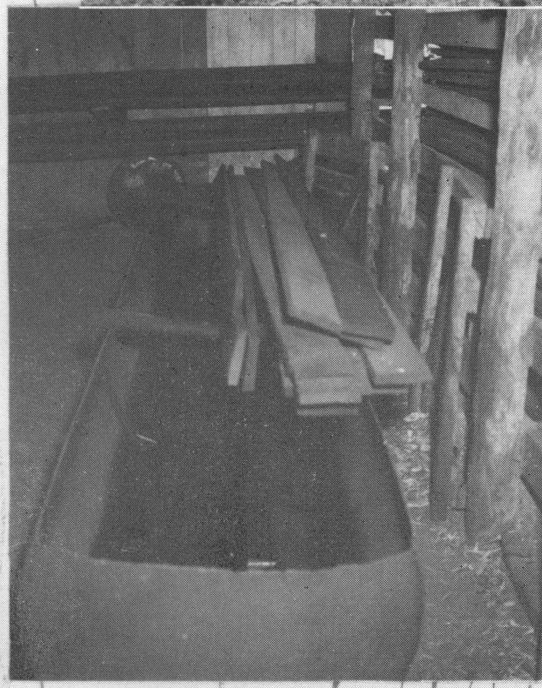


Miss Dot Halland

Low-cost

WOOD TREATMENTS



TEXAS AGRICULTURAL EXTENSION SERVICE
G. G. Gibson, Director, College Station, Texas

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COVER ILLUSTRATION:

The lumber and posts shown in these pictures were produced on the farm. In the background of the upper picture are sweetgum posts that were treated on the farm with chromated zinc chloride by the end-flow method. The pine posts in the corral were prepared and hauled to a local creosote plant. The oak lumber was treated on the farm by cold soaking in a 5 percent pentachlorophenol-diesel oil solution, as shown in the insert.

Low-cost Wood Treatments

C. W. SIMMONS, *Extension Farm Forester*
Texas A. & M. College System

LOW-GRADE HARDWOODS AND SMALL TREES OF all species can be utilized best by treating the lumber and round timbers with preservatives for many common uses. The principal need on farms and ranches for repairs and replacements and for many construction purposes is low-cost, round and rough-sawed wood materials that have been treated to resist decay, insects and fire. Uses and markets are expected to increase steadily for preservative-treated posts, poles and lumber materials which can be supplied at low cost from the abundant native and second-growth timber. Texas farmers and ranchers have about 33 million acres of woodland. One-third of this acreage produces trees of all sizes, including sawtimber. The remainder produces small poles and posts.

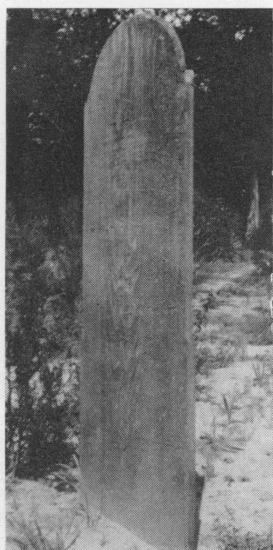


Figure 1. This untreated cypress marker near Sam Houston's grave is still sound after 71 years, but few naturally durable woods are available today.

profitably although they would be too expensive if produced by industry. For example, 4x4's can be sawed from sapwood poles as small as 5 or 6 inches in diameter and 6x6's from logs 7 or 8 inches in diameter since the bark left on the corners can be peeled easily by hand.

A variety of methods are used to treat wood. Brushing, spraying, dipping or soaking for a few minutes in the proper chemical gives

a shallow treatment. Soaking for longer periods or the end-flow method gives a more thorough treatment.

The choice of chemicals and treating methods depends chiefly on the timber species, on whether the wood is green or seasoned, and particularly on how it is to be used. Wood needs no treatment if it is kept dry, as inside a building and protected continuously by a good roof. Under conditions favoring decay or insects, as in contact with or near the soil or dampness, it should be treated thoroughly with preservative. Shallow treatments can prevent decay where wood is wet only intermittently and will dry quickly, as in porches, roofs, siding, steps, gates, board fences and wooden parts of tools and equipment. Shallow treatments are more effective against decay than paint, but porches and siding may require preservatives or solvents that can be painted over when dry. Treatments should be more thorough in the humid than in the drier regions of the State.

Oaks and pines, which are mostly second-growth sapwood, make up over half the timber available in Texas and should supply most of the treated wood products used in the State. Posts of these species will last 15 years or longer if they are green-peeled, then seasoned thoroughly and soaked in a strong preservative until penetrations are at least $\frac{1}{2}$ inch deep. Oak and pine posts also can be seasoned with bark on without decay until the bark loosens, then peeled easily and treated by soaking. Posts, poles and lumber from pines that have grown fairly rapidly can be prepared to treat satisfactorily by practically all methods.

All ring-porous or coarse-grain woods, such as oaks, hickories and pecan, should be seasoned properly and treated by soaking methods.

In the drier regions of the State many species, such as ash, elms, hackberry, hickories, pecan and wild China, can be seasoned in sound condition with bark on, then peeled and treated by soaking.

About one-third of the native trees in Texas are birch, bays, elms, magnolia, sweetgum, blackgum, tupelo, cedars, cottonwood, willow, maple and sycamore. These are diffuse-porous, fine-grain woods, which should be treated freshly cut, green and with bark by the end-flow method. Lumber and sawed tim-

bers of diffuse-porous species with high sap-water content can be treated green by soaking for 1 week or more in a water-type preservative.

Only a shallow treatment can be given to ash by any method.

The amount of preservative that wood will absorb during the treating process depends on the species of tree. Ring-porous hardwoods of slow growth rate absorb more preservative than those of fast growth rate; but diffuse-porous woods of fast growth rate, including cone-bearing trees, absorb more preservative than those of slow growth rate. Ring-porous woods, such as the white oak group, have pores nearly closed and retain preservative longer than open-porous woods, such as the red oak group.

All woods treat much deeper through the ends than through the side, but in sawed and split posts, the preservatives penetrate most easily through the bark side by soaking.

PRESERVATIVES USED IN TREATING WOOD

Preservatives require either oil or water to dissolve, dilute and carry the preservative (toxicant) into the wood, after which the solvent evaporates, leaving the preservative in the wood. The most common oil types used are pentachlorophenol (penta) and creosote. Two practical water types are zinc chlorides and borates.

Water-type Preservatives

Some waterborne preservatives are too poisonous or expensive, and some corrode metal. Borates, on the other hand, prevent rust of iron materials used in wood construction. Zinc chlorides will corrode metal only in concentrated solutions. Borate-treated wood dries rapidly after treating or after a rain.

Plain zinc chloride has been used for over 100 years to protect wood against decay and insects. With heavy absorptions it also will retard fire. Improved types used since 1938 are 1) chromated zinc chloride (CZC), which is 82 percent zinc chloride and 18 percent sodium dichromate; and 2) copperized CZC, which is 73 percent zinc chloride, 20 percent sodium dichromate and 7 percent cupric chloride. All zinc chlorides dissolve in cold water. They normally are used in 10 percent strengths (1 pound per gallon of water) for wood that will be in the ground, and in weaker strengths for wood exposed above ground. The chromated forms dissolve more completely and should stay in the wood longer than plain zinc chloride.

Borates cost much less than the other chemicals, and it takes only 1 to 1½ pounds

per gallon of water to treat effectively the most absorptive woods. Although the zinc chlorides stay in wood longer and resist termites better than the borates, the borates are over twice as toxic to wood-decaying fungi as plain zinc chlorides. Leaching of borates out of the wood when used in contact with the ground must be reduced by double-treating (soaking again) the borate-treated wood in sealers, such as CZC or limewater solutions, penta and oil, creosote and oil or old lube oil alone (See pages 6-7). Since borates are cheaper and easier to use and store than other preservatives, they are ideal to use as the principal preservative for simple home treatments of absorptive woods, with another chemical as a sealer for wood to be used in the ground. Borates, except the finely ground polybors, must be heated to dissolve in water.

The new, finely powdered polybors cost about twice as much as borax, but according to the manufacturer, they contain about twice as much of the preservative agent, boron trioxide (66 percent), as borax. Thus, the manufacturer reports that polybor is equivalent to almost twice as much borax, which has only 36 percent boron trioxide.

In addition to protecting wood against decay and insects, fire retarding is important in the dry climates. Burning in absorptive wood can be retarded effectively at the least cost when the wood is treated thoroughly with a borate solution, then dried and sealed in CZC solution to penetrate at least ¼ inch.

Expensive water-type preservatives, when used for the more absorptive woods, must be diluted to weaker strengths: zinc chloride and CZC to about 5 percent, and copperized CZC to 4 percent.

The only water-type preservatives that will show penetration by color changes are the CZC forms. A coloring agent would have to be added to the other water types if desired for them to show penetration.

Oil-type Preservatives

Toxic oil types commonly used are pentachlorophenol (penta) and creosote. In eastern states, some low-cost use also is made of copper naphthenate (Cu/N) in 1 to 3 percent strengths. Penta ordinarily is used in 5 percent strength, with fuel oil, diesel or kerosene as solvents. The oils of moderate to high viscosity, such as No. 2 fuel oil, are the best solvents to use in treating posts.

Creosote is used for over 90 percent of the wood products treated commercially by pressure methods. No. 1 grade (A.W.P.A.) coal-tar creosote can be diluted with petroleum oils, usually in a 50-50 mixture, which about equals 3 to 5 percent penta in cost and effec-

tiveness. Lower grade creosotes, purchased with an undetermined amount of nontoxic tar or petroleum in them, should not be diluted in this manner. Creosote is the best preservative for wood that will be in water continually.

Expensive oil-type preservatives, when used for the more absorptive woods, must be diluted to weaker strengths: penta to 3 percent, Cu/N to 1/2 to 1 percent, and creosote to about 35 percent.

The only oil-type preservatives that will show penetration by changes in color are Cu/N and creosote.

Average Cost of Preservatives

Prices vary widely according to chemicals, grade, concentration, amount purchased and distance from supply. Preservatives should be purchased in quantities sufficient to take advantage of wholesale prices since they are some 15 to 25 percent cheaper when bought by the ton.

Borax in the granular form is supplied by a number of wholesale chemical dealers and distributors in Houston and Dallas at a cost now of about 5 cents per pound, or less in ton quantities. Polybor and boric acid cost about 9 cents per pound wholesale in Houston. The borates normally are packed in 50 to 100-pound multi-walled paper sacks. They will keep in good condition indefinitely, and there is less risk of waste, deterioration and hazard in storing surpluses for future use than with other chemicals. About 20 percent can be saved if borates are bought by the ton.

Chromated zinc chloride costs about 14 to 16 cents per pound, and copperized CZC costs about 18 cents per pound in 600-pound drums, f.o.b. East Chicago. Plain zinc chloride costs about 12 to 14 cents per pound plus freight from some of the wholesale chemical dealers in Texas.

