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KILN DRYING GREEN OAK FOR BEER BARRELS

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With the right kind of equipment kiln drying green oak for beer barrel stock presents no real problem. The cooperage industry's prejudice against the use of kiln-dried staves, however, is not without warrant. In the past, experiments in the use of kiln-dried barrel stock have left the beer barrel manufacturers so skeptical concerning the practicability of kiln drying green staves and heading that, under normal conditions, probably nothing but staves that had been air dried from 6 to 9 months would have been used.

At present the available supply of air-dried stock is inadequate to permit the cooperage industry to meet the unprecedented demand for beer barrels. With fingers crossed, therefore, the coopers are letting contracts to have their staves and heading dried in convenient but not selected kilns. In all too many instances, however, the stock so dried has caused so much loss and the product made from it has been so generally unsatisfactory that, as a final resort, many barrels have been made from green material. With the demand for barrels as it is, with the costs made high by the necessity of using poorly kiln-dried staves on one hand and the obvious difficulties encountered in attempting to use green barrels on the other, it is no wonder that the substitute barrel manufacturers can operate their plants to capacity.

It is the purpose of this article to point out where some of the trouble lies and to suggest methods by which staves and heading may be kiln dried to a state of moisture equal in every respect to well air-dried stock. Unless equipment and processes are modified to meet the requirement imposed by the drying characteristics of the oak itself, kiln drying is doomed at the start.

The Kiln for the Job

To attempt the drying of green oak staves in a kiln which was designed to season oak flooring is analogous to using a trip hammer in repairing a watch. If successful one is in luck but the odds are all against him.

Green beer barrel staves and heading demand a low temperature-high relative humidity drying schedule. Moreover, the allowable deviation from the optimum schedule is very small. The successful seasoning of this

class of material, therefore, requires a kiln which is susceptible of accurate temperature and relative humidity.

As usually designed, the very nature of the natural draft compartment and progressive types of kilns make it difficult to reliably maintain low temperatures and high relative humidities and at the same time produce enough circulation within the kiln to insure uniform drying conditions in all parts of the load. For best results then the stave-kiln should be equipped with some mechanical means of producing a rapid and uniform rate of circulation in all parts of the load.

The low temperature-forced circulation kiln is not just a figment of the imagination. It is a real practical kiln which can be purchased from any one of several dry kiln companies. Such kilns are now drying staves successfully. The product is fully as good as the best air-dried stock. If kiln drying is to become standard practice with the cooperage industry, however, many more of these kilns will be needed. Experienced observation and acquaintance with kiln drying over a period of years indicate that the total capacity of all the suitable kilns which are conveniently located is not sufficient to meet the present demands for dry beer staves. The standard of drying now produced by the average run of unsuited kilns tends to discredit the use of oak for beer barrels. Without the right kind of kiln equipment, cooperage stock should be air dried, for in the long run, poorly dried staves and heading will work a hardship on the entire cooperage business.

Operation of the Kiln

The operator of a stave-kiln is as important to the success of the undertaking as the kiln itself. It is no fault of the average operator that he does not know how to kiln dry beer barrel staves and heading because it has only been common practice but a few weeks. Moreover, his experience in kiln drying hardwood and softwood lumber is of little value to him in his new problem of kiln drying green white oak barrel stock. He is accustomed to thinking in terms of high kiln turn over. Perhaps he has been able to dry a charge of lumber in a few hours or a few days at most. When he discovers that oak staves are not dry in two or three weeks, he may try to speed up the drying by raising the kiln temperatures. When he finds a large percentage of the staves honey-combed because he used high temperatures he, not knowing the cause, will think he had bad luck. Someone may have told him that it is a good plan to initially steam the kiln load of staves at high temperatures for hours, maybe days. How should he know that oak will develop honey-combing and become end checked in drying after having been subjected to temperature much above 120° F.?

If he makes use of the available information on the subject of the drying characteristics of green-white oak he will discover that he

may not allow the kiln schedule to deviate much from the following:

Stock moisture	Dry bulb temperature	Relative humidity
	°F.	Percent
Initial to 45	110	75
45 to 40	115	70
40 to 30	120	65
30 to 25	125	60
25 to 20	130	50
20 to 15	135	40

If the kiln operator is to turn out barrels at the proper moisture content he must frequently determine the moisture content of his load. Often it will take 30 or 35 days to dry a charge of green staves to a moisture content of 18 or 20 percent. Realizing that he is faced with a new problem an operator with initiative will know what his kiln charge is doing all the time. The Forest Products Laboratory has prepared a bulletin on the subject of kiln drying which contains many hints with which the operator should be familiar. They may, if properly made use of, correct a bad situation before it is too late.

