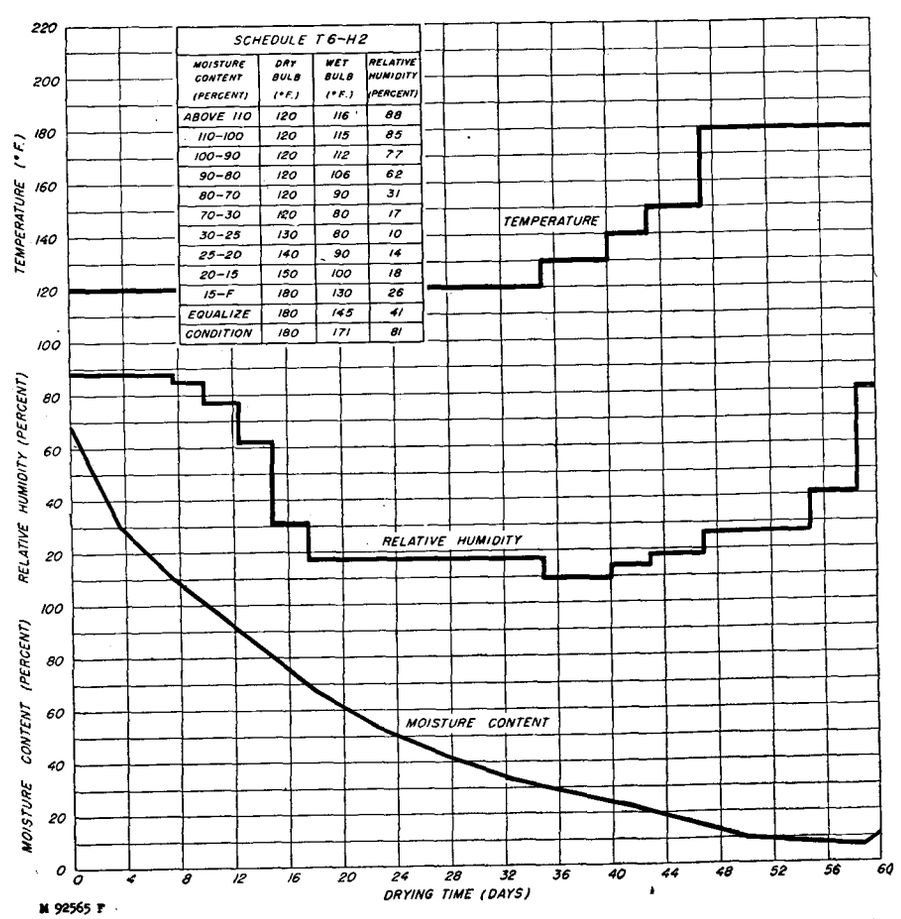
[1]Suggested kiln schedule and estimated drying time based on nearly satisfactory results with schedule T8-H3.



SCHEDULE T10-E3

MOISTURE CONTENT (PERCENT)	DRY BULB (°F.)	WET BULB (°F.)	RELATIVE HUMIDITY (PERCENT)
ABOVE 60	140	135	87
60-50	140	133	82
50-40	140	129	73
40-35	140	121	56
35-30	140	105	31
30-25	150	100	18
25-20	160	110	21
20-15	170	120	24
15-F	180	130	26
EQUALIZE	180	152	50
CONDITION	180	171	81

Figure 6.—Kiln conditions and drying curve for 1½-inch swamp tupelo heartwood using schedule T10-E3.



SCHEDULE T6-H2

MOISTURE CONTENT (PERCENT)	DRY BULB (°F.)	WET BULB (°F.)	RELATIVE HUMIDITY (PERCENT)
ABOVE 110	120	116	88
110-100	120	115	85
100-90	120	112	77
90-80	120	106	62
80-70	120	90	31
70-30	120	80	17
30-25	130	80	10
25-20	140	90	14
20-15	150	100	18
15-F	180	130	26
EQUALIZE	180	145	41
CONDITION	180	171	81

Figure 7.—Kiln conditions and estimated drying curve for 1½-inch water tupelo heartwood for suggested kiln schedule T6-H2.

mixed in with the sapwood would be for the sawyer to take off only a small amount around the log as sapwood. The rest, as it comes off the saw onto the green chain, should be marked as heartwood, and it should be dried as such.