The per gallon cost of water solutions made at home depends only on the amount and cost of the preservative chemical used. Chemicals should be used which have been prepared to dissolve easily; those such as coarse borascu are unsuitable as wood preservatives.

Pentachlorophenol normally is sold in a concentrate to be mixed 1 part to 10 parts of oil for preparing a 5 percent strength. This concentrate ranges in price from about \$2.20 to \$3.50 per gallon in 50-gallon drums. A 5 percent strength made from the concentrate costs 35 to 50 cents per gallon when made with 10 parts of oil purchased locally. This strength should be used for treating the least absorptive woods. A 3 percent strength made with 1 part of the same penta concentrate to about 17 parts of oil costs about one-fourth less than

the 5 percent strength and should be used for treating bark-seasoned posts of oak or slow-growth pine. Some penta and creosote are sold in ready-to-use strengths, but then freight must be paid on the oil in the mixture, which would cost less locally. Creosote, which costs 50 to 60 cents per gallon in 50-gallon drums, should be diluted to one-third to one-half strength with local oils.

Dealers and representatives in Texas who sell these wood preservatives at wholesale or at prices practical for farm use are located mostly in Houston and Dallas. Their names and addresses can be obtained from telephone directories, from your county agricultural agent or by writing the extension forester, Agricultural Extension Service, College Station, Texas.

Ask the producers and representatives as well as the nearest dealers for the prices on different quantities of preservatives and for freight-cost estimates. Farmers should band together to buy in greater quantities so that they can take advantage of the lowest prices.

How To Prepare Preservatives for Strengths Desired

The preservatives that are sold ready-to-use are usually too expensive for most uses on the farm. An appreciable saving can be made in freight costs by buying concentrated liquid or solid chemical forms, and adding the proper solvent at the place of treatment. The solvent may be water or a petroleum oil. If a liquid concentrate such as pentachlorophenol is used, its percent strength must be learned from the dealer. In applying the formula below, ignore impurities in the concentrate where they make up less than 2 or 3 percent of the weight of the chemical.

$$\text{Formula: } P = \frac{a - b}{b}$$

In which:

P= number of pounds of solvent to be added to each pound of concentrate to give the required strength of the treating solution.
 a= percent strength of the concentrate.
 b= percent strength of the treating solution desired.

The following examples illustrate how to use this formula:

Example 1. For oil types such as pentachlorophenol concentrate, how many pounds of petroleum oil must be added to each pound of a 54 percent strength concentrate, to dilute the preservative to a solution of 3 percent strength?

$$P = \frac{a - b}{b} = \frac{54 - 3}{3} = \frac{51}{3} = 17 \text{ pounds.}$$

Thus, for each pound of this concentrate, add 17 pounds of kerosene, diesel or fuel oil to prepare a 3 percent solution. (Kerosene weighs about 6½ pounds per gallon; diesel oil of medium weight about 6.7 pounds per gallon; and No. 2 fuel oil about 7.3 pounds per gallon.)

Example 2. For water-dissolved, pure, solid chemicals, such as zinc chlorides or borates; how many pounds or pints of water must be added to each pound of dry chemical (considered as 100 percent pure) to obtain a solution of 10 percent strength?

$$P = \frac{a - b}{b} = \frac{100 - 10}{10} = 9 \text{ pounds. Thus,}$$

for each pound of chemical, add 9 pounds of water. (Water weighs 8½ pounds per gallon, or approximately 1 pound per pint.) For practical purposes, therefore, 1 pound of dry, salt-type chemical per gallon of water is considered a 10 percent strength in preparing these waterborne wood preservatives; ½ pound per gallon is a 5 percent strength and 1½ pounds per gallon makes a 15 percent strength.

Zinc chloride sometimes is sold in concentrated water solutions of 50 to 70 percent strengths to prevent sweating (absorbing water from air) and hardening. If a concentrated water solution is bought, substitute its strength in the formula to find the amount of water to add to make a treating solution of the proper strength.

Unless sealed in airtight drums, any dry form of zinc chloride or chromated zinc chloride that is left over should be mixed with some water to make a concentrated solution for better storage and easier use. Mix an equal amount, pound for pound, of chemical and water to make a 50 percent solution for storage. To prepare a 10 percent strength from this mixture, add 2 pounds of the 50 percent concentrate to 1 gallon of water. One pound of this concentrate to 1 gallon of water would make a 5 percent strength. Wooden barrels should be used for storing zinc chloride solutions since in concentrations they corrode metal.

Mixing Water-type Preservatives with Solvent

All borates except the polybors must be heated to dissolve in their water solvent. The water must be heated to about 130 degrees F., or barely too hot for the hand, in order to dissolve borax or a mixture of borax and boric acid in strengths high enough (10 to 15 percent) for effective preservative treating. At this temperature, stirring will dissolve these chemicals quickly. Borax when used without

boric acid should be kept warm to at least 100 degrees F. in order to keep the solution at a 10 percent strength during treatment. To treat the most absorptive woods with the 10 to 15 percent strength of borax, either heat the vat of treating solution and keep it at a temperature of 100 to 125 degrees F., or heat the vat and allow it to cool alternately a number of times.

Polybor will dissolve at as low as 68 degrees F. and stay in solution at 10 percent strength, but when used in 15 percent strength, polybor must be kept at a temperature of at least 85 degrees F. A 15 percent strength of borax water must be kept at a temperature of at least 120 to 125 degrees F. If used in 20 percent strengths for the most effective fire-retarding treatment of absorptive woods, borax must be kept heated at a temperature of 125 degrees F. and polybor at about 113 degrees F. An equal strength of borax-boric acid mixture requires slightly higher temperatures than polybor.

Treatments with a waterborne solution are over twice as fast and penetrate better when the solution is heated, but unless cheap fuel is used such as bark and waste wood, warm soaking usually is no cheaper than cold soaking for longer periods. A simple furnace, made with the vat over a trench, its sides sealed with dirt, and with chimney, heats faster, saves fuel during the warming period and reduces the fire hazard, Figure 2. Heating should be done on clean, open ground and at a safe distance from buildings.

Zinc chloride, the chromated zinc chlorides and polybors will dissolve in cold water, but they can be used warm in soak treating to increase penetration and absorption in green or dry wood. Chromated zinc chlorides should not be heated over 140 degrees F. since—above that temperature—some of the chromium compounds may precipitate out of the solution.

Zinc chlorides and borates or lime and borates cannot dissolve together in the same solution because they form compounds which are more or less insoluble. They are used separately for double treating the most absorptive woods since they form insoluble compounds in the outer wood that will protect longer against decay and insects and give good fire retardance at the lowest cost. CZC is better than lime to seal up the borates but is more expensive. Good service tests on the CZC sealer are available, page 11, but none on lime. Lime is only slightly soluble in water and should be used in cold solution since it is more soluble in cold than in warm water. Shell lime is probably a little more soluble than rock lime. Absorptive woods that have been treated to saturation with borax solution by soaking 1 or 2 days should be



Figure 2. This vat for warm soaking posts in borax-water is placed over a trench. The sides and one end of the trench are sealed with dirt; the chimney is built of old ice cans.

dried thoroughly, then soaked another 24 hours to saturation in lime water or in 5 to 10 percent CZC to a penetration of about $\frac{1}{4}$ inch.

Mixing Oil-type Preservatives with Solvent

Use oil-type preservatives in cold solution to prevent fire. It would be suicidal to heat preservatives used with light oil diluents, such as kerosene or diesel oil, which have a high flash point. Preservatives used with heavy oils can be heated fairly safely through steam or hot-water pipes run into the vat.

Diesel oil and kerosene are good, thin solvents for treating lumber with penta. These solvents evaporate rapidly out of the wood and leave the toxicants in it. A still faster drying diluent is mineral spirits, which penetrates more deeply as well. These thin oils should be used where wood is to be finished with a good coat of paint. Thin, fast-drying solvents should be used, for example, to treat porch floors by brush application so that the floor can be painted after drying a few hours. The lighter colored types of penta concentrate can be used with the thin solvents for treating wood that is to be painted.

Before placing oil-preservative treated posts in the ground, the posts should be dried in horizontal piles under shade to prevent bleeding and to reduce cracking. Checking or cracking may expose the untreated wood. Bleeding is often severe when posts, freshly treated with oil solubles, are installed during hot weather before they dry. Much of the preservative then runs out with the oil.

If borate-treated posts are to be placed in wet soils, they should be sealed with heavy oil, penta and oil or, still better, with creosote and oil.

Uses for Crankcase Oil

Crankcase oil (used lube oil) formerly was used as a pentachlorophenol or creosote diluent and sometimes was used alone as a preserva-

tive. However, crankcase oil is not recommended for the following reasons: (1) it is at times so sludgy as a solvent that it congeals some of the preservative out of solution; (2) it bleeds continually from the wood in hot weather and wastes preservative; (3) it reduces nail holding; (4) it increases the fire hazard; (5) used liberally, it is effective against termites but not decay and (6) there is still danger that some grease waste included in crankcase oil may contain chlorinated naphthalenes. This compound once was used to improve grease and in some instances killed cattle which licked or came in contact with it. Lubricant producers reportedly have not used this compound in recent years.

Otherwise, crankcase oil has proved to be a good, low-cost soil sterilant when mixed with borax (page 19), and also a sealer for the ground ends of borax-treated posts when double treated. In this combination, the advantages of borates (good decay and fire resistance) make up for the disadvantages of the oil, and the oil resists leaching and insects. If the oil is not too thick and is free of sludge, it can be strengthened for use as a borate sealer with 1 to 2 percent penta or 25 percent creosote.

Caution

1. Chemicals suitable for wood preservatives must be sufficiently toxic to protect the wood against decay organisms and insects. Preservatives as such are poisonous to humans and animals if taken internally and must be stored away from the house and out-of-reach of children and animals. The treating operations should be fenced or housed to keep animals and children away.

2. Use oil-type preservatives in cold solutions to prevent fire. See the mixing instructions on this page.

3. It is probably safer to treat feed troughs, hay mangers and silo lumber with the least poisonous and odorous preservatives by light and clean methods since more poisonous preservatives, such as penta, will leach out into the silage. The wood used to support and shelter such equipment can be treated by any of the preservatives.

4. Use gloves when working with penta preservative since it blisters the skin. Keep soap and clean water handy to wash penta preservative off hands and face immediately.

5. Glasses or goggles should be worn when oil-type preservatives are used.

6. Use water-type preservatives on wood that will support vines or be in contact with any plant growth.

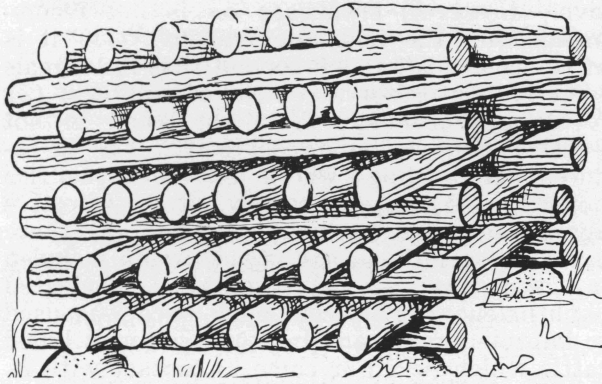


Figure 3. These posts are piled loosely for rapid drying. For slow drying, posts are piled with less air space between them.

