CREOSOTE, ITS USE AS A WOOD PRESERVATIVE

In The

RAILROAD TRANSPORTATION INDUSTRY

With

ENVIRONMENTAL CONSIDERATIONS

Prepared By

DAVID A.WEBB

Chairman, Railway Tie Association Research & Development Committee
Administrative Director, Creosote Council II
Past President, American Wood-Preservers' Association

Introduction

The creosote pressure-treated wood crosstie has been the very foundation of the North American railroads for more than 125 years. 'Me use of creosote and its solutions with coal tar and heavy petroleum as a preservative for timber crossties, switch ties and bridge timbers is somewhat unique as compared to other pesticide products. These preservative materials are not broadcast sprayed or otherwise widely distributed over large areas as often occurs with those pesticides applied to field crops.

Creosote preservatives are pressure impregnated into wood materials, such as crossties, inside closed cylinder retorts. The pressure process represents over 99% of all the creosote treated wood products; while less than I% is applied with non-pressure methods.

The use of creosote for the railroad transportation industry represents the major use of this preservative. The latest Wood Preservation Statistics - 1997 as prepared for the American Wood-Preservers' Association (AWPA) provides the following information concerning wood treated with creosote and its solutions; along with the other two major wood preservatives - oilborne and waterborne systems.

Total volume of treated wood based on production reports from a total of 454 plants was 728 million cubic feet

– creosote and its solutions represent a total of 97 million cu. ft. (13.3%) of treated wood products (major use being crossties),

– oilborne preservatives (predominately pentachlorophenol solutions) represent a total of 36 million cu. ft. (4.9%) of treated wood products (major use being utility poles),

– waterborne preservatives (predominately CCA copper chrome arsenic solutions) represent a total of 581 million cu. ft. (79.9%) of treated wood products (major use being lumber & timbers),

Major treated wood products, which accounts for 86% of the total production, were:

– lumber & timbers: 478 million cu.ft. (98% treated with waterborne),

– crossties, switch ties & bridge timbers: 82 million cu.ft. (nearly 100% with creosote),

– utility poles: 64 million cu.ft. (49.5% with oilborne; 35.8% with waterborne; and 14.6% with creosote).

The proceeding information is to enable the reader to focus on the major uses of treated wood products and the three (3) major preservatives that are used by the pressure treating wood industry. It should be considered that the three major preservatives creosote, oilborne (penta) and waterborne arsenicals - are wood preservatives pesticides that are registered under FIFRA (Federal Insecticide Fungicide and Rodenticide Act), which is administered by the United States Environmental Protection Agency (EPA).

Further it is important to note that all preservatives were reregistered in January of 1986 after an extensive eight year review by the EPA, After EPA's careful evaluation of the risks involved when exposure to these wood preservative chemicals occurred, the agency concluded that there would not be a significant risk to the applicator of these preservatives as long as specific label modifications were made. A part of this deliberation took into account the significant economic benefits which result from the use of these wood preservatives.

The reregistation of the preservatives was focused on the chemicals and their uses. There were no restrictions placed on treated wood and its use. Subsequent Data-Call-In efforts by the EPA has focused on what effect, if any, treated wood has on the environment. A similar evaluation of the major three preservatives has been ongoing by the Pest Management Regulatory Agency (PMRA) of Health Canada.

Creosote and Its Use Considerations

A major purpose of this paper is to provide some information concerning the effect of creosote treated wood products on the environment. In addition, however, there are some economic and specific uses for creosote treated wood that need to be given consideration.

The Railway Tie Association (RTA) publishes within their Crossties magazine information which indicates trends for crosstie production, inventory and pricing of lumber and crossties (Figure 1). It should be noted that with an untreated tie priced at $18; cost of treatment with creosote being $9; thus the total cost of a treated crosstie without fasteners would be approaching $30. This information is of use in comparing the relative cost of timber crossties as compared to alternative materials such as concrete, steel and plastic that have been used in special situations as crosstie material. The production and inventory data indicates the trend for supply and demand of crosstie materials.

