SEASONING WITH CHEMICALS

BY W. K. LOUGHBOROUGH

U. S. Department of Agriculture, maintained at Madison, Wisconsin, in co-operation with the University of Wisconsin
Hints concerning the possibility of seasoning lumber by chemical means have been seen in these columns on several occasions. The Forest Products Laboratory announces a new process that reverses normal drying action. This means that drying under the chemical process takes place from the inside out, thereby reducing checking to a minimum.

AFTER three years of intensive work to develop a satisfactory method of drying planks, ties, and other large items of species that defy the best known methods of air drying and kiln drying, the Forest Products Laboratory has worked out a new process that attains a freedom from seasoning defects heretofore thought impossible. The process is satisfactory for both softwoods and hardwoods. It is particularly applicable to the hardwood forests growing in the bottom lands of the lower Mississippi Valley, the profitable utilization of at least 25 per cent of which is now largely prevented for want of adequate seasoning methods.

Items, such as wide flat-sawed plank cut from refractory hardwoods and large boxed-heart timbers which heretofore checked under the most carefully controlled drying conditions, can be seasoned by this process with little or no degrade. The drying time can, in general, be reduced well below that normally required in kiln drying.

The process; like most other new developments, has certain peculiarities of its own, some of which are advantageous, whereas others are deleterious. They will be discussed later.

The process essentially consists of soaking green wood in an aqueous solution of some chemical, then removing it from the solution and subsequently air drying or kiln drying it. In the development of the process many items of lumber were soaked or steeped in various water solutions including sodium chloride (common house salt), mono-ammonium phosphate, zinc acetate, and several other chemical solutions. Several processes very satisfactory from the seasoning standpoint resulted from this work. These have been lumped together under the general head of "salt seasoning" or, more properly speaking, "chemical seasoning."

That common salt has the property of attracting moisture when stored in a damp place is common knowledge. Lumbermen taking advantage of this property have been known to sprinkle salt on checked lumber in order to attract moisture, dampen the surface of the lumber, and thus close the checks. Occasionally they have also sandwiched salt between layers of lumber in an air seasoning pile to reduce surface checking. Thus it will be seen that the use of salt in assisting in the drying of wood is not entirely new. The process is, rather, a more complete application of the knowledge of the properties of chemical solutions to the seasoning of wood.

In ordinary seasoning processes wood dries from the outside in, a fact which explains why wood so often checks in drying. When wood is properly chemically seasoned the wood dries from the inside first; that is, it dries from the inside out. If full advantage be taken of the chemical seasoning the surface fibers of wood are squeezed together throughout most of the drying period. Under these conditions it is impossible for wood to surface check in drying.

The fundamental principles underlying chemical seasoning are very simple. It is a well-known fact that when a chemi-
cal is dissolved in water the vapor pressure of the solution is lower than the normal vapor pressure of water. For example, the water-vapor pressure in an air-tight space over a saturated solution of common house salt is approximately 75 per cent of the normal vapor pressure of water. In other words, the vapor pressure of the brine is about three-fourths that of fresh water. In carrying out the process with a saturated solution of common house salt, the salt will diffuse from the brine into the water held by the green wood. Eventually the water in the wood will become saturated with salt and its vapor pressure will be in equilibrium with a 75 per cent relative humidity. Therefore, as long as the relative humidity of the air surrounding the wood during subsequent seasoning does not become lower than 75 per cent the water in the salt saturated layer of wood cannot evaporate. This layer of wood tends to retain its green dimension in spite of the fact that it is being subjected to a relative humidity as low as 75 per cent, which, with untreated wood, would cause active drying and shrinkage.

In chemical seasoning, the green wood is soaked in the chemical solution just long enough for the salt to penetrate the outer surface of the wood. Consequently the water in the center of the board or plank, being fresh, has a normal vapor pressure; that is, the water in the center of a salt-treated green board or plank is 33 per cent higher in vapor pressure than the salt-saturated moisture contained by the outer fibers. Moisture moves from the interior to the surface in response to this vapor pressure gradient and is evaporated. Thus, salt-treated green swamp oak plank, for example, can be safely dried in air having a relative humidity as low as 75 per cent without surface checking, whereas when untreated it will commonly surface check in air having a relative humidity as high as 92 per cent. The ability to use a drying atmosphere of lower relative humidity is reflected in increased drying rate and minimized seasoning degrade.

The process entails no actual chemical reaction between the wood and the chemical used but depends entirely upon the distribution within the moist wood of the original chemical with an accompanying gradual change in vapor pressure. The extent of penetration of the chemical, as influenced by the original moisture content and time, and the resulting vapor-pressure gradient within the area penetrated will be dealt with in subsequent reports.

