

What are Hardwoods? Why do we care?

Eastern Hardwoods:

- red oak
- hard maple
- black cherry
- white ash
- soft maple
- yellow birch
- black walnut
- poplar
- hickory
- white oak

These hardwoods tend to be used for high value-added interior-use applications:

- Furniture
- Millwork
- Cabinets
- Flooring

These hardwoods are also used for such industrial and commercial applications as:

- Railroad Crossties
- Pallets
- But these products are typically not kiln dried....

Hardwood Drying, Specifications:

- Kiln dried to 6-7% MC
 - (North American market; European perhaps somewhat higher)
- Without surface, end or interior checking
- Flat
- Without residual drying stress
- Appropriate color

How are these specifications achieved?

- Control the drying process.
- Know the wood.
- Know the customer.
- Always understand and consider the "big picture".
- Always understand and consider the "little details".
- It is not easy!!!

The hardwood drying process: • Drying begins as soon as the tree is cut.

- Manage logs.
- Manage freshly cut lumber.
- Stack and sticker promptly.
- Dry promptly.
 - Air drying yard.
 - Predryer.
 - Kiln.
- Maintain control!!





























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So, how do we dry?

- Kiln Dry.
 - Good quality, productive
- Air Dry, then Kiln Dry – Energy savings, kiln utilization efficiency
- Predry, then Kiln Dry - Good quality, productive (oak)
- Vacuum Kiln Dry

 Fast, specialty items,

Kiln Drying Schedules -

- The purpose is to dry as rapidly as possible, to be economical.
- However, drying must be controlled to avoid value reducing defects.
- Typically, the temperature and the relative humidity (wood EMC) are controlled.
- Relative humidity lowered as wood dries.
- When below FSP temperature is raised and relative humidity lowered as wood dries.

Some typical schedules -

Stage	Wood moisture content ^a	Major defect risk
I	Green to 2/3 green	Formation of surface and end checks, stain, warp
П	2/3 green to 30% MC	Aggravation of surface and end checks
ш	30% MC to final	Conversion of checks to honeycomb, cupping, overdrying
IV	Final	Unequal final MC, casehardening

What else do we need to know?

- What is the application?
- What final MC is desired?
 - Interior use? 6-7% MC
 - Exterior use? 12-15% MC
- What is the history green, air dried, PAD, kiln dried?
- · Bacterially infected?
- Pre-existing damage surface and end checks?

Some typical schedules -

	4	4/4 and 5/4 (T3-D2)			6/4 and 8/4 (T3-D1)		
Initial MC (%)	Dry-bulb temperature (°F)	Wet-bulb depression (°F)	Wet-bulb temperature (°F)	Dry-bulb tem- perature (°F)	Wet-bulb depression (°F)	Wet-bulb temperature (°F)	
>50	110	4	106	110	3	107	
50	110	5	105	110	4	106	
40	110	8	102	110	6	104	
35	110	14	96	110	10	100	
30	120	30	90	120	25	95	
25	130	40	90	130	40	90	
20	140	45	95	140	45	95	
15	160	45	115	160	45	115	
Equalize	170	43	127	170	43	127	
ondition	180	10	170	180	10	170	
ndition I oak spec	180 cies, 6/4 stock is us	43 10 sually dried by the	127 170 e 8/4 schedule.	180	43 10	127	

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Some typical schedules -

	Dry Kiln Sche	dule T1-C5*(modifi	ied), 4/4-inch White (Color Hard Ma	ple
%MC range	Dry Bulb °F	Dry Bulb °C	W.B. Dep. ⁶ F	% RH	% EMC
above 40	100	37.8	10*(1,2,3)	68	11.8
40 - 35	100	37.8	14*(1,2,3)	56	9.6
35 - 30	100	37.8	20*(1,2,3)	41	7.4
30 - 25	105	40.6	35*(1,2,3)	16	3.5
25 - 20	105	40.6	40*(1,2,3,4)	8	1.8
20 - 15	115	46.1	45*(1,2,3,4,5)	8	1.7
15 - 7	120	48.9	45*(1.2,3,4,5,6)	10	2.3

Additional issues with oak -

- The ring-porous nature means that earlywood cells are low density while latewood cells are high density.
- White oak has tyloses in the large vessels which significantly reduces permeability.
- Red, and in particular white oak have large ray cells, which create zones of weakness which contribute to checking.
- Fast end and surface drying causes checks.

Even more additional issues with oak -

- Evaporated acids from drying are corrosive.
- Regional differences in drying characteristics and value.
- May have bacterial infection.
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Additional issues maples, and other "white woods" including ash and birch -

- Goal is to keep wood as white, and bright as possible.
- Dry as quickly as possible.
- Keep temperature low (under ~ 105 F, 40 C until MC in core is below 20%.

Hard M	Iaple		
Fresh log W	22,100	- 181	
H I 4 wk log	25.62		
E 8wk log			
	Winter	Spring	Summer
N Fresh log O	Winter	Spring	Summer
N Fresh log O R M 4 wk log	Winter	Spring	Summer

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Also,

as wood dries it shrinks, as wood shrinks,

stresses develop.





During "Stress Relief",

• Moisture is added to the "shell" to cause it to try to swell against the core, relieving the stresses.

Stress Relief Conditioning

• High EMC and Temperature

- Adds moisture
- High temperature moves moisture faster
- High temperature means wood is not as strong so stress relieve more readily.











Drying characteristics, schedules and other useful information can be found in several sources.

- USDA FPL schedule book.
- FPInnovations Drying Manuals
- Dry Kiln Operator's Manual
- Drying Hardwoods
- Dry Kiln Association meetings
- Local knowledge.
 - Look to your purchasing agent and contacts in the field.

Thank you!

- Questions?
- Comments?
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