BEST TIMES TO TREAT WOOD

Seasoned wood can be treated by soaking, brushing or spraying whenever the weather is not damp or too cold and the wood is properly prepared. The best treating season is late summer; therefore, September is usually the best month since it ordinarily offers the best drying weather. Wood seasons slower and with less checking and splitting if it is cut in winter and seasoned under a good roof with open sides. Frozen wood must be thawed out and treated in a warm room.

Seasoning can be hastened or retarded to some degree by the way the pieces of wood are spaced in the piles. Posts should be cross piled 1 foot above ground. If alternate layers have only two posts, Figure 3, drying is faster. Seasoned wood will absorb moisture in wet or damp weather but will dry in a few days with sunshine and good ventilation. When pine and oak posts are seasoned in the shade with bark on, the shade seems to stimulate insect activity needed to loosen the bark and increase the mold or sapstain.

About any kind of weather, if not freezing, is suitable for treating freshly cut, green posts and poles with waterborne preservatives by sharpened pipe or tire tube end-flow. Posts treat by end-flow slower in the summer, but less solution drips out.

SOAK TREATING POSTS SEASONED AFTER GREEN PEELING

Different species of posts are arranged in groups according to how easily they can be treated satisfactorily by cold soaking after all outer and inner bark is removed and the posts have been well seasoned for 3 to 6 months or longer. Good strong preservatives should be used. Penta in 5 percent strength is used most

commonly. Species from most states have been tested with penta by the U. S. Forest Products Laboratory and other agencies, but only those species occurring in Texas are listed in this publication.

Following are the groups of woods arranged according to how easily they can be treated by soaking after green-peeling and seasoning:

Group 1. *Absorptions and retentions fair to good, and penetrations into sapwood through the side reasonably good, after a soaking period of 48 hours or longer:* all species of pines and oaks except blackjack. Only posts of these species can be green peeled, seasoned and prepared properly to absorb uniformly at least 6 pounds per cubic foot of 5 percent penta in cold solution. Posts should have thick sapwood. Fast-growth pine saplings and slow-growth oaks treat best. Red oaks treat faster and absorb more preservative than white oaks (white oaks include post oak and live oak, which are most numerous), but white oaks bleed less at end, thus retain more preservative and last longer.

Group 2. *Absorptions, retentions and penetrations poor to fair after a soaking period of 48 hours or longer:* beech, black cherry, elms and hickories get fair to good penetration but not as consistently as pine and oak; green ash, catalpa and hackberry get poor to fair penetration.

Group 3. *Absorptions through ends good, but transverse penetrations (through the side) into sapwood generally poor after a soaking period of 48 hours or longer:* blackgum, boxelder, cottonwood, maple, sweetbay, sweetgum, tupelo, willow. Good end penetration usually is obtained for about 1 foot in these species; thus only material other than posts and not over 2 to 3 feet in length is apt to show satisfactory full-length treatment. A large number of posts of these species will use up considerable preservative and may decay rapidly at the middle. Sweetgum and some of the other species as well, according to some tests, can be treated more uniformly full length by cold soaking than these classifications indicate. It is advisable to use about 3 percent penta for the species in Group 3.

Some species are not included in these groups because of limited testing although they grow fairly abundantly in Texas, such as Chinese elm, cypress, locusts, mesquite, mulberry, pecan, sassafras and wild China. Many of these have durable heartwoods, but they should be treated if their sapwood is more than 1 inch thick in order to repel borers or termites. They may be treated by soaking although probably not as well as pines and oaks. Some of these species treat more satisfactorily

in the drier regions by modified methods discussed later.

These groupings indicate that only pine and oak with thick sapwood give good results by soaking treatments. Posts of these species must be seasoned properly and peeled cleanly full length, including scraping, incising or shaving off about $\frac{1}{8}$ inch of outer wood at the ground-line zone. Good to fair absorptions and retentions, as in the case of the third group, do not offset uneven distribution of the preservative. Only shallow penetrations, averaging $\frac{1}{4}$ to $\frac{1}{2}$ inch deep, can be expected for slow-growth pines or fast-growth oaks after soaking 3 days or longer.

The Texas Forest Products Laboratory has experimented with southern yellow-pine posts which were seasoned after green peeling then treated with 5 percent penta by the cold-soaking process. The Laboratory suggests the following steps to treat satisfactorily and to avoid excessive cost with this expensive solution: (1) peel the posts thoroughly so as to remove all inner bark, and scrape the surface around the ground line; (2) season the posts for 3 to 6 months in open piles under a good roof cover, after which the posts should be free of bright color, pitch glaze, checking, cracking and decay; and (3) cold soak all posts for 3 days or longer.

Peeling green posts with machine peelers is cheaper and removes more inner bark than

usually can be done by hand; and because of some beating on the surface, the posts season with less surface glaze and hardening. If several hundred posts are to be debarked, a machine should be made. Several publications in the reference list, page 25, give directions for constructing post peelers.

Posts should absorb uniformly at least 6 pounds (about 0.8 gallon, which is about 30 cents worth) of the 5 percent penta preservative per cubic foot. A round post about 5 inches in diameter at the middle and 6 feet long contains about 1 cubic foot. If treated uniformly, with penetration at least 1 inch deep in all sapwood, a post can be expected to last 20 years or longer. At this rate, an average post of 3 to 4 inches in diameter ($\frac{1}{2}$ cubic foot, more or less) should absorb at least 3 to 5 pounds (15 to 25 cents worth) of penta to last 15 to 20 years. A few posts should be weighed before and after treating to determine the amount being absorbed. The ground ends absorb more preservative if they are placed butts down in a deep verticle drum and submerged full length. Three oil drums can be welded end-to-end for this purpose, Figure 4, left. Another way is to treat the butts in 5 percent penta in drums 30 to 35 inches high, then place the tops down in taller drums, Figure 4, right, and treat them in 3 percent strength. The top few inches of the post need more preservative than the rest of the above-ground end. Large-diameter posts must soak longer than small posts; so they should be seasoned longer and treated separately.

Growth of the mold *Trichoderma* can be induced on the surface of freshly cut green-peeled posts and poles of pine and sweetgum by spraying them with sodium fluoride solution, which is tolerant to this mold but destroys other molds and fungi. After the mold-covered post is seasoned, more preservative can penetrate the side of the wood. It will soak up about five times more preservative than wood without mold growth. A cheaper or weaker preservative, such as 3 percent penta, 5 to 10 percent CZC or 10 to 15 percent borates should be used to treat mold-covered posts.

SOAK TREATING POSTS PEELED AFTER SEASONING

In East Texas, posts of pine and hardwood posts of oak, elms, hickories and hackberry, can be seasoned with bark on by weathering for 4 to 8 months; but species other than these usually decay before the bark loosens. In West Texas, these species and a few others can be seasoned with bark on even longer if necessary. Weathering and insects will loosen the bark

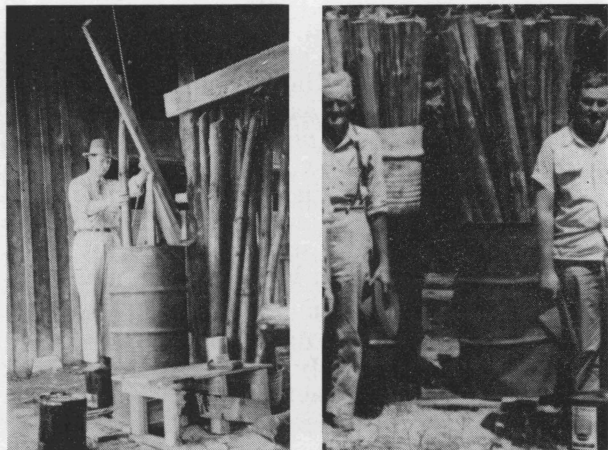


Figure 4. Seasoned posts of suitable species may be soak treated by either of these two methods.

LEFT: The tall drum contains 5 percent penta-diesel oil solution. It is made of three oil drums welded end-to-end and sunk half length in the ground; the posts are submerged full length and held down by a lever with a weight on the end. The treated posts at the right are draining in a tub before they are piled to dry.

RIGHT: The tall drum contains 3 percent penta for soaking the above-ground ends of posts. The ordinary oil drum at the right contains 5 percent penta for soaking the ground ends.

for easier peeling and induce a greater amount of sapstain, which makes the wood more treatable. It is then treated by soaking in a vat of strong, water-type preservative, such as the borates. Posts that are peeled after seasoning absorb and retain two to five times as much preservative as green-peeled posts seasoned as long; so the cost of the chemicals would be exorbitant if expensive preservatives were used.

There are many advantages to using sound, bark-seasoned posts: (1) when seasoned properly so that the bark falls off in clumps, the posts peel clean with little labor, which saves 10 to 15 cents per post; (2) the wood has less checking, and pines have practically no pitch glaze; (3) the time required to soak with good absorption normally is reduced 50 to 75 percent; (4) all the sapwood can be treated thoroughly and uniformly in all posts when they are saturated; and (5) by using a low-cost preservative in good strength, lower costs for good treatments are assured. Experience has shown that deep and uniform penetration of weak or inexpensive preservative assures long-

er service than a shallow penetration or low retention of strong or expensive preservative. After debarking, the posts can season still longer, if necessary, with less decay.

Of the species that are suitable for treatment after bark-seasoning, posts cut from the tops season in the shortest time and absorb the most preservative. Unless seasoned 2 years or longer, the hardwoods absorb only one-half to two-thirds as much as pines. Dead pine trees that stand and season (Figure 5) may remain sound for about a year, with the bark loosening better than on posts that were cut to season. Insects which loosen the bark of pine-sapling posts, and insects and weathering which loosen the bark of oaks, ordinarily weaken posts less than 10 percent when they are seasoned only 4 to 8 months. Oak posts usually are stronger after bark seasoning than pine and can be smaller. Pine posts should be at least 3½ inches in diameter.

The bark may slip easier from oaks if they are felled and left to season with the tops on, or if they can be poisoned with sufficient 2,4,5-T to kill the trees quickly. In either case, oaks should season 1 or 2 years for the bark to loosen. Small pine, oak and hickory saplings killed by insects or burning are easy to peel and treat.

Green-cut sapling posts of pine and oak should be piled under shade for best seasoning and bark loosening. They should be piled more loosely in humid than in arid climates. After seasoning the sapling posts 3 to 4 months in East Texas or longer in West Texas, start testing a few posts about every 10 to 20 days for easy peeling. When the bark is loose enough to remove clumps by hand, hand tools or machine, with less than one-fourth the labor required for green peeling, the posts are ready to peel. If posts are cut in winter, they must season longer (7 or 8 months) since the insects will be inactive until spring starts, but wood seasons in winter with less checking and splitting.

