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Wood Preservative Treatments for Crossties and Potential Future Treatments

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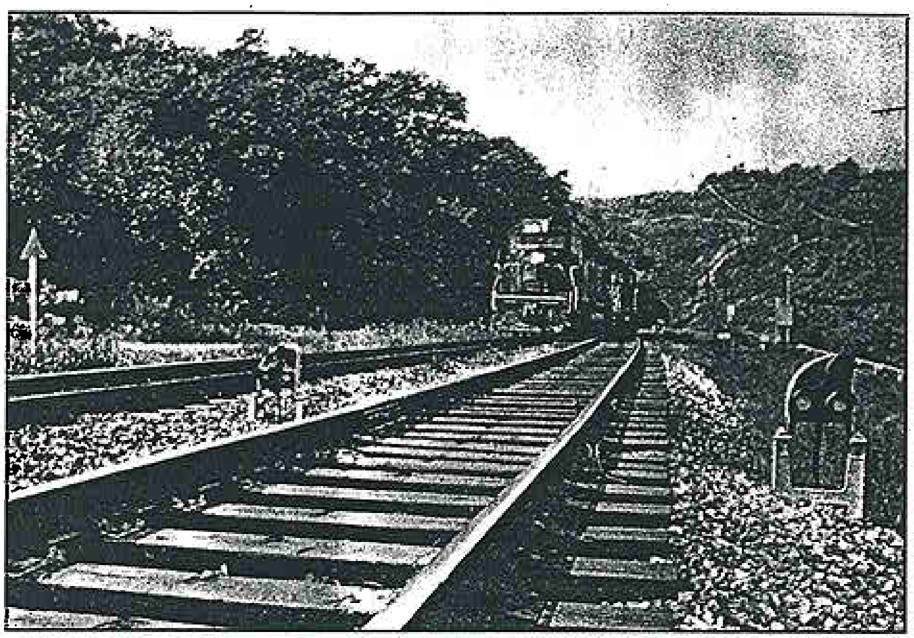
Abstract

This paper describes the current type of creosote treatments and recent American Wood Preservers' Association (AWAP) Standard changes for creosote which are used in the treatment of wood crossties. The origin of creosote and its historical use as a wood preservative and its excellent serviceability with hardwood timbers, which are used as crossties, are also described. Information is also given concerning the Environmental Protection Agency's (EPA) deliberation concerning the reregistration of creosote as a wood preservative. And finally, there is a look at potential new wood preservatives and systems to enhance the performance and serviceability of the wood crosstie.



Creosote treated wood crossties are the major support system that is used to maintain rail gauge on Class 1 railroads.

Introduction

Wood preservatives in the United States had their first application in the treatment of wood for crosstie material for use by the railroads. This paper will discuss the preservatives and methods that have been used to treat this wood product -- the crosstie. Prior to initiating this discussion, it is important that historical information be provided concerning the use of crossties and the wood preservative chemicals that were used to treat them.

This country has had an abundance of timber resource for construction materials. As a result, even though the railroads initially experimented with other materials such as stone and steel, they ultimately decided to use wood to fasten the rails and maintain gauge for the track system. Initially the type of wood which was used was cypress, walnut or chestnut. Towards the end of the 19th century the supply of these naturally durable timbers decreased, and it became necessary to use nondurable woods, such as red oak, and treat them with a preservative. If not treated, the service life of red oak is estimated to be about five years; when treated with a preservative, such as creosote, the expected service life would be increased sixfold. There are also many other nondurable woods which can serve very adequately as crosstie material. These include, for example, the maples, birch, beech, the gums, Douglas fir and southern pines, to name just a few. It also must be considered that with any wood species, including durable woods, the sapwood does not have any durability and must be treated with preservative. White oak is an example of a decay resistant timber which must have its sapwood treated to give maximum serviceability.

