RAILWAY TIES

TREATING PLANT OPERATIONS AND PRESERVATION

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Regardless of the species of wood used for crossties or the quality of wood in the crosstie, it is necessary that the crosstie be seasoned properly prior to treatment and then well treated if it is going to give good service life in track. The purpose of seasoning the tie is not only to reduce the moisture content so that good penetration of preservative can be obtained when the tie is subsequently treated. It is equally important to develop the checks that would otherwise occur in service and which would penetrate through the treated zone thereby opening up untreated wood to potential attack by decay organisms.

The objective of treatment is also two-fold. First, it is desirable to penetrate the wood as deeply as possible from the end, the side surfaces and the surfaces of the checks that formed during seasoning. Wherever there is penetration there is long-term protection against decay. Secondly, using a heavy bodied preservative such as creosote or creosote admixed with coal tar or heavy petroleum oil, considerable protection against weather is obtained. If the rate at which the surface of the tie absorbs and desorbs moisture during both inclement and good weather is reduced, the possibility of the tie developing seasoning checks in service is also reduced. That is why a heavy concentration of creosote preservative close to or on the surface of the tie is beneficial.

Before the crosstie can be seasoned and then treated, however, it must first be handled through the receiving station at the tie plant. Received at the plant either in rail cars or trucks, the ties are unloaded onto a breakdown table where they are passed one by one through double end trim saws.

The ties then move past the inspection station designed so that the inspector can see all four sides of the tie and both ends. He grades the tie on the basis of the size and quality of the wood, then pushes the proper programming button to move the tie to the particular bay set aside for that grade and species of tie.

If the ties are to be incised prior to treatment, they then are sent to the incising machine. Incising gum and other hardwood ties prior to seasoning is very beneficial because it prevents the development of deep, long checks in a tie both during seasoning and after installation in track. The incising knife marks function to let the surface of the tie act somewhat as an accordian bellows as the tie seasons and changes dimension.

Thus, the magnitude of stresses which develop during changes in moisture content are controlled.

After sorting and/or incising the ties are ready for seasoning.

There are four processes commonly used to season crossties. These are: (1) Air Seasoning, (2) Kiln Drying, (3) Vapor Drying and (4) Boultonizing. Each has its advantages and disadvantages.

AIR SEASONING

Air seasoning is the time-honored method of seasoning crossties prior to treatment. The cost of handling, capital equipment requirements and energy requirements are minimal. It is time consuming, however, and when interest rates are high, the method is not necessarily the lowest cost method. Air seasoning does not lend itself to fluctuating demand so common in the past history of the tie market. Leaving the grading skids or the incising machine the crossties are stacked into air seasoning units or ricks. A rick will consist of approximately 45 to 55 ties. Each tie in a layer is separated from the tie on either side by an air space of about 2 inches. Each layer is separated from adjacent layers by forming a zig zag, "V" type of layering commonly referred to as the German Stacking Pattern or by 2x2 or 2x4 inch spacers.

The ricks are then carried to the seasoning yard where they are stacked in tiers for air seasoning.

The ties are air-seasoned for various periods of time, depending on species, seasoning yard conditions, the time of year they go into stack, the ability of the species to withstand decay, and lastly, the history of past practices.

Frequently, a railroad will designate or specify a time period for a given species to be air seasoned and may determine the moisture content of the ties after that period of time has elapsed. When a time period for seasoning is specified, it is general practice to air season oak ties 12 months, whether they went into stack in September or January, and in this period of time the moisture content will have dropped from an initial level of approximately 80% to an average of 45 to 50%. The outer inch of wood, however, will be at a much lower moisture content than the center.

Gum, and some of the hardwood ties will season to a moisture content of 35 to 40% in as little as 4 to 5 months. In the south, it is dangerous to hold these species for a longer air seasoning period because they have little resistance to decay.

Rather than specifying a required seasoning period for a given species of crossties, it is better practice to specify the moisture content which the ties must season to, before the seasoning period can be considered complete. This results in maintaining crosstie inventories at the lowest level and at the present carrying rates for interest, this concept is not only better technically but also economically. American Wood Preservers Association Standard C-6 contains a tabulation of the moisture content to which crossties should be seasoned before treatment.

Following the air seasoning period, the ties are moved to the tramming station and prepared for treatment. At this time, ties can be selectively doweled as a means of controlling future checking and splitting. Or anti-checking devices, such as nail plates, can be driven into the tie ends for similar control.

The ties also may be passed through the boring and adzing station. At this time, crossties may be bored either for the tie plate pattern or for a penetration pattern. Occasionally ties are both bored and adzed.

Softwood ties such as Douglas fir may be incised at this point. Incising knives penetrate into the wood a distance of 3/4". Each tooth mark serves as an entry point for preservative during subsequent pressure treatment. As mentioned previously this process is also used, prior to seasoning, to alleviate checking in some species of hardwood ties.