The wood will be damp after peeling, and it should dry thoroughly in loose piles for about a week before it is treated. If the weather is rainy, pile the peeled posts under an open shed or cover to dry. The more thoroughly the posts dry after peeling, the more solution they will absorb. To determine the amount of solution being absorbed, weigh a few posts before treating, then weigh them again after they have been soaked for 1 or 2 days.

The solution should be a low-cost water-borne type, but if less than 1 gallon is being absorbed per average-sized (3 or 4 inch) post, the solution should be strengthened. A considerable amount of an oil-dissolved preservative would be absorbed if used, but if dissolved



Figure 5. Dead pines like those pictured lower right are easiest of all woods to prepare and treat. The average-sized posts (4 inches in diameter) pictured upper right absorbed 1 to 2 gallons of borax-water. The posts pictured upper left were sealed at ground end with chromated zinc chloride. The posts pictured lower left were sealed with heavy oil at the ground ends. All of the sealed posts are still sound after 9 years in fences.



Figure 6. All the steps in treating insect-peeled posts are shown here: (1) untreated posts; (2) the posts are soaked full length in a vat of borax-boric acid or polybor; (3) after drying, they are sealed at ground ends by soaking in drums of heavy oil; (4) posts that have been treated and sealed.

in a heavy oil solvent, the preservative would bleed out, and the posts would not hold staples. The cheapest waterborne chemicals that can be used in required strength of at least 1 pound per gallon are borax, which costs about 5 cents per pound, and other borates, which cost about 9 cents per pound.

Table 4, page 24, shows borax tests based on bark-seasoned dead pine-sapling posts, with the middle diameters ranging from 2 to 5 inches. Annual rings averaged $\frac{1}{4}$ inch wide. About 2 gallons of 10 percent borax water was absorbed per post, and all posts were still sound after 7 years in fences in East Texas. After 8 years, all unsealed posts less than $2\frac{1}{2}$ inches in diameter failed at ground end because of termites. The larger posts are all still sound, and those over 4 inches in diameter are expected to last 10 to 15 years. The ground ends of 87 borax-treated posts, averaging $3\frac{1}{2}$ to 4 inches in diameter, were sealed over with about 1 quart of 5 to 10 percent CZC. These double treatments cost less than 6 cents per post for borax and CZC chemicals in 1946, and the posts are all still sound after 9 years and effectively fire retarding. The double-treated posts are expected to last 15 to 20 years. Shavings cut from sealed portions of the double-treated posts will char but will not blaze when exposed to flame. Twenty-six borax-treated pine posts were sealed by soaking up 1 quart of lube oil at ground end, and these were also sound after 9 years. The annual cost during the service life of 15 to 20 years for all of the double-treated posts is less than 1 cent per post including labor. Creosote-treated posts cost at least five times more, and over twice as much per year of service.

A horizontal vat is needed for heating borax to about 130 degrees F. in order to dissolve it in 10 to 15 percent solutions (page 7). The solution is maintained by warming it to about

100 degrees F., which means an additional stoking of the fire once or twice during the treating period. Do not place posts in the vat before the borax is thoroughly dissolved. A solution heated and kept warm also increases penetration and total absorption. Treat with borates only the posts that are over 3 inches in diameter of the most absorptive woods. Then dry the posts and soak the ground ends in a sealer solution.

END-FLOW TREATING UN-PEELED GREEN ROUND POSTS AND POLES

This is the simplest method of all and will treat most species satisfactorily if preservative also is spread into the tops of the posts. A post can be cut from a green sapling and treated in 1 to 36 hours by this method with the least labor and preparation before it is placed in the fence row. Bark is always left on since it makes the chemical spread more thoroughly until the wood seasons. Also, it stays on well at the ground end and reduces leaching. After the posts are installed, the bark serves to seal in preservative. Round posts and poles of fine-grain, diffuse-porous wood and high moisture content, treat more satisfactorily by end-flow when in a freshly cut, green condition than by soaking after seasoning. End-flow is the only treatment in which measured amounts of preservative solution are used for each post or pole according to size and species. Hence, there is less guesswork and uncertainty than with most other methods. (See the treating table on page 23.)

The end-flow method for treating green wood requires a waterborne preservative which dissolves in cold water or will stay in solution after cooling. Posts and poles require 4 to 8 quarts of preservative solution per cubic foot, depending on the species, sapwood thickness and moisture content. To assure using enough solution according to the treating table, measure the diameter outside the bark of posts and poles at midpoint between the two ends; but if the pole or post tapers rapidly, this measurement should be an average of both ends outside the bark.

In 10 percent water solution ($\frac{1}{4}$ pound per quart), CZC costs 4 cents per quart and polybor 2 to $2\frac{1}{2}$ cents. Borax-boric acid, $\frac{1}{2}$ pound each per gallon of water, costs about 2 cents per quart and less with only $\frac{1}{3}$ boric acid to $\frac{2}{3}$ borax for warm weather. These costs are estimated to include freight on the chemicals. In warm weather, polybor will dissolve in unheated water and stay in solution in 15 percent strengths, costing about 3 cents per quart. There is some assurance that the average-siz-

ed post treated by 15 percent polybor will last about as long (average 15 years) as those treated with the same amount of 10 percent CZC. A sufficient amount, usually 1 to 2 gallons of solution per cubic foot, depending on species, must be used to treat a post or pole full length. (See the treating table on page 23.) If the posts are seasoned about 30 to 45 days after treating by standing them intake-end up, the solution spreads full-length to the other end although the treatment will be more thorough at intake end or large end which must be placed in the ground.

Posts have been treated with CZC by the sharpened-pipe end-flow method in Texas for about 12 to 15 years with good fire retarding, and none that were properly treated have been reported as failing. In Pennsylvania and Connecticut, where posts have been treated even longer by tire tube end-flow with CZC, none have failed at ground end in 14 to 15 years although many that were not treated full length failed at top ends. Treating posts with borates by end-flow in the ground end is suggested only to lower the cost of treating the most absorptive woods, such as sweetgum, or to treat the above-ground end of a post of any species. (See pages 10-11 for borate treatments by soaking method.)

Posts should be sound to the center and free of defects, such as fire scars or dead wood on the outside. Sapwood thickness should be at least 1 inch, and the annual rings of the diffuse-porous woods, including pine, should be wider than $\frac{1}{8}$ inch. Different species of saplings to small-size trees are divided into the following groups according to how satisfactorily they can be treated by end-flow:

Group 1. *End-flow treatments are very satisfactory for posts when freshly cut green and with bark on:* blackgum, beech, magnolia, bays, boxelder, maples, linn, willow, cottonwood and Texas mountain cedar (juniper). Since posts of these species do not treat satisfactorily by soaking after seasoning except for a short distance at the end, they should be treated by end-flow.

Group 2. *End-flow treatments for posts when freshly cut green with bark on also are very satisfactory, but it is possible to treat the posts by soaking methods although not practical in some cases:* sycamore, river birch, red cedar, sweetgum, tupelo, elms and pines. Only pine can be prepared easily and treated satisfactorily by cold-soaking methods after seasoning; absorption by the others is likely to be too slow or not uniform if they are treated by soaking. Moreover, sycamore, birch and knotty and fissured woods such as cedar are too difficult to peel for soaking.

Group 3. *Although tested to a less extent, these usually treat too slowly by end-flow and also slowly and with only shallow penetration by soaking after drying:* principally the woods with finest grain, such as dogwood, haws, ironwood and persimmon, but also ash, which is coarse grained but has clogged pores.

Group 4. *Treatments by end-flow usually are unsatisfactory, and it is ordinarily best to treat by soaking after seasoning:* the ring-porous and coarse-grain woods, such as the oaks, hickories, pecan, locusts and mesquite. They are more porous, and their sapwood absorbs more preservative by end-flow than posts from fast-growing trees, but one-third or more of the preservative solution may run out with the sapwater drip. Ordinarily, the posts of most coarse-grain species should be bark seasoned thoroughly before they are peeled and treated by soaking 2 or 3 days in tanks, vats or drums.

Posts and poles must be treated full length even though the end-flow method is used. Thorough full-length treatment is assured for each post and pole by one of the following methods: (1) an amount of solution in excess of the amount shown in the table can be used, and the sap drip, which will contain some chemical, can be saved near the end of treatment to use as water for making more solution; (2) the small ends can be given a light end-flow treatment with preservative such as polybor solution before the butt ends are treated with either CZC or polybor solution; (3) after treating only the butt ends (large ends) with sufficient solution for full-length treatment according to the treating table, stand the posts and poles small ends (above-ground ends) down to dry for 30 to 45 days, which will spread preservative to the small ends; or (4) soak the small ends peeled or unpeeled, in a drum of CZC or polybor solution about 2 weeks to treat them by diffusion after the butt ends have been treated by end-flow. The most critical parts of a post are the ground zone, nailing side and top-end surface. The ground ends will be treated most thoroughly when all or most of the solution is run in at the butt ends.

If the posts have been cut 6 to 12 hours, or for less time in dry weather, 1 inch of the wood should be sawed off at each end to expose fresh wood surface for the solution to flow in and sap to drip out. Pitch may spread rapidly over the ends of green pine after cutting during certain seasons. After an hour or two, when pitch bleeding slows down, cut off 1 inch or less of wood at each end to expose a clean, freshly cut surface. If preparations for treating are incomplete, posts can be stored under water for several weeks to keep them wet and treatable. The ends of green willow or cottonwood posts that are cut on a dry, hot day may

shrink watertight immediately. In this case, stand the small end in a can or trough containing water 1 or more inches deep to allow the sap to run out and the solution to flow in from above after water has soaked into and swelled the freshly cut end wood. Cottonwood and willow posts treat most rapidly in the spring, late fall and winter. In the spring, the sap drips out immediately from the lower end of freshly cut sweetgum when the solution is poured into a pipe or tube at the elevated end of the post, and the solution will run into the post full-length until all its pores are clogged with chemical. The sapwater drip from most species with high sap content, like sweetgum, usually shows at the lower end of posts after a few minutes of treatment. These species with high sap content require long treatment, but their sapwood absorbs more preservative both by sapwater displacement and by diffusion.

Treating periods of from several days to over a week are required for end-flow treatment of long poles and house logs. It is doubtful whether the long poles could be treated satisfactorily without some pressure on the head of the solution. Only the most treatable woods of fast growth and with thick sapwood should be used for long poles or house logs. Species suitable are in great number: sweetgum, blackgum, tupelo, birch, cottonwood, willow, cypress, soft elms, bay, sycamore, maples, boxelder,

pinus and red cedar. For uses above ground, such as house logs, a 10 percent polybor or borax-boric acid or 5 percent CZC solution should be used. In these strengths, all of these solutions cost about the same per gallon. Solutions must be used in ample amounts for thorough full-length treating. The poles should then be seasoned for 1½ to 2 months by standing them small ends down, in order to spread the solution to the tops.