It is important to note that through the use of wood preservative treatments, nondurable woods have significantly increased the available supply of timber for crosstie material. Some of these woods have superior mechanical properties but otherwise would not be acceptable as crosstie material. Through the use of wood preservatives, not only in the area of crosstie treatment, but utility poles, lumber and timber piling products, there has been a significant reduction in the drain of our timber resource material. The use of preservatives in the United States on an annual basis saves 220 million trees. The approximate savings would be $6 billion per year. At the same time, this wise use of a renewable resource -- wood, and best forest management selective cutting practices contribute to a "healthy" forest. On an annual basis forests release 9 million tons of oxygen and consume 6 million tons of carbon dioxide which would be a favorable condition for reducing the so-called "greenhouse" effect on the earth's atmosphere.

Treatment of Crossties

The type of preservative used during those early years of treating wood crossties was creosote. In fact the first wood preservative treatment in the United States was for railroad crossties using creosote

American Wood-Preservers' Association Standard

P2-89
Standard for Creosote Solution

1. The material shall be a pure coal tar product derived entirely from tar produced by the carbonization of bituminous coal. It may either be a coal tar distillate or a solution of coal tar in coal tar distillate.

2. The new material and the material in use in treating operations shall conform to the following detailed requirements.

	New Material		Material in Use	
	Not Less Than	Not More Than	Not Less Than	Not More Than
2.1 Water, % by Volume	—	1.5	—	3.0
2.2 Matter Insoluble in Xylene, % by wt.	—	3.5	—	4.5
2.3 Coke Residue, % by wt.	—	9.0	—	10.0
2.4 Specific Gravity at 38C Compared to water at 15.5C.				
2.41 Whole Creosote	1.08	1.13	1.08	1.13
2.42 Fraction 235-315C	1.025	—	1.025	—
2.43 Fraction 315-355C	1.085	—	1.085	—
2.5 Distillation: The distillate, % by wt. on a water free basis, shall be within the following limits:				
2.51 Up to 210C	—	5	—	5
2.52 Up to 235C	—	25	—	25
2.53 Up to 315C	32	—	32	—
2.54 Up to 355C	52	—	52	—

3.0 Tests to establish conformance with the foregoing requirements shall be made in accordance with the standard methods of the American Wood Preservers' Association. (See Standard A1)

P3-67
Standard for Creosote-Petroleum Oil Solution

Creosote-petroleum oil solution shall consist solely of specified proportions of coal tar creosote which meets AWPA Standard P1 and of petroleum oil which meets AWPA Standard P4. No creosote-petroleum oil solution shall contain less than 50 percent by volume of such creosote or more than 50 percent by volume of such petroleum oil.*

*Owing to the lack of suitable methods of analysis, it is not possible to determine the relative amounts of either component once these materials have been blended. The purchaser may, therefore, wish to consider obtaining the materials separately and having them blended under his supervision.

P4-86
Standard for Petroleum Oil for Blending with Creosote

Petroleum oil for blending with creosote (Standard P1) shall conform to the following requirements:

1. Specific gravity.*—Specific gravity at 60F/60F not less than 0.96** (not greater than 15.9°, API) ASTM, Standard D 287.
2. Water and Sediment. — Water and sediment (BS&W) not more than 1 percent. ASTM Standard D 96.
3. Flash Point. — Flash point not less than 175 deg.F, as determined by the Pensky-Martens closed tester. ASTM Standard D 93.
4. Viscosity. — The viscosity shall be expressed as Kinematic vis. cSt at 210F by ASTM D 445. It shall not be less than 4.2; nor more than 10.2. Oils of higher viscosity may be used, provided the penetration requirements are met. The purchaser may specify the viscosity best suited to his requirements, allowing the supplier a tolerance of plus or minus 10 percent of the valued specified (Equivalent vis. SUS at 210F shall be 40 min. to 60 max by ASTM D 88).
5. Each of the foregoing determinations shall be made in accordance with the ASTM method currently in effect. The ASTM Standards referred to herein may be obtained from the American Society for Testing Materials, 1916 Race Street, Philadelphia, PA 19103.