KILN DRYING

Kiln drying while not the most common method for seasoning crossties prior to treatment is nevertheless a very effective way. As with other artificial methods, its use must be restricted to drying ties which have not been partially air seasoned. Otherwise serious checking is apt to occur which will impair the quality of the tie. Kiln drying is generally restricted to drying the gums and other hardwoods rather than the oaks which dry much more slowly.

Ties to be kiln dried are loaded into ricks such that each tie on a layer is separated from adjacent ties by a space of about 2 inches. Each layer is separated from adjacent layers using nominal 2x2's or 2x4's.

The ricks are loaded to flat bedded kiln trams such that when loaded to the kiln the length of the ties are parallel to the length of the kiln, although there is no reason why this must be a hard and fast rule. During the drying a forced air draft circulates from the heating plenum through the layers of ties being dried and then back to the heating plenum.

The temperature of the air entering the load is maintained at approximately 230°F. As it passes over the load it transfers some of its heat to the ties and to the water which is being evaporated. As such, a temperature drop of 10 to 15°F might occur in the single pass during the early stages of drying.

When kiln drying, it is desirable to maintain a good rate of air flow through the layers of ties. A minimum of 250 feet per minute will dry gum ties to 35 percent moisture content in 4 to 5 days. Some kilns constructed in the last 5 to 8 years, however, can develop air speeds of 800 to 1200 feet per minute and this results in greater turbulence, better heat transfer, and consequently shorter drying times.

During the kiln drying, some of the circulating air must be spilled to the atmosphere and replaced with fresh air in order to discharge the moisture picked up from the charge being dried. Thus, the process does develop waste heat which is not recoverable. Therefore, the process is somewhat energy intensive as well as capital intensive.

VAPOR DRYING

The vapor drying process for artifically drying ties was introduced by the Taylor-Colquitt Company shortly after World War II. Invented by Dr. Monie Hudson, it was received with considerable interest but at best with mild acceptance because "everyone" knew that such a severe drying cycle would surely degrade the ties to the extent that they would not be serviceable.

Dr. Hudson was perhaps the first to develop the concept that if ties were to be successfully dried at high temperatures they had to be processed without previous air seasoning. The concept applies not only to the vapor drying process but to any lumber or timber dried by any other high temperature, rapid drying method.

When ties are to be vapor dried, they are loaded to the treating trams immediately following grading and separation into species. Each layer of ties on the tram is separated from adjacent layers by at least 2 stickers, 3/8" thick or thicker. Provision is not made for separating ties on a layer but on the other hand, ties are not placed in a layer as tightly as they might be.

Core samples, for use in determining an estimate of the moisture content of the ties before seasoning, should be taken at this time. This information is subsequently used to calculate the amount of water that must be removed from the ties during the drying operation to reduce the moisture content to a specified level.

As an alternate to making this calculation, some plants will substitute experience and arbitrarily make the decision to remove a given quantity of water per cubic foot being treated.

After the trams of ties are charged into the cylinder, a vacuum is drawn to discharge a portion of the air in the cylinder and the vacuum is then broken with live steam. This is a precaution against fire.

Sufficient vapor drying solvent is introduced to a level approaching the level of the tram rails in the cylinder. A good solvent is one that has a boiling range between 260°F and 300°F. Crude xylene having a boiling point of about 280°F is ideal not only because of the boiling point but also because it is aromatic, as is creosote, and thus does not tend to sludge when contaminated with creosote. Unfortunately, xylene is one of the more expensive solvents available for a vapor drying operation and thus some plants substitute a

VM&P naphtha type solvent having a suitable boiling range.

As soon as the required amount of solvent has been transferred to the cylinder, steam is turned into the heating coils and the solvent is brought to a boil. As the vapors from the solvent contact the cold ties, they condense, transferring a portion of the heat to the ties. The condensed liquid falls back into the boiling bath. Gradually, the temperature of the ties is brought up to 212°F and water starts to vaporize from the ties. When the temperature at the top of the cylinder reaches 240°F the vapor valve is opened and the mixture of solvent vapor and water vapor moves to a condenser and then to a separator. This occurs after about 2 to 2-1/2 hours of heating. The solvent condensate collected in the separator is returned to the bottom of the cylinder as make-up solvent. The water condensate collected in the separator is measured and weighed and then transferred to the waste disposal system.

The drying process is continued at a vapor exhaust temperature of 240°F until sufficient water is collected to reduce the moisture content to the desired level, i.e. 50% for oak and 35% or less for hardwood ties. The total time of the drying operation is approximately 11 to 14 hours dependent upon the condition of the ties before processing, the ambient temperature, and the degree of dryness desired.

When the operation is completed, the cylinder is emptied of solvent and a vacuum is then drawn. This vaporizes additional moisture from the ties and also some of the vapor drying solvent which was absorbed in the ties during the active drying operation. The ties are then ready for treatment.