Moisture Condition of Staves

There is much yet to be learned about the moisture content of beer barrels in use and about the moisture content of staves and headings as it affects the manufacturing process. If, however, it is assumed stock which has been air dried from 6 to 9 months is satisfactory then a kiln process can be arranged which will practically duplicate the results of air drying as far as moisture content is concerned.

Air-drying conditions vary in different localities. No two piles are erected exactly alike. The inherent drying characteristics of the oak may differ. Because of these factors, therefore, the moisture condition of all staves after a given period of seasoning will not be the same. Air seasoning studies conducted by the Forest Products Laboratory provide data from which some idea of the probable range in average moisture of various lots can be obtained.

After six months of air drying the average moisture content of a shipment of staves can be expected to range from 25 to 35 percent. After nine months of air drying the moisture content of a shipment of staves can be expected to range from 20 to 30 percent. The ends of a

stave will be drier than a section cut from the longitudinal center. Moreover, the outer shell of a stave will be drier than its core. When the average moisture content of a stave is 30 percent the extreme surface fibers may have a moisture content of 12 to 14 percent while the core in the wettest parts of the stave may contain as much as 40 percent moisture. When the average moisture of an air-dried stave is 20 percent the range in moisture content from surface to center may be from about 12 percent to 24 percent.

This is a rough picture of the probable moisture condition of staves found satisfactory from the standpoint of bending, shrinkage, and general use. Staves should therefore be kiln dried until the moisture content of their core reaches about 25 percent.

In the low relative humidities used in the ordinary dry kiln process, the surface fibers will become much drier than the surface of an air-dried stave when each have the same average moisture content. This fact is partly responsible for the bad reputation of kiln-dried staves. The higher moisture content of the core of a kiln-dried stave perhaps tends to shrink more than an air-dried stave having the same average moisture content. The difference in behavior of a kiln-dried and air-dried stave in this respect will not be noticed except at high average moisture content values and then only when the kiln-dried staves have been dried in excessively low relative humidities.

Probably, the lower moisture content of the surface fibers of kiln-dried stock, however, is most troublesome because such fibers do not bend well. A kiln-dried stave, particularly when its outside fibers are excessively dry, tends to break more than well air-dried staves do. The advantages air drying has over kiln drying in this respect, however, are not inherent in the two processes. By the use of a final conditioning treatment in a suitable kiln the surface of the staves can be brought to any desired moisture content. A relative humidity of 80 percent at a temperature of 140° F. will cause the surface fibers to reach an equilibrium moisture content of 14 percent. Six or 8 hours' exposure to these conditions will put the surface of a kiln-dried stave on the same moisture condition as the surface of an air-dried stave. Accordingly the bending qualities of the kiln-dried stave, everything else being the same, should be equal to the air-dried stave.

End Coating

Green oak is more apt to end check when kiln dried than most of our native species. While it is recognized that shallow end checks are not considered a serious defect in barrel staves, nevertheless, once a check starts it is likely to tear deeply into the wood. Careful examinations indicate that this condition is prevalent in the kiln-dried stock that is now being utilized. The checks tend to follow the plane of the

wood rays and when deep and numerous these checks produce a condition at the end of the stave analogous to a stack of veneer. When the bending pressure is applied to the ends of such staves they naturally buckle.

It is, therefore, desirous to prevent end checks as much as possible. This can be accomplished by the use of high relative humidities during the early stages of the drying, but high relative humidities tend to increase the drying period. Perhaps it is economical in the long run to end coat the staves and heading with a good water resistant coating such as filled hardened gloss oil. This procedure enables one to use lower relative humidities and the increased kiln turn over will go a long ways toward paying for the end coating. The Forest Products Laboratory will send upon request full instructions for preparing this end coating.

If it is not expedient to coat the ends of every piece in the kiln charge, the uncoated ends should be butted tightly so that it will only be necessary to coat the ends which can not be butted. For best results the coating should be applied before any checks have developed. If the stock is badly end checked the end coating will have little value.

Summary

Oak is the most difficult of our native species to kiln dry because the moisture moves through it very slowly, it tends to check and ultimately honey-comb unless high relative humidities are used in the early part of the drying process, and if green and exposed to temperatures in excess of 120° F. it tends to honey-comb when subsequently dried even in high relative humidities.

Nevertheless it is technically feasible to kiln dry white oak staves and heading green from the saw provided a kiln is available in which low temperatures and high relative humidities can be simultaneously and accurately maintained through the kiln and load. For best results a forced circulation kiln is required. Suitable kilns are now on the market and are being used commercially. In such kilns green white oak staves are satisfactorily dried in from 3 to 6 weeks depending on the original moisture content and the final moisture content desired.