Within the *Introduction Section* Wood Preservation Statistics prepared for AWPA were sited for the volume of treated wood produced in 1997 for the three major preservatives - creosote, waterborne (CCA) and oilborne (penta) systems.

Also tabulated from the Wood Preservation Statistics Report are data for the volume of creosote treated wood produced for the railroad industry in 1997. In the statistical survey a total of 249 plants responded, which represents 72% of the estimated total volume of creosote treated wood (Table 1).

The information given in Table 2 provides data on the volume of creosote treatment of wood crossties and switch ties. Since 1984 the number of creosote treated crossties has fluctuated, but indicates a trend toward A "mature" market for crossties. As reported in 1997, 75,939M cubic feet (this represents about 19 million crossties) were produced. Of that number, it is estimated that something on the order of 75% of those crossties were used by the Class I Railroads; with the other 25% used by the Shortline Railroads and Construction Companies.

Data given in the two Tables provides information in 1,000 Cubic Feet of treated wood. In addition, the following statements need to be considered when reviewing the information:

The standard crosstie dimension is 7x9 inches in cross-section and eight (8) and one-half feet in length (which gives a total of 3.7 cubic feet per crosstie). There are however, variations as often tie material will be cut to a cross-section of 6x8 inches with a length of nine (9) feet Also the 7x9 inch tie can be nine (9) feet in length. Some of the Class I's will accept a certain percentage of 6x8s, e.g. "not to exceed 10% of the total within the shipment"

Of the three creosote treated products - crossties, switch ties and timbers - their percentage of the market is respectively - 92%, 7% and 1%

Creosote Treated Wood and Its Effect on the Environment

The use of creosote as a wood preservative is well documented within the Proceedings of American Wood-Preservers' Association (AWPA). The development of the wood preserving industry within North America and throughout the world has historically been based on the need to protect nondurable wood species from wood destroying organisms. During the late 19th century, the railroads, which were involved in a vigorous construction program to link the major industrial cities in North America, were using naturally durable timbers such as black locust, cedar, chestnut, and white oak. Ultimately, it was not possible to utilize naturally durable timbers because they simply were not available in sufficient, cost effective, quantities to meet the demand of the railroads.

A similar statement can be made for the potential use within the railroad transportation industry of alternative materials for crossties. These materials include concrete, plastics and steel ties. They must be "cost effective." Concrete crossties are not giving the estimated service life of 50 years, which was promoted by the producing industry. Ties in the North East Corridor are being replaced in some instances after only ten years in-track.

Wood is a renewable resource. It is the only structural material that is renewable. This resource has, for the most part, in North America been managed to sustain itself; it has been renewable. In direct contrast, Continental Europe has not managed its forest resource in a manner to provide wood products. This is the specific reason that concrete crosstie material must be used for the rail systems in Europe. There is not wood available for use as crosstie material.

The use of creosote for preserving wood can be considered the oldest of the three major preservatives that is being used in North America. The treatment of wood railroad crossties with creosote was first initiated with the Bethel full-cell pressure treatment process at the Somerset, Massachusetts plant in 1865. Twelve years later, the Louisville and Nashville Railroad treating plant was built in Pascagoula, Mississippi. Construction of these plants is considered the beginning of the modem pressure treating industry in North America.

The use of creosote as a wood preservative for both pressure and non-pressure processes has been well documented in the AWPA Proceedings. It is not the intent of this brief paper to describe creosote, it's solution and serviceability, however, it is the intent to discuss some of the environmental effects of creosote treated wood products.

It is somewhat ironical that the wood preserving industry has developed significant volumes of information concerning the service-life performance of its treated wood products. However, the industry had not developed, prior to the 1990's, a significant amount of information concerning the environmental effects of creosote treated wood products. The following pre- I 990's information is cited for reference purposes concerning the environmental effects of creosote treated wood:

Von Rumker, et al. (1975), in a report for the United States EPA, stated that the evidence available indicated that the environmental hazards posed by creosote treated products were minimal. They cited reports characterizing the loss of creosote constituents by vaporization from the treated wood as compared to the loss of similar PNA compounds, and in much greater quantities, that occur from pine forests.