The vapor drying process is also somewhat energy intensive. For every pound of water that is evaporated, approximately 10 lbs. of solvent must be vaporized. The heat of vaporization of the solvent is such that for every Btu required to vaporize water, approximately 1 Btu is required to vaporize the solvent. Thus, the process might be said to be 50% efficient.

One major advantage of the process is that immediately following drying, the ties are available for treating. Because they are hot, they take treatment readily. Penetration of creosote is generally deeper than is obtained in air seasoned ties. To obtain the utmost in treatment, consideration needs to be given to specifying increased retention for vapor dried ties so that the processor is able to use that oil which is needed to obtain the increased penetration.

The cost of a vapor drying plant is considerably more than a conventional wood treating plant because of the increased tankage required and the oversized condensers, separators, and steam generators. For this reason, some processors will try to conduct vapor drying operations in two cylinders and then transfer the ties following drying to a third cylinder for treating. This is a sound economical practice but it is desirable to schedule the treatment and drying such that the transfer is made from one cylinder to the next with only a minimal time delay so that the ties will not lose their heat.

BOULTONIZING

The Boultonizing process for seasoning wood commodities was invented by Sir Samuel Boulton of England in the late 1800's. As the Boultonizing 'art' was practiced for oak and hardwood crossties up through the 1960's, it was the most misused of all of the artificial seasoning methods. Most often, it has been used in the past to process partially air seasoned ties, and this, of course, resulted in severe checking and splitting when proper drying was accomplished. Furthermore, in times past, it was not the practice to separate the layers of ties on trams and as such it was impossible for the hot creosote to reach most of the surfaces of the ties. Only the outside ties and the ends of other ties on the trams received appreciable drying. Thus, many ties on the trams did not receive proper treatment following the seasoning and gave short service life.

When a tie is Boultonized properly, it will have low moisture content and good treatment. It will provide service life equal to that of a vapor dried tie.

The ties to be Boultonized should be loaded to trams in exactly the same manner as are vapor dried ties, i.e. every layer should be separated from adjacent layers by 2 or more stickers at least 3/8" thick. After the cylinder is charged, hot creosote is pumped in until the tops of the ties on the trams are covered. Most cylinders that are used for Boultonizing are equipped with expansion tanks for creosote. These are mounted above the cylinder. When such are available, it is the practice to merely fill the treating cylinder and this assures coverage of the ties.

The next two steps are conducted more or less simultaneously. A vacuum of 20 inches mercury or greater is pulled on the cylinder and steam is turned into the heating coils or to an external heat exchanger to bring the creosote oil up to the Boultonizing temperature as rapidly as possible.

As the hot creosote oil transfers some of its heat to the ties, the temperature of the ties increases to the boiling point of water and the moisture in the ties begins to vaporize. This vapor passes up through the creosote bath and into the vacuum line to a condesner. The condensed water is collected in a measuring tank which is periodically emptied to the waste water treating plant.

The Boultonizing period is continued until the total water collected, predetermined as when vapor drying, is sufficient to reduce the moisture content to the desired level. Generally, the Boultonizing time will exceed that required for vapor drying. Twenty to twenty-four hours may be required to Boultonize oak crossties.

Following the Boultonizing, it is normal to empty the cylinder of oil and draw a short vacuum. This will evaporate additional moisture. The ties are then ready for pressure treatment.

In the past, the practice was to use relatively mild Boultonizing temperatures such as 175°F to 180°F. The low temperatures were used in an effort to control degrade which in fact was actually being caused by the practice of Boultonizing partially seasoned, prechecked ties. Experience today has indicated that Boultonizing temperatures as high as 230°F can be used successfully when ties have not had prior air seasoning. Naphthalene vapors from the creosote tend to plug the condenser tubes when too high a temperature is used, however, and thus Boultonizing temperatures are more often limited to 200° to 210°F.

It should be pointed out that regardless of the temperature of the oil during the Boultonizing process or during vapor drying for that matter, the temperature of the crosstie is only that of evaporating water. At a vacuum of 20" mercury, the boiling point of water is 161°F and this will be a close approximation to the temperature of the ties during such an operation.

A Boultonized tie has the same treatability as a vapor dried tie. The tie is preheated and the creosote can penetrate it quite easily in comparison to an air seasoned tie. The process is the least energy intensive of any of the artificial seasoning processes inasmuch as the only waste heat is that contained in the water vaporized from the ties. The system is also the least capital intensive.

Thus the Boultonizing process has much in its favor as compared to vapor drying or kiln drying.

In summary, each of the four methods of seasoning crossties prior to pressure treatment have pluses and minuses.