The uncolored heartwood problem did not exhibit itself in the case of the swamp tupelo.

Control of Warping

Because of the presence of interlocked grain in the tupelos, warping is a considerable factor in their drying. All forms of warp occur: cup, bow, crook, and twist. A minor study of the effect of various kiln schedules on warping was carried out in the drying of the 4/4 material. The object of this study was to find out if there were any differences inherent to the schedules themselves that would result in less warping. General research on the stresses in wood as it dries and on shrinkage of wood indicates that more "set" occurs when lower temperatures and low humidities are used in comparison with higher temperatures and higher humidities. If "set" can be established during the period when the lumber is comparatively green and straight, it should be a deterring factor to warping. The kiln conditions used in this experiment were the initial run of high temperature and high humidity T12-E5, the satisfactory run T8-F4, and a moderately low-temperature, low-humidity schedule T4-E6. In order to eliminate the factor of weighting, a uniform weight of approximately 15 pounds per square foot was used on all piles. The piles themselves were five layers high, so the warping expected would be about average for the upper third of a kiln truckload of lumber. That is where the major difficulty from warping occurs.

In general, there were no differences in the amount of warping as a result of the differences in kiln schedule. This is in accord with previous general findings on the effect of kiln schedules on warping. There is no practical advantage in using a low temperature if warp control is the object. Drying time with the low-temperature, low-humidity run was slightly longer, 29 days in place of 27. Drying defects were generally not serious under this schedule, however. As indicated by Torgeson,[9] weighting of the kiln load to 90 pounds per square foot or more could be expected to give considerably greater control of warp. It may be necessary or desir-

[9] Does Weighting of Kiln Loads Reduce Warping in Kiln Drying of Hardwoods? O. W. Torgeson. U. S. Forest Products Laboratory Report No. D1769-14. Wood and Wood Products. Apr. 1952.

able to use a means of clamping down the load with irons fastened either by strong springs or by take-up devices instead of weights. Whether the use of a low-temperature, low-humidity schedule in combination with weighting or clamping would be helpful has not been determined.

Case-hardening Relief and Final Moisture Content

In all cases the general procedure for equalization and conditioning as given in Report No. D1791 was followed. Good relief of case-hardening was generally attained. Some modification of the procedure was necessary because of the extremely variable drying rate of the different items of tupelo with the consequent result in different final moisture content values and the need for long equalization treatments. The E. M. C. conditions used during the conditioning were generally such as to give a final desired average moisture content of 8 percent, that is, about 11½ percent E. M. C. Because one end of each specimen was not end coated, the average moisture content went down below the moisture content that a fully end-coated kiln sample would go to under the same conditions. As a general procedure, a 6 percent E. M. C. condition was used when the driest specimens got down to 5 percent or less. Even under these conditions, many of the specimens continued to dry until their indicated moisture content, based on the calculated oven-dry weight, was in the neighborhood of 2 percent. Average moisture content values of the wetter specimens were in most cases brought to 7½ to 8 percent or lower. Because of the slow drying rate of many of the higher moisture content specimens under the 6 percent E. M. C. condition of equalizing, in some of the runs a 5 percent E. M. C. condition was used. The 5 percent E. M. C. condition resulted in a little faster drying of the wettest specimens and did not dry the driest specimens so low as to give reverse case-hardening. Generally good relief of case-hardening was attained, except that the exceptionally high moisture content specimens still came out with case-hardening.