Poles of birch, sycamore and cedar are used for ornamental effects, such as rustic fencing, since the thin, tight bark of these species stays on longer than the bark of most other species. It can be tacked down after several years wherever it loosens.

End-flow Treatment of Poles with Tire Tubes

This method is suitable for treating poles that measure over 5 inches in diameter at the butt end and about 16 feet long, for use as house logs, sills, bridge stringers, utility poles and posts for barns, gates and fence corners. Either a 5 percent CZC or 10 percent polybor solution can be used to treat poles full length that will not be in contact with the ground or to treat the above-ground ends of poles in contact with the ground. Old tire tubes ordinarily are used full length to hold enough solution to treat the full length of long poles.

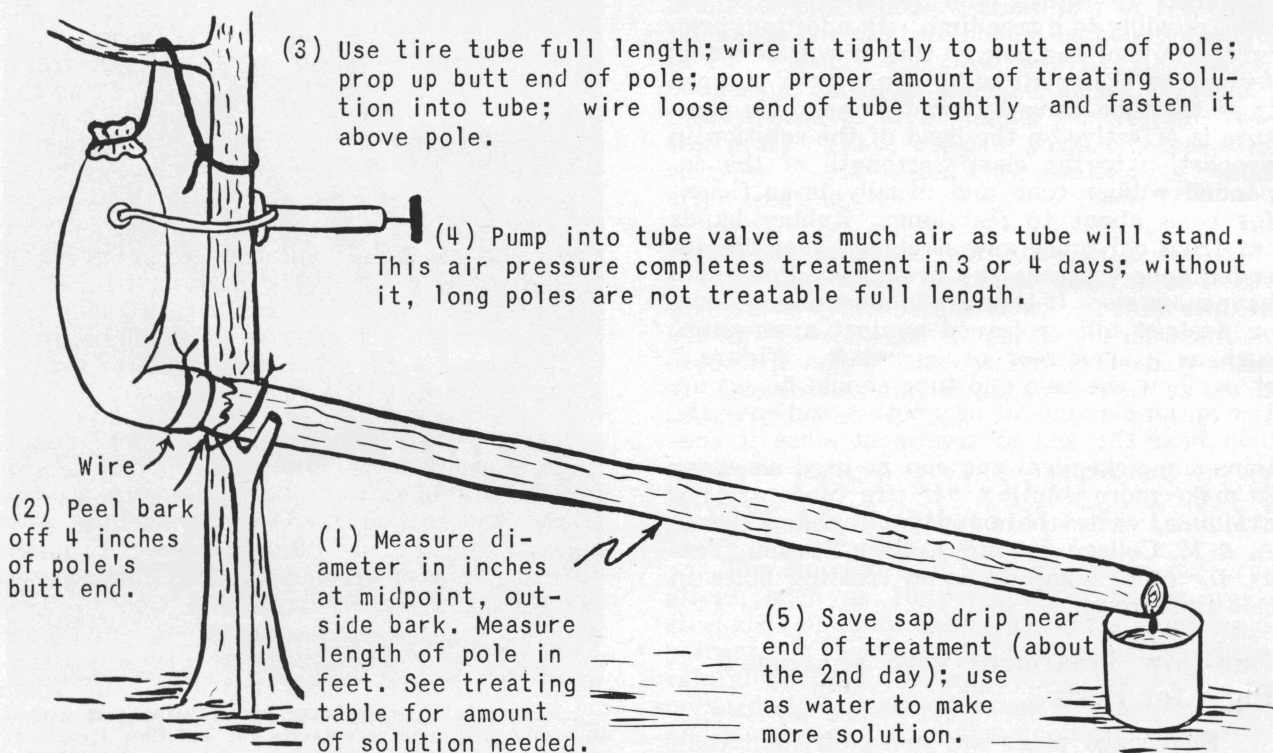


Figure 7. Tire tubes are used for pressure treatment by end-flow of green, unpeeled poles or large posts.

To prepare the tube, cut through it at least 1 foot from the valve. Any puncture can be closed by running a small bolt through the puncture and into a hole in small blocks of wood at each side of the tube. The end farthest from the valve is stretched over about 4 inches of the butt end of the pole after this much bark and wood at the butt end have been shaved to smooth roundness. Smoothing the end is less important for the smooth-bark species. Some grease applied to the wood that will be in contact with the tube assures a watertight connection.

The rubber tube is held fast and watertight to the butt end of the pole by one or two wires twisted tightly around the tube. To prevent cutting the tube under the tightened wire, double back 1 or 2 inches of the tube before wiring. Oversized tubes can be overlapped lengthwise and wired tightly if the rubber is not too thick. No. 12 malleable wire is recommended and can be tapped down tightly over the lap of the tube or any depression in the wood with a hammer. Two or more wrappings of haywire are also satisfactory.

After testing the tube with water to find and stop leaks, pour the required amount of solution according to the treating table into the loose end of the tube leading off from the butt of the pole and close this loose end airtight by doubling back the end of the tube and wiring it tightly with pliers. This loose end then is stretched up tightly and fastened above the pole, possibly to a tree limb. In addition, prop up the butt of the pole so that it will be a few feet above the small end. Air is then pumped in at the tube valve by hand pump. Air pressure is effective on the head of the solution in proportion to the elastic strength of the expanded rubber tube and usually is sufficient for poles about 16 feet long. Rubber bands cut from old tubes and stretched over the inflated tube increase the pressure. Poles will have more slope if they are laid small-end down on a steep hill or leaned against a structure such as a shed roof or barn loft. Figure 7 shows how the pole and tube should be set up. Use an ample amount of solution and save the drip near the end of treatment since it contains some chemical and can be used as water to make more solution. If tire tubes are not available, write the extension forester, Texas A. & M. College System, College Station, Texas, for other suggestions on treating poles in this size group.

End-flow Treatment with Sharpened Pipes for Posts

Sharpened pipes are more efficient than tire tubes for treating posts that are less than about 5 inches in diameter at butts. Boiler

flues, test drill stems, irrigation pipes and other thin metal pipes can be cut into about 15-inch lengths and sharpened at one end to serve as receptacles for the treating solution. Pipes must be sharpened with a long beveled edge outside for easy driving and to prevent splitting of wood. One man, using a small Swedish bow saw or a small power saw, can cut, haul and treat about 50 posts per day with about \$4 worth of solution if polybor is used, or \$6 worth if CZC is used. An average of $\frac{3}{4}$ gallon ($\frac{3}{4}$ pound of CZC or at least 1 pound of borate) is required per average sized post of most species.

Select a pipe about $\frac{1}{2}$ to 1 inch smaller than the sawed-off butt end of the sapling post. The pipe must be larger than the heartwood center and cover as much of the outer sapwood ring as possible. Drive the sharp end of pipe about $\frac{1}{4}$ inch into the butt end of the post with a wooden mallet, just far enough for the pipe to stand up securely and to hold the solution without leaking. Look into the pipe, and if no light shows through where the pipe joins the end of the post, there will be no leaking. Stand the post on the small end in a can or trough and lean the butt end against a fence, building or tree. Pour in the solution, Figure 8, which will flow in and displace the free sap



Figure 8. A waterborne preservative is measured into pipe and cone receptacles for end-flow treatment of these small posts. The sharpened pipes are cheaper to use since the cone receptacles require rubber gaskets.

and force it to run out at the lower end. It may be necessary to fill the pipe with treating solution two or more times in order to use all of the amount shown in the treating table on page 23.

The farmer should start with a few pipes and treat a small number of posts, then acquire a larger stock of pipes as he studies the sizes of saplings available, learns by experience and looks around to find the best kind and sizes of pipes needed. Farmers who plan to treat posts which are 3 to 5 inches in diameter at the butts, should get a stock of sharpened pipes in two or three diameter sizes, 2 and 3 inches and some 4 inches. Most of the pipes should be about 3 inches in diameter since the average-sized post is 3½ to 4 inches in diameter at the butt. Treatments are slower and less effective when the posts are too much larger than the pipes.

The best and cheapest pipes to cut in lengths and sharpen are the thin metal drill stems, usually 3 inches in diameter, that are used and frequently discarded by seismic crews of oil companies. Long, beveled and sharp edges on thicker metals, such as boiler-tube pipes, can be turned at one end on a machinists' lathe in about 3 minutes, which is more efficient than grinding. Pipes cut from aluminum irrigation pipes should be very satisfactory if they can be sharpened easily without chipping. Avoid beveling inside a thick metal pipe, as it will compress the wood and retard or possibly prevent the flow of solution into the wood. Rub grease on the sharpened edge to cause the pipe to drive in more easily and to prevent leakage should the post crack slightly. A slight leak usually stops after a few minutes.

After the posts are treated, the pipes are removed so that they can be used to treat more posts. The treated posts can be set in a fence immediately, but it is better to stand them small ends down for 30 to 45 days in order to spread the solution more thoroughly into the small ends, unless these ends have been treated otherwise (See page 12). Except for a thin ring of sapwood a few inches below the butt, the solution will spread outward sufficiently to the bark since the pipes used usually are less than 1 inch smaller than the butts. Pipes should be stored in a dry place and dipped in oil, particularly if they were used with zinc chlorides.

Although it is a little slower to treat with pipes than with tire tubes, pipes force more solution to penetrate the sapwood nearest the heartwood as well as toward the bark; thus the posts ordinarily absorb more.

Modified End-flow Treatments for Sweetgum and Oaks

Sweetgum posts of rapid-growth trees contain a high proportion of sapwater, which must be displaced full length for thorough end-flow treating. A common method of treating sweetgum is to use twice the table amount of treating solution in about ½ strength, such as 5 percent CZC or 10 percent borate. A method which gives longer service for sweetgum is to use first the table amount in about ½ strength and then repeat the table amount in full strength.

In oaks, more than one-third of the solution may run out with the sap drip. To treat oaks by end-flow, use half the table amount of polybor in the strength shown in the table; then use the remainder of the table amount of polybor in 15 percent strength or the remainder of the table amount in a 10 percent solution of CZC. Save the drip and use it as water to make more solution with the same chemical as in the drip, adding 1 to 1½ pounds of chemical per gallon of drip. Post oak and other white oaks retain more solution than red oaks and will last longer.

Although end-flow usually requires waterborne preservatives and freshly cut green posts, red oaks may be treated by end-flow with oil-type preservatives after seasoning. Use 3 to 5 percent pentachlorophenol mixture in oil for pipe end-flow treatment of red oaks. The oil in the mixture should be heavy enough to run through the post slowly. At least 6 pounds of chemical should be used per cubic foot of post (4 or 5 pounds per average red-oak post). These red-oak posts treated with oil types should be laid horizontally to dry soon after treating.