Air seasoning results in probably the lowest direct cost method but when interest rates are high, it might not result in the lowest cost tie. Its major disadvantage is that the ties are pressure treated without any preheating and thus the air seasoned tie might end up with the poorest treatment. This is particularly true when ties are processed in the winter time.

Kiln drying is a practical method of drying hardwood ties prior to treatment. It is a high cost process and thus it undoubtedly will never become widely used.

Vapor drying is the first of the accelerated seasoning methods to receive wide acceptance by the major railroads of the country. It is, however, both capital and energy intensive. It results in a well treated tie because the ties are hot before the pressure treating phase begins.

Boultonizing has the same advantages as vapor drying, but is less capital and energy intensive. Certain preconceived ideas regarding Boultonizing must be overcome, however, and modern concepts of processing the ties must be substituted. Boultonizing, properly conducted, results in a seasoned tie that takes treatment as well as a vapor dried tie.

PRESSURE TREATMENT

Regardless of whether an air-seasoned or an accelerated seasoning method has been used, the basic process used for pressure impregnating the ties is the same.

Before discussing the process, however, a few words on preservative selection is in order. There are three basic preservatives used to process crossties. These are creosote, mixtures of creosote and coal tar, or more accurately blended coal tar distillates having the same properties as mixtures of creosote and coal tar, and mixtures of creosote and heavy #6 type petroleums. The creosote coal tar and the creosote petroleum solution have more "body" to them than a straight creosote distillate and at the same time have suitably low viscosity at the treating temperature of about 200°F that good penetration into the wood can be obtained. Therefore they are the preferred preservatives. While some heavy petroleum oils provide preservative protection this factor is generally discounted in the creosote/petroleum mixes. As such, some railroads will specify heavier retention when using this preservative.

While the industry does use pentachlorophenol solutions in #2 fuel oil and waterborne preservatives such as chromated copper arsenate for the treatment of other commodities, it is uncommon to use these preservatives for the treatment of crossties. Number 2 fuel oil is not sufficiently heavy bodied to provide good weather resistance to the surface of the tie and heavier petroleum solvents have viscosities much too high to obtain good penetration using normal treating cycles. The waterbornes naturally do not give good weather protection and for some reason they often seem to cause degrading of some of the hardwood species.

Charges of crossties are always treated using, what the industry labels as an empty cell cycle. After the cylinder is charged with 500 to 750 ties, loaded on trams, and the cylinder door is sealed, the air pressure in the cylinder is increased to a level of 25 pounds per sq. in. up to 60 to 70 pounds per sq. in. depending upon the species being treated. This air not only fills the space surrounding the crossties but also enters into the wood and fills the cell cavities within the wood structure.

By holding the initial air pressure on the cylinder when preservative is pumped into the cylinder, the air is trapped in the cell cavities.

After the cylinder is filled with the preservative, additional solution is pumped into the cylinder to increase the pressure to a level of 150 to 200 pounds per sq. in. There is only one place for this additional preservative to go, and that is into the wood cells. The pressure is maintained at the maximum pressure level for a period of 4 to 6 hours until the desired injection of preservative into the wood is achieved. The pressure should be maintained on the charge of ties until flow to the cylinder has practically ceased. This assures the most complete penetration into the wood. There are some users of crossties who, in an effort to reduce preservative costs, specify retention levels that are so low that the treating operator must cut his pressure cycle short to avoid using more preservative than specified. Thus, the maximum injection and maximum penetration in crossties is not realized. This is an error to be avoided.

After the pressure phase of the cycle is completed, the preservative in the cylinder is returned to the supply tank. A vacuum is then drawn on the cylinder for 30 minutes to an hour. As the pressure in the cylinder is reduced from 150 to 200 pounds down to the vacuum level, the air that was originally trapped in the cells of the wood expands and forces some of the excess preservative injected into the ties out of the wood. This leaves the cell walls coated with preservative rather than leaving each cell cavity filled with preservative.

Following the vacuum period, the drips are recovered and returned to the supply tank. The treating cycle is finished.

The amount of air pressure initially applied to the cylinder plays an important part in controlling the final retention of preservative in the ties. The greater the initial air pressure the greater will be the amount of preservative that is kicked out during the pressure reduction and final vacuum phases of the cycle. As a normal practice the initial air pressure will be adjusted so that the final net retention in the charge will amount to 7 pounds preservative per cubic foot of wood in oak crossties and 9 to 11 pounds per cubic foot of wood in the gum and some of the other hardwood crossties.

It takes a minimum of 6 hours to treat a charge of air seasoned ties. It is better to use a longer cycle in the winter time to allow the ties to be heated during the impregnation period. This will help keep the preservative oil thin which aids penetration.

Once treating is completed, the cylinder door is opened and the charge pulled from the treating cylinder. It is then ready for inspection, loading, and shipment to the use site.

If proper attention has been paid to the production, the seasoning, and the treatment, the ties are then good for 25 years or more of service.