Wade, et al. (1987), evaluated water samples taken adjacent to creosote marine piling. Samples of water were taken from the surface sheen, the water column, and the bottom sediment. The water samples were analyzed using two procedures:

– acute toxicity test with sea urchin, *Areachia punctulata,*

– mass spectrophotometric gas chromatography (MSGC) analyses.

The MSGC analyses showed the presence of creosote components in the water surface sheen samples. There was no identifiable compounds found in the water column sample. In addition there was no measurable toxicity in the water column when the sea urchins were exposed.

The movement of creosote components from a treated wood utility pole into the surrounding soil is considered to be negligible. A study conducted at Mississippi State University (1975) found none of the major creosote components in soil samples collected to a depth of six (6) inches and ranging from two (2) to twentyfour (24) inches from the pole. The creosote components either oxidized or biodegraded.

Several other studies support the fact that creosote components are readily biodegradable. These studies included the work by Belast, et al. (1979) and Seeman, et at. (1977) which reported on the biodegradation of creosote/naphthalene treated timber piling. In addition, researchers at the United States Naval Civil Engineering Laboratory specially identified the metabolism of creosote (biodegradation) with certain marine micro-organisms. The research was conducted by Drisko, et al. (1962) and (1966).

Several researchers have summarized the effects of migration and mitigation of preservative from creosote treated wood products in the environment - Davis, et al. (1993), and Lamar and Kirk (1994). The later two researchers summarized the results of many projects and conclude the microbiological treatments may be used as remediation of creosote contaminated soils.

It is also important to consider the ubiquitous nature of creosote components, which often are common and abundant in the soil. Blumer (1961) found isomers

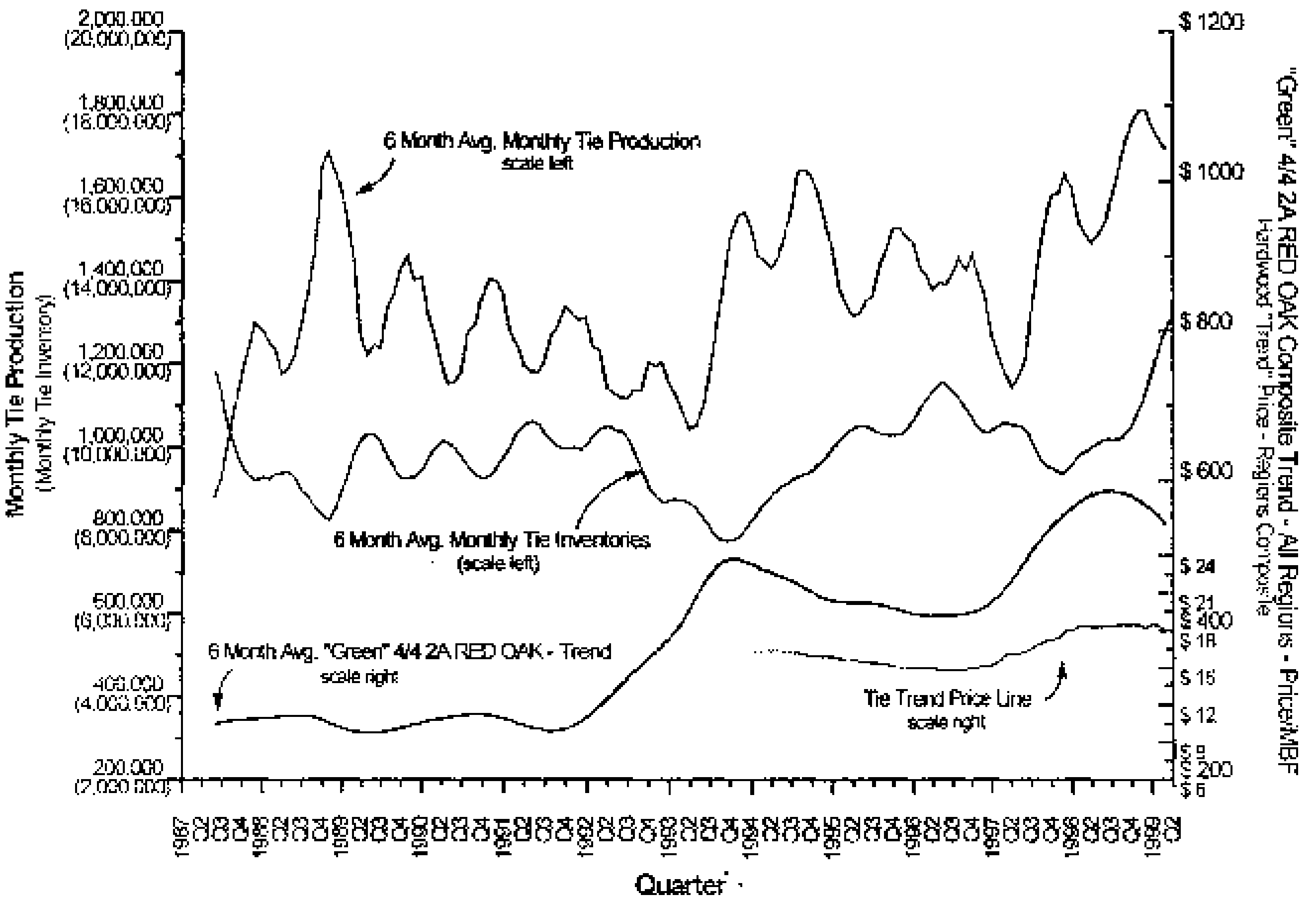
of benzopyrene in soil samples collected in rural areas of Massachusetts and Connecticut. Also present in the samples were other PNA compounds, which included phenanthrene, anthracene, pyrene, chrysene, and fluorenthene (also found in creosote). Conclusion was that these PNA compounds are indigenous to the soil and probably occur as a result of wood pyrolysis and biological degradation of plant tissue.