When seasoned with the bark on, fast-growth pine, willow and birch also can be treated with oil-types by end-flow, but they require a thin oil solution of penta. This solution should be only 3 percent strength since posts of these species may retain over twice as much preservative as red oaks.

SOME POST TREATMENTS FOR WEST AND SOUTHWEST TEXAS

The simplest and least expensive preservatives, such as 10 percent borate, or weak strengths of more expensive kinds, such as 5 percent CZC or 3 percent penta, suffice where rainfall is light. Average-sized posts of oaks or hard elms, seasoned about 2 years in West and Southwest Texas, absorb oil-type preservative quickly in hot, dry weather. They can be treated by pouring or sprinkling 1 to 2 pints

of 2½ to 3 percent pentachlorophenol-kerosene solution around the ground line of the post and for at least 6 inches above and below it, or the ground ends can be soaked about 30 minutes. Another pint should be poured on the top end and along the nailing side. The posts should soak to saturation full length, however, if borate solution is used. If termites are bad, the ground ends of borate-treated posts, after drying a few days, should be double treated by dipping in 3 percent penta or old lube oil.

Mesquite posts, green or seasoned, with or without bark, and from old-growth tree stems or post-sized limbs, can be treated full length with 3 percent penta-kerosene during summer in West Texas to repel borers. The penta-kerosene can be poured or sprinkled on the posts, or the posts can be dipped in it; but it is more effective when the posts are soaked in it a few hours. Mesquite posts with these light treatments have been in a fence near Ballinger for about 10 years, and all the posts are sound, with practically all borers repelled. A preliminary kerosene treatment at the base of trunks will kill old mesquite; and, if kerosene is sprayed the full length of a post in the tree, it will repel the borers long enough for the wood to season before it is cut. Such a post will be easier to debark and will respond better to the final soaking treatment of a few hours in 3 percent penta-diesel oil. One-fourth to one-third strength of creosote in diesel oil can be substituted for the penta. Mesquite has one of the most naturally decay-resistant heartwoods, and by treating the thin sapwood of peeled posts thoroughly with 5 percent penta to prevent borers from entering the untreated heartwood, mesquite posts of average to large size should last 40 to 60 years—much longer than the naturally durable woods and other treated posts.

The Trans-Pecos mountain pines and oaks also can be bark seasoned for borate-water soaking; but if sapwood is thin, a 3 percent penta or 5 to 10 percent CZC solution should be used.

Freshly cut, green posts and poles of oaks, cedars, cottonwood, willow and Chinese elms in West Texas can be treated full length by end-flow for long service and at the least cost with a 10 to 15 percent strength of borax-boric acid or polybor.

POSTS REQUIRING MOSTLY GROUND-END TREATMENT

Split and sawed oak posts, preferably post oak, live oak and other white oaks, that have a high proportion of sapwood and have been seasoned 12 to 18 months with bark, or long enough for easy removal of bark and greater



Figure 9. Split and sawed oak posts should be treated at the ground end with oil-type preservative as shown on the right. After a few years in the ground, only the top of the untreated post at the left remains.

absorption, can be treated by soaking the ground ends only for 12 to 24 hours in a drum of 3 percent penta-oil preservative, Figure 9. If seasoned 2 years or longer, posts with thick sapwood may absorb ½ gallon at ground ends, in which case 15 percent borates can be used. The untreated tops must have enough heartwood for stapling and supporting the fence. The purpose of the butt treatment of split or sawed oak posts is to make the ground-end sapwood last as long as the heartwood, which normally will last over 15 years above ground. If untreated, the sapwood of these oak posts would last only about 2 years at ground end in East Texas and about 6 years above ground. Keep the preservative level up to at least 6 inches above the ground line by pouring more solution into the drums as the posts absorb it. It would be wise to keep the preservative level up to this point even though the preservative will creep up 6 to 12 inches in oak posts. Oil drums about 30 inches high with one end cut out, are useful for the butt treatments. A number of split, white and post-oak posts treated with penta in this manner in Liberty County are all sound after about 8 years, which is about the limit of the service life of untreated, split post-oak posts.

For use in West Texas, bark-seasoned round sapling posts with thin sapwoods, such as hard elms, wild China and all oaks, also may be treated at the ground ends only by soaking in drums after they have been peeled full

length. It would be advisable to dip the top ends of these posts in an oil-type solution for a few minutes.

Post oaks grown on poor sites or where rainfall is light, have thick, rough bark. Use a single-bit axe to knock the bark off such posts. Blackjack oak is difficult to debark and does not treat as easily as other oaks. Red oaks have less durable heartwood than white oaks. If red oaks are split or sawed, they should be treated full length for use in East Texas and treated at ground ends with tops dipped in solution for West Texas. Red oaks do not retain preservatives as satisfactorily as the white-oak groups. Unpeeled, split, oak posts can be seasoned longer before debarking with less danger of decay and insect damage than round sapling posts. Poles to be used in barns and sheds can be treated thoroughly at ground ends by soaking in drums, and they can be brush treated thoroughly above ground with penta. See page 18 for another method of treating the above-ground ends of barn poles. If the sapwood is not too thick, it should be hewed off the nailing side.

NAILING TREATED POSTS

In using treated sapwood posts, particularly those made from the more absorptive woods and those treated with oil-type preservatives, drive nails or staples at a downward angle to hold the fence boards or wire better. The staple points must not be driven vertically into the grain of the wood. It is important to nail or staple into the heartwood of split and sawed oak posts when only the ground-end sapwood has been treated.

INEXPENSIVE TREATMENTS FOR SAPWOOD LUMBER

Lumber to be used above ground and exposed to weather so that it can dry when damp, does not require as thorough a preservative treatment as lumber that will be in contact with ground or dampness. In either case, lumber of any thickness will not warp or twist if it is cut from straight-grain timber and then seasoned properly. Timber that has been grown at a uniform rate through proper thinning will make the best lumber.

Green sapwood lumber of most species can be treated by soaking in a long vat of waterborne preservative. If dry, sapwood lumber can be treated by soaking in either oil or water-type preservative. Penetrations in either green or dry lumber are likely to be shallow through the sides of the wood unless soaked long enough.

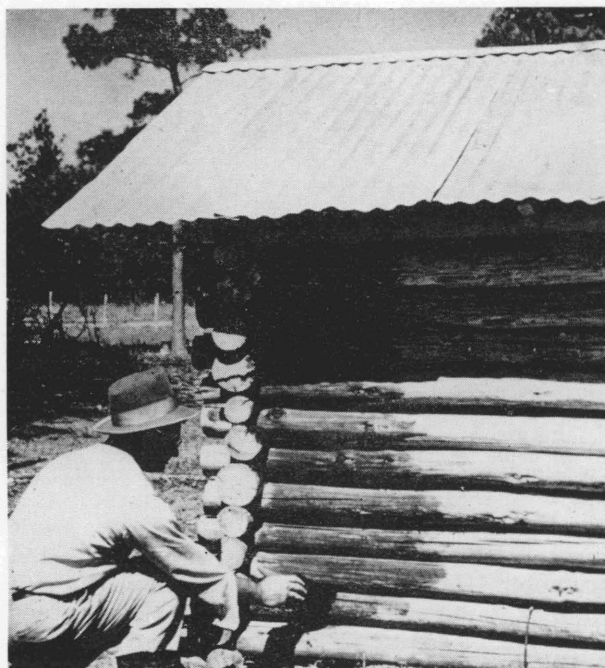


Figure 10. Pentachlorophenol diluted with kerosene penetrates old wood rapidly by brush application and is practical for treatments such as this.

If only a very shallow treatment for lumber is required, spray the green lumber with polybor solution of at least 20 percent strength; or dust polybor over each layer of wetted green boards as they are piled flat under a shed. The pile must be covered with straw or sawdust so that the wood will dry slowly. Lumber treated by this method can be used where seasoned materials are unimportant, and sometimes is preferred because it can be nailed and sawed easily. Seasoning is not necessary for sills or joists or for lumber used for fencing, gates and feed racks.

Green sapwood lumber of most species may be given either a shallow or a deep treatment by soaking for either 1 week or 2 to 3 weeks in waterborne preservative. This is called the "steeping method." The layers of lumber must be separated while submerged so that the solution can reach all surfaces. To separate the layers, place wooden stickers about $\frac{1}{2}$ inch thick between the layers. Only chemicals which can be dissolved in cool water should be used. One to $1\frac{1}{2}$ pounds of polybor per gallon of water or $\frac{1}{2}$ to 1 pound of CZC are suitable. The chemicals diffuse slowly from the water solution into the sapwater of the green wood until a balance is reached. Thus, green woods with a high sapwater content would receive the most chemical by this process. Soaking green wood reduces the amount of chemical in the vat solution, and more chemical must be added before the solution is used again. However, it is difficult to determine ac-

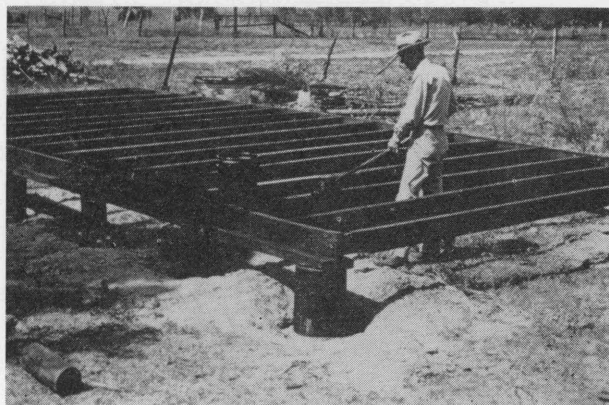


Figure 11. Pentachlorophenol diluted with heavy oil is being mopped on the foundation wood of this building. The posts are sections cut from a creosoted pole.

curately the amount to add, even with a hydrometer test. A shallow penetration of about $\frac{1}{8}$ to $\frac{1}{4}$ inch usually is obtained in the sapwood per week of soaking. The amount of penetration depends on the species and thickness of the sapwood. A shallow penetration is sufficient for many off-ground uses. Deeper penetration to at least $\frac{1}{2}$ inch may require several weeks' treatment. After treating green lumber by the steeping method, dry it slowly under a shed to reduce surface checking if seasoned lumber is required.

Slow drying the green-treated lumber under a shed to reduce surface checking also makes the shallow penetration of waterborne preservative of at least $\frac{1}{4}$ inch more effective for exposed uses above ground. Slow drying also reduces surface hardening so that the lumber can be sawed or nailed more easily. Hardened steel nails which bend less easily can be used, or softer nails can be stuck in soap or grease.

Steeping is the best method of treatment for the lumber of most hardwood species except oaks, since most hardwoods season with greater difficulty and treat less satisfactorily with preservative after seasoning than does pine or oak. If treated green by the steeping method for about a week, hardwood lumber and timbers can be piled flat (without stickers), but they should be covered with hay to retard drying.