At first it might be thought that the increased drying rate mentioned would be offset by the time lost while the planks are soaking in the salt solution. Experiments show, however, that the green lumber dries at the same rate while submerged in the salt and water it would in air maintained at bath tem-

Figure 2 — Two pieces of overcup oak from the same plank: (Up per) Salt seasoned and kiln dried. (Lower) Kiln dried under a conservative schedule.
perature and a relative humidity in equilibrium with the vapor pressure of the solution. The rate of drying in the bath naturally depends on the chemical, on its degree of saturation, and on the bath temperature.

Salt seasoning methods thus far have been applied to ash bolts, small aspen half logs, beech squares, sections cut from large yellow birch logs, western red cedar poles and shingles, Douglas fir boards, planks and timbers, hickory handles, southern swamp oak plans, dimension and ties, persimmon golf head blanks, shortleaf and loblolly timbers, and redwood boards of sinker stock.

In most of the experiments either common house salt or mono-ammonium phosphate has been used, although a number of other chemicals, such as zinc acetate, invert sugar, borax, baking soda, and a combination of common house salt and sodium sulphate, have also been used.

Some of the experiments have been merely exploratory. The major chemical seasoning experiments demonstrated that all items tried could be dried more satisfactorily than they could be when dried by orthodox air seasoning and kiln drying methods.

One or two examples will serve to illustrate the difference between the results obtained in commercial practice and those obtained by chemical seasoning methods.

While the lumber industry has kiln dried Douglas fir in structural sizes on an experimental basis the practice is considered impractical because of the long drying period. For example, to kiln dry 6x12-inch Douglas fir from a green condition to an average moisture content of 16 per cent requires two months or more. For economic reasons timbers as large as these are normally air dried. This method of seasoning is, of course, very slow, and large timbers tend to check badly. To be specific, it takes a year or more to air dry 6x12-inch Douglas fir to a moisture content of 15 per cent at Madison, Wisconsin. During the drying surface checks penetrate to an average depth of 1 3/4 inches.

By way of comparison with present commercial practice matched salt-treated timbers were dried to 15 per cent moisture content in 34 days. This time included eight days in the salt-treating tank and 26 days in a dry kiln maintained at a temperature of 160 degrees Fahr. The checking was confined to intergrown knots; otherwise the timbers were perfect.

After soaking 8/4 wide flat-sawed southern swamp red oak planks in a saturated solution of salt and water for eight days it was possible to kiln dry them without degrade in 28 days, or a total drying time of 36 days. It required 225 days to kiln dry matched untreated material. Moreover, the amount of degrade in the untreated kiln dried planks was prohibitive despite the fact that very mild conditions of temperature and relative humidity were maintained during the long drying period. By the salt seasoning method 4/4 green overcup timber was dried in 16 days, including the four days the lumber was soaked in the brine. By the best kiln drying practice untreated lumber of this species and thickness could not be satisfactorily dried green from the saw in less than 40 days.

Significance of Chemical Seasoning

The specific processes involving the use of different chemicals that have been developed for the seasoning of various items of wood have been thoroughly proven on a laboratory scale. If the methods used can be shown to have successful commercial application the nation's forest capital will be increased by changing the status of some species from weed trees to valued stands of potential building and cabinet lumber.

Where checking in poles and timbers creates sales resistance, chemical seasoning methods may increase the demand for such products by removing the cause of unpopularity. While, in the general scheme of seasoning, chemical seasoning promises to take its place with time-honored air drying and the more recent method of drying in a kiln, much more work will be required before its usefulness can be commercially demonstrated. The next logical step to take would be putting the knowledge acquired at the laboratory to a commercial test.

In the meantime work at the Forest Products Laboratory is being continued in developing special procedures for the many different species and items of American woods. Detailed studies of the effects of the chemicals remaining in the wood are also to be undertaken, since some of the modifications of properties as the result of introducing various chemicals into wood are beneficial and some are detrimental. For instance, in addition to permitting more rapid seasoning than heretofore possible and at the same time reducing seasoning degrade certain chemicals offer fire and decay protection whereas others increase the hazards from these sources. Some chemicals are corrosive to metal fastenings, some lower the electrical resistance of wood, some dull the knives of woodworking machines, and practically all of them cause unfinished wood to become moist at relative humidities below saturation, the precise behavior depending upon the chemical used. In short, the commercial application of chemical seasoning to specific seasoning problems remains to be made.