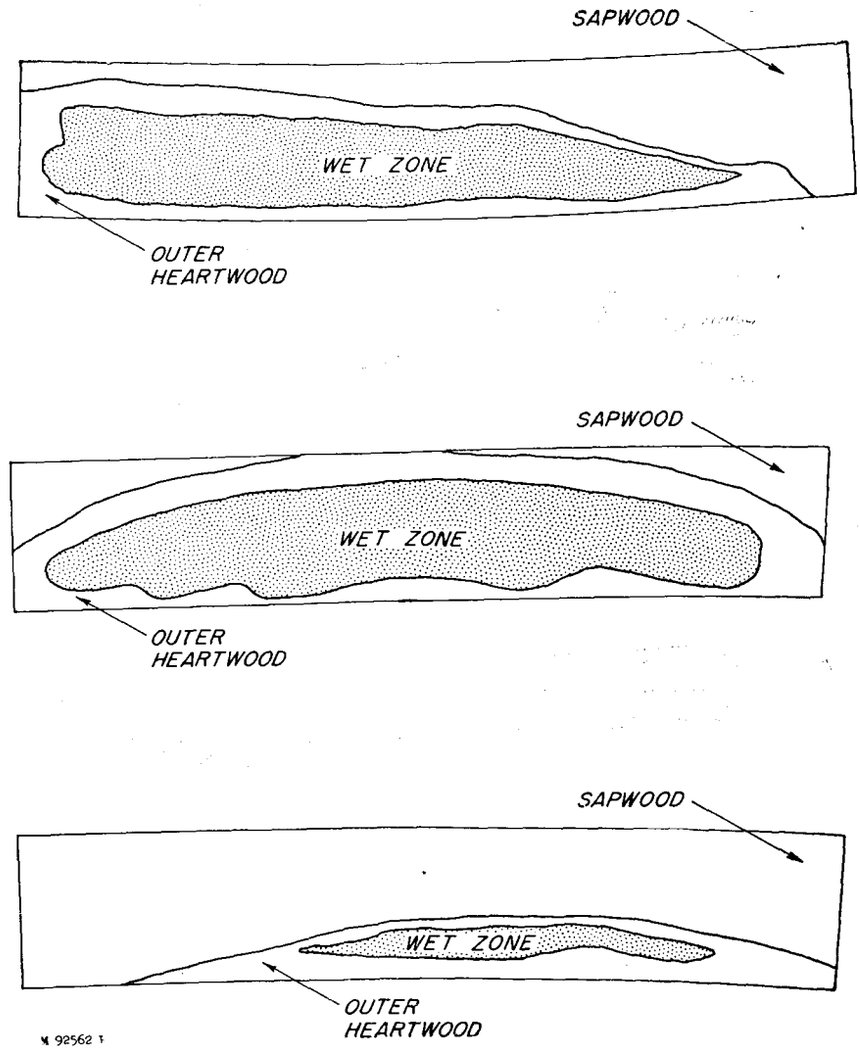


Figure 8.—Gross sections of water tupelo in which all the wood had the appearance of sapwood when green but a definite zone, called outer heartwood, had the drying characteristics of heartwood.

Moisture pick-up was rather high, 3 to 4 percent. As a result of this, the final moisture content of sections cut from the middle of the specimens ranged from about 9 percent to 10.4 percent in the 6/4, although they came out closer to 8 percent in the 4/4. For wood like tupelo, control of moisture regain perhaps could be obtained by using a shorter conditioning time with the same E. M. C. conditions. It would also seem desirable to dry the wettest samples down to 7 percent instead of 8 percent, as called for by the standard procedure. While 9 percent might be a satisfactory final moisture content for stock to be made into furniture for use in the South, if such stock is to be used in the North, a lower final moisture content is desirable. For the time being, it is suggested that the moisture content of the driest sample before equalization and the E. M. C. of equalization be 1 percent lower than the values called for in table 2 of Report No. D1791 for any final desired average moisture content. The E. M. C. for conditioning should be the same as the table calls for.