Although green lumber ordinarily must be steeped in waterborne preservative, rough-sawed, green oak and elm lumber that contains less sapwater can be given a shallow treatment by soaking for 1 week or longer in a thin oil-type preservative, such as penta and diesel oil. Green, rough-sawed oak and elm lumber treated by this method will dry with less warping and can be nailed more easily than untreated lumber.

If wood is to be dried before it is treated by soaking, season the lumber under a shed or in a well-covered pile, to prevent alternate wetting from rain and drying too rapidly from exposure to sun. This will reduce checking, warping, honeycombing and hardening. The seasoned sapwood of pine and gum that is covered with sapstain mold will absorb $\frac{1}{6}$ pound or more of solid CZC or borate per board foot (2 pounds or more per cubic foot), which is enough to retard burning.

When moderately dry to seasoned pine or oak lumber is soaked in waterborne preservative, both water and chemical penetrate the sapwood. The lumber then may be dried again for a few days or weeks to allow the water of the preservative to evaporate. Drying treated lumber is important only if it is to be used in parts of buildings where shrinkage in drying should be avoided. For use in interior trim, flooring and furniture, lumber should be both air dried and kiln dried or else air dried under shed for 12 months or longer.

Dry sapwood lumber of pines, oaks, elms, hackberry, hickories and pecan that has been seasoned under a shed, can be soak treated more thoroughly and in the shortest time (1 to 3 days) if oil-soluble preservative is used. If seasoned lumber of these species is treated with waterborne solution, it should soak longer, about 1 week.

Seasoned pole rafters or lumber also can be treated lightly by laying them in a V-shaped trough and pouring oil-type preservative over them. Construct a trough by bending a sheet of metal roofing into a V-shape. Prop up one end of the trough, and rest the other end in a tub so that the preservative will drain into the tub. As the preservative drains, pour it back over the rafters or lumber repeatedly. The above-ground end of barn posts also can be treated this way after the ground end has been treated by soaking (See page 17).

PAINTING TREATED WOOD

Wood that has been treated with waterborne preservatives can be painted or varnished without discoloration after the wood dries. Painting or lime whitewashing is also important as a sealer over the borate-treated lumber for long service at least cost. Painting alone protects wood from weathering, retards moisture and improves appearance, but does not prevent decay. Fire-retarding paints are not nearly as effective as deep penetration of zinc chlorides or even borates in good strength, but the combination should assure long service and good protection against fire, decay and insects. Wood treated with preservatives diluted by thin oil, should dry thoroughly before it is

painted. Penta should be diluted with mineral spirits for more rapid drying. A primer coat of aluminum paint can be used under some other paints to prevent discoloration. Siding can be soaked treated with a specially manufactured mixture of penta and water repellent to resist decay, leaching and staining, and to increase paint holding. Heavy oil-type treatments cannot be painted over, even after years, without some discoloration.

INEXPENSIVE TREATMENTS OF SOIL AROUND THE HOUSE

Crankcase oil alone is fairly effective against termites when an ample amount is used. It is safe to use on or in the ground under the house and in a trench around the house.

Dig a trench about 6 inches wide by 6 inches deep, outside of and against the foundation, and pour the oil over layers of soil as it is filled back into the trench. This treatment is likely to kill shrubs that are planted close to the house. Before laying concrete or other material against the wood of the house for outside steps or porches, saturate the soil beneath with old lube oil. Some penta or creosote can be added to the oil next to the house foundation.

Borax, preferably borascu, although it will not dissolve in the oil, can be mixed with lube oil and soil to prevent or retard plant and fungus growth. Tree and bush-root growth around sewer lines leading from the house can be prevented by mixing oil and borascu or other borates liberally with the soil next to the sewer pipes.

TABLE 1. Selecting Good Preservative Treatments

| Common woods of Texas | Av. sapwood thickness | Method 1. | |
|-------------------------|-----------------------|----------------------------------------------------------|-----------------------------------------|
| | | Ease of peeling bark from green posts by machine or hand | Effectiveness of treatment ² |
| Ash and wild China | ½ to 1½ in. | moderately easy | poor, ash fair, w. China |
| Birch | 1 to 2 in. | difficult | fair-side good-ends |
| Blackgum and tupelo | 1 to 2 in. | moderately easy | poor-side good-ends |
| Cedars | ¾ to 1½ in. | difficult | poor-side poor-ends |
| Cottonwood and willow | ¾ to 1½ in. | easy | good in few tests |
| Cypress and catalpa | 1 to 2 in. | easy | poor-side good-ends |
| Elms and hackberry | ½ to 1½ in. | moderately easy | fair-side good-ends |
| Hickory and pecan | ¾ to 1½ in. | moderately easy | fair-side and ends |
| Locust and mesquite | ½ to ¾ in. | moderately easy | fair-side and ends |
| Maple, magnolia and bay | 1 to 2 in. | easy | poor-side good-ends |
| Oaks, red | ½ to 1½ in. | moderately easy | fair to good—full length |
| Oaks, white | ½ to 1½ in. | moderately easy | fair to good—full length |
| Pines | ¾ to 2½ in. | easy | fair to good—full length |
| Sassafras | ½ to ¾ in. | difficult | fair-full length |
| Sweetgum | 1 to 3 in. | moderately easy | poor-side good-ends |
| Sycamore | 1 to 2 in. | moderately easy | fair-side good-ends |

¹To use this table, look in the first column for the species of wood which is to be treated, and choose the method (1, 2 or 3) indicated as treating posts of this wood most effectively. Posts 4 inches or larger in diameter, which take good treatments by any of these methods, should last 15 yr. or longer. These treating methods and the chemicals they require are described more fully on pages 4 to 15 of this bulletin.

²For treatment by method (1) to be rated fair to good, the preservative should penetrate at least ¼ inch through the side of posts, and the posts should absorb about 3 qt. per cu. ft. of 5% penta or 3 to 4 qt. of 10% CZC solution. Pines and oaks are rated highest by this method.

³For treatment by method (2) to be rated good, the post must be sound after seasoning with bark; the preservative should penetrate all the sapwood

for Sapwood Posts of Different Woods¹

| Method 2. | | Method 3. | | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|-----------------------------------------|
| Soaking treatment for the absorptive woods of fast-growth pine or slow-growth, coarse-grain hardwoods. Posts are seasoned with bark on with least decay and insect damage until bark loosens for easiest peeling and best soak treating. Soak posts 1 to 3 days to penetrate all sapwood in a water solution of 10 to 15% borates, 5 to 10% CZC or 2½ to 3% penta-diesel oil mixture. Borate-treated posts should be sealed at ground ends and the top end surface painted. | | End-flow treatment of round, freshly cut, green posts and poles with bark left on permanently. Requires a water solution of 10% CZC or 15% polybor or borax-boric acid. Use sharpened pipes for posts 3 to 5 in. in diameter at butts; use tire tubes for larger and longer poles. Fast-growth, fine-grain woods, which have thick sapwood and a large amount of sapwater, are rated highest by end-flow treatment. | | |
| Sound wood seasoning with bark before peeling, East Texas and West Texas | Effectiveness of treatment ³ | Av. % sap-water in green sapwood compared to weight of dry wood | Av. quarts preservative retained per cu. ft. (See Table 2 or 3) | Effectiveness of treatment ⁴ |
| fair-E. Texas good-W. Texas | fair-full length | 51% | 3 | fair-ground poor-top |
| poor-E. Texas none-W. Texas | fair-full length | 80% | 4½ | good-ground fair-top |
| fair-E. Texas none-W. Texas | fair-side good-ends | 115% | 5 | good-ground fair-top |
| good-E. Texas good-W. Texas | poor-full length | 45% | 3 to 4 | good-ground fair-top |
| good-E. Texas good-W. Texas | erratic | 171% | 6 | good-ground fair-top |
| fair-E. Texas good-W. Texas | fair-side good-ends | 142% | 5 | good-ground fair-top |
| fair-E. Texas good-W. Texas | fair to good— side and ends | 75% | 3 to 4 | good-ground fair-top |
| fair-E. Texas good-W. Texas | fair to good— side and ends | 57% | 3 to 4 | fair-ground fair-top |
| fair-E. Texas fair-W. Texas | fair to good— side and ends | 40% | 3 | poor-ground poor-top |
| poor-E. Texas none-W. Texas | fair-side good-ends | 95% | 4 | good-ground fair-top |
| good-E. Texas good-W. Texas | good-full length | 76% | 3 | poor-ground poor-top |
| good-E. Texas good-W. Texas | good-full length | 76% | 3 to 4 | fair-ground fair-top |
| good-E. Texas good-W. Texas | good-full length | 115% | 4 to 6 | good-ground fair-top |
| fair-E. Texas none-W. Texas | fair-full length | ? | 3 | not tested |
| fair-E. Texas none-W. Texas | fair-side good-ends | 137% | 8 | good-ground fair-top |
| poor-E. Texas poor-W. Texas | fair-side good-ends | 130% | 6 | good-ground fair-top |

full length and the posts should absorb about 8 qt. of 10% borax or 5% CZC solution per cu. ft. Posts of the species that are rated fair usually absorb less preservative, 3 to 6 qt. per cu. ft.; thus the strengths should be increased to 15% for borates or 10% for CZC, or 2½ to 3% penta can be used.

⁴Posts and poles of most species can be treated most effectively by end-flow. To be rated good, all the sapwood should be treated full length, with the solution more concentrated in ground end than at top. This method is suitable for woods rated "good-ground and fair-top." To insure a good top treatment, stand the posts small ends down to season for about 30 days, poles 45 days. This will spread the solution full length. If the most absorptive woods are treated with borates, the end surfaces should be painted after seasoning to seal out moisture.

TABLE 2. Cubic Foot Content of Round Posts and Poles¹

| Middle diameter, inches | Length in Feet | | | | | | | |
|-------------------------|-----------------------------------------|-----|-----|-----|-----|-----|------|------|
| | 6' | 6½' | 7' | 8' | 10' | 12' | 14' | 16' |
| | Content in cubic feet per post or pole: | | | | | | | |
| 2 in. | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 |
| 3 in. | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 |
| 4 in. | 0.5 | 0.6 | 0.6 | 0.7 | 0.9 | 1.1 | 1.2 | 1.4 |
| 5 in. | 0.8 | 0.9 | 1.0 | 1.1 | 1.4 | 1.6 | 1.9 | 2.2 |
| 6 in. | 1.2 | 1.3 | 1.4 | 1.6 | 2.0 | 2.4 | 2.6 | 3.1 |
| 7 in. | 1.6 | 1.7 | 1.9 | 2.1 | 2.7 | 3.2 | 3.7 | 4.3 |
| 8 in. | 2.1 | 2.3 | 2.4 | 2.8 | 3.5 | 4.2 | 4.9 | 5.6 |
| 9 in. | 2.7 | 2.9 | 3.1 | 3.5 | 4.4 | 5.3 | 6.2 | 7.1 |
| 10 in. | 3.3 | 3.5 | 3.8 | 4.4 | 5.5 | 6.6 | 7.6 | 8.7 |
| 11 in. | 4.0 | 4.3 | 4.6 | 5.3 | 6.6 | 7.9 | 9.3 | 10.6 |
| 12 in. | 4.7 | 5.1 | 5.5 | 6.3 | 7.9 | 9.4 | 11.0 | 12.6 |

¹How to use this table: Measure the diameter of the post or pole at the middle in inches and the length in feet. Then find this diameter in the first column of the table and read the cubic foot content under the proper length column. Example: If a post is 4 in. in diameter and 6½ ft. long, it will have 0.6 cu. ft.