*To convert the specific gravity of Group 0 petroleum oils at 60F/60F to specific gravity at 38C/15.5C subtract 0.0140. For Group 1 oils subtract 0.0162. Group 0 oils are those whose specific gravities at 60F/60F are not less than 0.9665. Group 1 oils are those whose specific gravities at 60F/60F are not less than 0.8504 and not over 0.9664.

**Petroleum oil of lower specific gravity may be used provided experience or test shows that it may be blended with creosote without the formation of excessive sludge.

in the Bethel full-cell pressure process in a plant at Somerset, Massachusetts, in 1865. In order to economize on the amount of creosote preservative used to treat wood, two other types of pressure processes (empty-call treatment) were developed. These creosote treatments used atmospheric, or "an initial air pressure," to reduce the amount of creosote injected into the wood. These two processes were known respectively as the Rueping and Lowry processes. When compared to the Bethel process, they retain a significantly smaller amount of creosote during the treatment of crossties.

Creosote and its solutions with coal tar and petroleum can be considered the oldest of the commercial preservatives that are used to treat wood. Over 99% of all crosstie and switchtie material is treated with creosote solutions. The other two types of preservatives, pentachlorophenol and the waterborne arsenicals, are not significant factors in the treatment of crosstie material. In the AWPA Standard C6 for crossties, pentachlorophenol in a petroleum solution meeting the requirements of Standard P9 for heavy solvent is permitted. However, the waterborne arsenical preservatives are not permitted according to the C6 Standard for use in the treatment of crosstie material. Essentially, it is considered that a certain degree of "weather protection" is provided by a creosote and/or oil type treatment. The use of a waterborne arsenical preservative does not offer this protection to crossties. In addition, when treating the oaks and hardwoods, the results of the American Railway Engineering Association (AREA) stake test indicate that approximately twice the retention level for softwood species (southern pine) would be necessary to achieve the same service life in hardwood timber (red oak).

Creosote is a distillate by-product of coal tar, which is produced from the high temperature carbonization of bituminous coal. It is a complex mixture of polynuclear aromatic hydrocarbons (PAH) of which 18 compounds are present in the quantity greater than approximately 1%. Thus, these compounds in creosote come from coal which was originally formed from plant material such as trees, ferns and other green plants. Some of these PAH compounds that are found in coal and creosote are constituents of concern in drinking water supplies. For example, one of these compounds is benzo-a-pyrene (BAP) which is essentially ubiquitous in our environment. BAP is synthesized by plants; e.g., soybeans during their germination and growth. Also BAP is a universal constituent of combustion. These above comments concerning compounds in creosote will be brought more into focus during a later discussion in this paper concerning creosote, its uses and environmental effects.

The guidelines for the treatment of crossties and switchties using the wood preservative chemicals are given in the American Wood-Preservers' Association (AWPA) Book of Standards. With respect to the creosote that is generally used for treatment of crossties, there has recently been a change (1989) in the AWPA Book of Standards for the creosote treating solution. The Standard for Creosote Solution, P2, formerly contained the physical property description of four different types of creosote solutions that were designated as Type A, B, C and D. In 1989 the P2 Standard was changed to include only one type of creosote solution. The physical property characteristics of this material very closely resemble the type of material which was formerly designated as Type C (60/40). (Note attached AWPA Standards P2, P3 and P4.)

This change in the P2 Standard occurred, basically, because of economic reasons. The use patterns for the previous four types of creosote solution materials indicate that well over 85% of the creosote solution being used to treat crossties was Type C (60/40). With the pending Environmental Protection Agency (EPA) "Data Call-In" request for new information concerning creosote and its solutions, the decision was made by the creosote suppliers to reduce the number of registered creosote products. One can appreciate this action with respect to the economics concerning (1) the cost of developing information to satisfy the EPA "Data Call-In" request, and (2) the expense of "carrying" inventories of creosote solutions that may have a limited use in the marketplace.