Summary Statement

Although the information given in this paper is somewhat empirical, the evidence indicates that creosote treated wood products do not present an unreasonable health risk to man, animals, or have significant environmental effects. Creosote treated wood products can be safely used with proper precautions. As with many other materials, users of creosote treated wood need to use common sense use and handling practices. It is noteworthy that Goyette and Brooks (1999) have confirmed some of Wade's findings in their Canadian Sooke Basin Creosote Study. However, their study was much more detailed and it evaluated and found PNA materials in the bottom sediment in "close proximity" to the creosote piling. However, there does appear to be some biodegradation occurring with the PNA materials in the sediment near the piling of the Sooke Basin Creosote Study.

Figure 1

Crosstie Production/Inventory/Ha rdwood Trend Pricing as Compared with 4/4 2A Red Oak Pricing



NOTES: * Tie production and inventory are shown along with "green" 4/4 2A Red Oak in a six-month moving average format. This results in minimized monthly deviations and more clearly illustrates long-term trends. See chart below for actual tic production and inventory data.

* "Green" 4/4 2A Red Oak is considered a reasonable benchmark to compare with historical tie price movement. This data represents a "trend" line developed from a composite of all reporting regions, compiled with permission from and in cooperation with the *Hardwood Market Report.*

* The tie trend price line is just that-a trend line. The graph illustrates a composite number that reflects a consistent ratio between the high and low prices reported in tile *Hardwood Market Report* for all reported regions. For this reason, the line is only representative of trends, not actual pricing.

	1995		1996		1997		1998		1999	
	Prod.	*Inven.*	*Prod.*	*Inven.*	*Prod.*	*Inven.*	*Prod.*	*Inven.*	*Prod.*	*Inven.*
JAN	1,250	10,839	1,250	11,722	885	11,281	1,363	10,283	1,507	13,549
FEB	1,178	10,708	1,267	11,863	1,164	11,134	1,438	10,340	1,597	13,519
MAR	1,445	10,559	1,455	11,710	1,140	10,598	1,556	10,018	1,854	13,653
APR	1,309	10,446	1,385	11,572	1,424	9,733	1,653	10,220		
MAY	1,363	10,261	1,514	11,293	1,330	10,107	1,487	10,182		
JUN	1,546	10,231	1,383	10,655	1,309	9,340	1,746	10,244		
JUL	1,340	10,289	1,418	10,682	1,577	9,274	1,752	10,273		
AUG	1,601	10,200	1,493	10,463	1,901	9,154	1,799	10,568		
SEP	1,680	10,433	1,350	10,468	1,738	9,762	1,954	11,264		
OCT	1,600	10,511	1,610	10,058	1,787	9,245	1,933	11,798		
NOV	1,393	10,314	1,186	10,168	1,358	9,562	1,664	12,715		
DEC	1,432	11,435	1,050	10,386	1,575	10,135	1,749	13,284		

(In thousands of ties)

NOTE: This report is compiled from non-duplicating information furnished by major railroads and supplier companies.