Three treating methods are summarized in Table 1, pages 20-21. By method 1, a well-treated pine post should absorb about 3 qt. of preservative solution per cu. ft. Then a post with 0.6 cu. ft. should absorb 1.8 qt. of preservative (0.6 x 3).

By method 2, a pine post should absorb about 8 qt. of a lower cost solution per cu. ft.; so a post with 0.6 cu. ft. should absorb about 4.8 qt. (0.6 x 8).

If treated well by method 3, a pine post should absorb about 5 qt. of solution per cu. ft.; so the post with 0.6 cu. ft. should absorb about 3 qt. of solution (0.6 x 5).

TABLE 3. End-Flow Treating Table—Average Amounts of Solution Required To Treat Round, Unpeeled, Green Posts and Poles of Different Sizes with Cool, Waterborne Preservative Solution, such as 10% Zinc Chloride or 15% Polybor or Borax-Boric Acid¹

| Diameter of post or pole, inches | Gallons of solution required ² to treat posts or poles that are: | | | | | | |
|----------------------------------|-----------------------------------------------------------------------------|------------|------------|-------------|-------------|-------------|-------------|
| | 6 ft. long | 7 ft. long | 8 ft. long | 10 ft. long | 12 ft. long | 14 ft. long | 16 ft. long |
| 3 in. | 1/3 | 1/2 | 1/2 | 1/2 | 3/4 | 1 | 1 |
| 4 in. | 1/2 | 3/4 | 3/4 | 1 | 1 1/4 | 1 1/2 | 1 1/2 |
| 5 in. | 1 | 1 | 1 1/4 | 1 1/2 | 1 3/4 | 2 | 2 1/2 |
| 6 in. | 1 1/4 | 1 1/2 | 1 3/4 | 2 1/4 | 2 1/2 | 3 | 3 1/2 |
| 7 in. | 1 3/4 | 2 | 2 1/4 | 3 | 3 1/2 | 4 | 4 1/2 |
| 8 in. | 2 1/4 | 2 3/4 | 3 | 3 3/4 | 4 1/2 | 5 1/4 | 6 |
| 9 in. | 3 | 3 1/2 | 4 | 4 3/4 | 5 3/4 | 7 | 7 3/4 |
| 10 in. | 3 1/2 | 4 | 4 1/2 | 5 3/4 | 7 | 8 | 9 |
| 11 in. | 4 | 5 | 5 1/4 | 7 | 8 | 9 1/4 | 11 |
| 12 in. | 5 | 5 3/4 | 6 1/4 | 8 | 9 1/2 | 11 | 13 |

¹How to use this table: Measure the lengths of the posts and poles in feet. Measure the diameters of posts in inches outside the bark at midpoint. Measure the diameters of poles, and also of any posts that taper rapidly, at both ends and use an average of the two measurements as the diameter. Look in the first column of the table for the diameter of the post or the average diameter of the pole, then read the amount of solution required under the length column. Example—If a post is 4 in. in diameter and 7 ft. long, the amount of solution required is 3/4 gal. for most species.

Make up a small amount of solution, 5 to 10 gal. at a time. A half-gallon measure marked in quarts will be useful for measuring the amount of solution for each post or pole. Pour the proper amount of solution for the post or pole into the pipe or tire tube attached to the pole during treatment. If a tire tube is used full length, it probably will hold all of the solution that is required; but a pipe may have to be filled 1 or 2 qt. at a time.

²Use about this table amount of solution for most species, such as beech, birch, cedars, blackgum, elms, hackberry, magnolia, most pines, cottonwood and willow. Use approximately 1/4 to 1/2 more than the table amount for fast-growth pine, willow and cottonwood and cypress, tupelo, bay, sycamore. Use at least twice the table amount for sweetgum. The solution for sweetgum can be a weaker strength. (See page 15 and method 3 of Table 1.)

After all the required amount of solution runs in at the butt or intake end, remove the pipe and stand the post or pole small end down to season for 30 to 45 days. The chemical which is concentrated at intake end then will spread down to the small end and thus treat the post or pole full length to prevent decay at top end.

TABLE 4. Treatment Comparison of Sapwood Posts and Stakes Tested with Various Preservatives and Treating Methods

| Species of wood tested, post sizes and location of test | Green or seasoned wood | Preservative and strengths used | No. posts treated and method | Av. lb. preservative retained per cu. ft. of post ¹ | Percent posts failed | Estimated service life of posts for region tested ² |
|---------------------------------------------------------------------------------------------------|------------------------|---------------------------------|------------------------------|----------------------------------------------------------------|----------------------|----------------------------------------------------------------|
| Pine, fast growth (top diameters 2 to 5 in., length 6 ft.) East Texas | bark-seasoned | borax-boric acid 10% | 80 soaked | 2 borax-boric acid (1¼ borax & ¾ boric acid) ³ | 50% in 8 yr. | small—5 to 8 yr. large—15 yr. |
| | bark-seasoned | borax 10% (heated) | 87 soaked | 2 borax, ¼ CZC ⁴ | none in 9 yr. | 17 to 20 yr. |
| | bark-seasoned | borax 10% (heated) | 26 soaked | 2 borax 4 lube oil ⁴ | none in 9 yr. | 16 to 20 yr. |
| Chinese elm and honey locust round stakes, (top diameters av. 1½ in., length 1 ft.) West Texas | green | borax 10% (heated) | 16 end-flow | 1 | 12% in 13 yr. | over 15 yr. |
| | green | zinc chloride | 16 end-flow | 1 | none in 13 yr. | over 20 yr. |
| | green | CZC 10% | 16 end-flow | 1 | none in 13 yr. | over 20 yr. |
| | bark-seasoned | penta, 2½ and 5% | 16 end-flow | 5-7 | none in 13 yr. | over 25 yr. |
| Pine (top diameters 2½ to 7 in., length 7 ft.) Mississippi | seasoned | borax ½—boric acid ½ | 97 pressure | 0.92 | 94% in 19 yr. | 14 yr. |
| | seasoned | CZC | 96 pressure | 0.85 | 36% in 19 yr. | 22 yr. |
| | seasoned | coal-tar creosote | 98 pressure | 6.00 | 5% in 19 yr. | over 25 yr. |
| | seasoned | creosote ½—lube oil ½ | 98 pressure | 5.40 | 6% in 19 yr. | over 25 yr. |
| | seasoned | creosote 10%—lube oil 90% | 99 pressure | 7.10 | 74% in 19 yr. | 17 yr. |
| | seasoned | lube oil only | 98 pressure | 7.60 | 86% in 19 yr. | 16 yr. |
| | seasoned | lignite creosote | 98 pressure | 6.30 | 33% in 19 yr. | 23 yr. |
| | seasoned | penta 5%—oil 95% | 98 pressure | 6.70 | 1% in 19 yr. | over 25 yr. |
| | seasoned | penta 3%—oil 97% | 94 pressure | 6.40 | 3% in 19 yr. | over 25 yr. |
| seasoned | zinc chloride | 98 pressure | 0.94 | 26% in 19 yr. | 24 yr. | |

¹Lb. preservative retained is measured for the salt only of the water-type preservatives and for the oil and preservative of the oil types.

²Estimated service life for untreated sapwood posts of most species is 2 to 3 yr. in East Texas and Mississippi, and 4 to 6 yr. in West Texas.

³These borate-treated posts were not sealed at butts, and posts which were less than 2½ to 3 in. in diameter (about 40) failed at ground ends in the 8th year due to termites. Posts over 3 in.

in diameter were sound in the 9th year; posts 4 in. or larger are estimated to last at least 15 years.

⁴Sealing the ground ends of borate-treated, bark-seasoned posts with CZC or lube oil prevents leaching and gives the longest protection against decay, insects and burning at the least cost for treatments. The CZC sealer retards fire most effectively. Borate-treated posts should be sealed up to 6 inches above ground; above this point, the borate alone will be effective, except that the top end should be painted to prevent end-leaching.

REFERENCES

Most of the following publications on non-pressure treatments for wood are available free of charge from the agencies which issued them:

U. S. Forest Products Laboratory, Madison 5, Wisconsin

- R 1955 How To Treat Fence Posts by Double Diffusion
- R 1158 Tire Tube Method of Fence Post Treatment.
- R 621 Preservation of Timber by the Steeping Process.
- R 154 Methods of Applying Wood Preservatives.
- R 1468 Selecting a Suitable Method for Treating Fence Posts.
- R 1445 Treating Wood in Pentachlorophenol Solutions by the Cold-Soaking Method.
- R 761 Preservative Treatment and Staining of Shingles.
- R 919 Preservative Treatment of Window Sash and Other Millwork.
- R 149 Wood Preservatives.
- R 1757 Comparison of Wood Preservatives in Mississippi Post Study (a report each year).
- D 1730 Bark-Peeling Machines and Methods.
- Unnumbered, Permeability of Southern Pine as Affected by Mold and Other Fungus Infection.

Other information available from the U. S. Forest Products Laboratory:

Pressure Treating; Celcure; The Osmose Process; Painting; Fire Retarding Treatments; Wood Seasoning; Preservative Producers and Dealers; Designers or Builders of Treating Plants; Suppliers of Equipment; etc.

U. S. Department of Agriculture

Farmers' Bulletin 2049, Preservative Treatment of Fence Posts and Farm Timbers. (Division of Publications, Office of Information, U. S. Department of Agriculture, Washington 25, D. C.)

Farmers' Bulletin 1911, Preventing Damage to Buildings by Subterranean Termites and Their Control. (For sale: Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.)

Tennessee Valley Authority, Division of Forestry Relations, Norris, Tennessee. (These publications are unnumbered.)

Fence Post Treating.

A Tight Chain Post Peeler. (Includes plans for building.)

A Portable Drum Post Peeler. (Includes plans for building.)

Design and Operation of Open-Tank Treating Plants, Peeling and Treating Bark Seasoned Posts.

Texas Forest Service, College Station, Texas

Circular 34, Cold-Soaking Southern Pine Posts with Pentachlorophenol Fuel Oil Solutions.

Technical Report No. 6, Cold-Soaking Loblolly and Shortleaf Pine Fence Posts with Pentachlorophenol.

Connecticut Agricultural Experiment Station, New Haven 4, Conn.

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Georgia Agricultural Experiment Station, Athens, Georgia

Bulletin N. S. 10, Fence Posts for Piedmont Farms.

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