The excellent performance of creosote solutions for use in the treatment of crossties has been documented in the AWPA Proceedings, AREA reports and studies conducted by the United States Forest Products Laboratory in Madison, Wisconsin. For the most part these field tests have been conducted with small wood samples (3/4-inch stakes and 2x4 stakes) although the cooperative creosote test (1958) used southern pine post material. Several of the major Class 1 railroads have also conducted full-size crosstie tests within their own track system. It is generally considered that the average service life for creosote treated crossties has been reported to be 30 years. There are, however, instances when tie life will be reduced because of mechanical wear from high tonnage loadings on the track.

The general requirements for the treatment of railroad crossties and switchties are given in the AWPA C1 Standard. The specific requirements for treatment are given within the AWPA C6 Standard. The parameters and guidelines which are given in C6 focus on the areas of processing, conditioning methods and the results of treatment which include penetration and retention of preservative. It should be noted that this Commodity Standard (C6) is the only Standard within the AWPA Book of Standards which does not require an assay retention. The quality of treatment for the materials produced under the C6 Standard are according to "gauge" retentions. It should, however, be pointed out that various railroads do take an increment boring sample for penetration and often will analyze for creosote retention.

Crossties and the Environment

In January of 1986 the EPA concluded its 10-year review of the three major wood preservatives including creosote and its solutions. This process was known as the Rebuttable Presumption Against Reregistration (RPAR). With the conclusion of this review process (RPAR), the three major wood preservatives, including creosote, have been classified as "restricted use" which means that a certified licensed applicator directs or supervises the use of preservative chemicals in the treatment of wood products. The term, restricted use, needs to be further clarified. One should not appear "cavalier"; however, these restrictions that have been placed on creosote were, for the most part, not all that restrictive. To further elaborate, a certified applicator must be knowledgeable and aware of the protective clothing and procedures to follow in applying the wood preservative creosote. These directions for the use of the wood preservative are clearly stated on the label for creosote.

Creosote is a pesticide; however, treated wood is not. The creosote treated wood product, in this case crossties, is not regulated by EPA. The treated wood is currently exempt from Federal Insecticide, Fungicide, Rodenticide Act (FIFRA) and Resource Conservation Recovery Act (RCRA) regulations. EPA, in a 1980 letter to the Association of American Railroads (AAR), indicated that spent crosstie material would not be considered as a hazardous waste. It is important, however, to note that even though current EPA regulations do not consider treated wood products to be hazardous waste materials, there are individual state and local municipalities which may have specific guidelines for the disposal of spent crosstie material. The specific EPA recommendation for disposal of treated wood is "that disposal be by ordinary trash collection or burial." Thus, creosote treated crossties may be placed in landfills.

Within this area of concern about federal EPA regulations, it can be expected that there will be continued evolution. The EPA has recently proposed new requirements for the wood treating plant operations that could affect the overall facility cost of treating plants. The wood treating industry has responded to these proposed regulations indicating that there will be substantial costs which are not necessary. The wood industry has made significant steps towards more responsible management of its wood treating facilities from an environmental viewpoint.

Creosote treating solutions, for the most part, are contained and recycled to minimize the generation of waste materials. Improved housekeeping procedures have been implemented. Many of the crosstie treating plants have already put in place impermeable process areas (drip pads). The process waters and their effluents are being treated, recycled and discharged in accordance with federal and local regulations.

An excellent summary of the regulations affecting the treating industry was presented in the May/June 1990 issue of *Crossties* magazine. The article is entitled, "Regulation and the Future of the Wood Preserving Industry," by Victor Lindeheim and Jeffrey H. Bull. The paper provides a descriptive review of the environmental regulations affecting the wood preserving industry in the United States. This paper should be recommended reading for anyone involved in the crosstie industry.

New Crosstie Preservative Treating Systems

When a new wood preservative chemical is considered for use in treating wood crosstie material, there are several significant items which must be taken into account.

† A new wood preservative must demonstrate the efficacy of performance as a crosstie material through a series of evaluations for ground contact preservatives. The description of these tests is given in the AWPA guidelines for "new preservatives." The performance of these tests can be very time consuming -- six to eight years to complete the tests.

† A new wood preservative should be compatible with existing treating plant operations.

† This new wood preservative must also be cost competitive and be acceptable to the users of railroad crossties.

† And finally, a most important item -- the preservative chemical must be registered with the EPA as a pesticide. This registration would be in accordance with FIFRA. In order to obtain a registration, it is necessary to conduct various toxicity tests, as well as environmental fate studies, which may be designated by EPA. The cost of developing the required data for a new preservative can be significant.

These above four statements concerning the development of new wood preservatives need to have further clarification. As previously stated, it must be considered for the most part the average crosstie service life is estimated to be 30 years. Thus, there are three major reasons to develop new wood preservatives for treatment of crossties.

† Ideally, a new preservative would have less environmental concern as compared to the major preservatives which are used currently to treat wood.

† A less expensive preservative as compared to creosote.

† A new preservative system or the use of mechanical devices and fastening systems which would improve the service performance of creosote crossties.

It must be considered that even though a less toxic preservative is desired by the user of treated wood products, this preservative will be regulated under FIFRA by EPA. It's the author's opinion that it probably would become a restricted use pesticide. The EPA is essentially in the business of regulation and will not relinquish its control over the preservative materials which are used to treat wood products such as crossties. However, this does not mean that the wood preserving industry will not continue to look for new wood preservative treatments. On the contrary, the industry will always continue to search for new wood treatments which will provide its customers with improvements.

Creosote and its solutions have all been thoroughly evaluated and reapproved by EPA to be registered for use in the treatment of crossties. The likelihood of a completely new preservative being used for the treatment of crossties is minimal. The use of borates in conjunction with creosote may enhance the performance of crossties by reducing the possibility of "spike-kill." This is currently being evaluated in a cooperative test between Mississippi State University, the RTA and AAR.

In order to improve service life performance of those crossties which have sustained premature failure by mechanical wear, there are several tests currently being conducted cooperatively between RTA and AAR which should help provide useful information to railroads. These are listed as follows:

† The cooperative study with the Chicago and Northwestern Railroad Company at Des Plaines, IL, for the dowel-laminated crosstie.

† Investigations with the various hardwood species in stake tests being evaluated in cooperation with Mississippi State Forest Products Laboratory.

† Evaluation of the use of wear plates, end plates and dowel-laminated ties at the FAST Test Center in Pueblo, CO.

† Continued investigation with regard to the serviceability of creosote treated wood which was cut into crossties from gypsy moth-killed timber.

Conclusions

Creosote treated crosstie material is exempt from EPA regulations that pertain to pesticides. Once these crossties have completed their useful service life, they can be disposed of in accordance with EPA regulations in a landfill. These spent creosote treated crossties are not considered to be hazardous waste products. Their disposal, however, must conform to state and local regulations. These spent crossties also can be burned and used as a fuel to generate electricity. Creosote is put into crosstie timbers to stay in the wood and does not move or migrate from the treated wood to cause a significant environmental concern. Creosote treated wood crossties can be used safely and without adverse effects on man, animals or the environment. There is no evidence to the contrary! A very thorough evaluation of creosote treated products has occurred in conjunction with the EPA. The industry does understand the sensitivity of environmental issues and will continue to evaluate the impact of treated wood products on the environment.

As with many other chemical products, it is imperative that creosote treated crossties be used and handled with reasonable common sense procedures. Creosote treated crossties have been in use supporting railroad track structures for over 100 years, and it is projected that they will continue in use far into the future. ■

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