See facing page for individual regional trend lines.

Please note, with all "trend" lines, that in the real world of hardwood lumber and tie markets tile prices fluctuate, sometimes significantly, from week to week. All information presented in these graphs should be considered in the light of the most current pricing available. For actual reported weekly pricing, you may subscribe to:

Hardwood Market Report
(901) 767-9126

TABLE I

VOLUME OF WOOD TREATED* FOR RAILROAD INDUSTRY IN 1997

(Only includes production from 249 reporting plants)

	1,000 Cubic Feet	% of Total
Crossties	55,611	78
Switch Ties	49.382	6
Timbers**	1,062	1
Not treated for Railroads		
All Other Wood Products***	109268	15

*Creosote and Its Solutions
**Sawn timber products whose least dimension is five (5) inches or more (e.g. 5x7, 6x8, etc.)
***Includes poles, piling, fence posts, etc.

TABLE 2

TRENDS IN THE TREATMENT OF WOOD CROSSTIES AND SWITCH TIES

	1997	*1993*	*1990*	*1987*	*1984*
			(1, 000 Cubic Feet)		
Crossties	75,939	63,586	62,988	59,594	88,720
Switch Ties	*5,988*	*6,611*	*7,165*	*91306 89198*	
Timbers*	(not trackable due to influence of waterborne preservative treatment; however, note Table I for estimates for creosote treated timbers)				

It should be noted that the majority of all railroad wood products are pressure treated with creosote meeting the American Wood-Preservers' Association (AWPA) Standards for Creosote, P1/P13; Creosote Solution, P2; and Creosote-Petroleum Oil Solution, *P3*.

For the treatment of crossties and switch ties the United States creosote treating plants east of the Mississippi use Creosote Solution, P2; while Canadian and Western US plants often use Creosote-Petroleum Oil Solution, P3.

Bridge Timbers have generally been treated with Creosote meeting AWPA, P1/P13 Standard.

* Sawn timber products whose least dimension is five (5) inches or more (eg. 5x7, 6x8 etc.)

**Micklewright, J. T. *1998.* "Wood Preservation Statistics - 1997. Prepared for the American Wood-Preservers' Association.

LITERATURE CITED

Belas, M. R.; A. Zachary,; K_ Allen; B. Austin and R. R. Colwell. 1979. Microbial Colonization of Naphthalene/Creosote-Treated Wood Pilings in a Tropical Marine Environment. AWPA Proceedings 72:20-27.

Blumer, M. 196 1. Benzpyrenes in Soil. Science 134:474-475.

Crossties Magazine. May/June 1999. Published for the Railway Tie Association, Fayetteville, GA by Covey Communications Corporation, Gulf Shores, AL.

Davis, M. W.; J. A. Glaser; J. W. Evans; R. T. Lamar. 1993. Field Evaluation of the Lignin-Degrading Fungus *Phanerochaete sordida* to Treat CreosoteContaminated Soil. Environmental Science and Technology 27(12): pp 2572-2576.

Drisko, R. W. and T. B. O'Neil. 1966. Forest Products Journal Vol. 16, No. 7.

Drisko, R. W.; T. B. O'Neil and H. Hochman. 1962. Metabolism of Creosote by Certain Marine Micro-Organisms. Technical Report R-230, U.S. Naval Civil Engineering Laboratory, Port. Hueneme, CA.

Goyette, D. and K. Brooks. 1999. Sooke Basin Creosote Evaluation Study. Environment Canada, Pacific & Yukon Region, North Vancouver, BC.

Lamar, R. T. and T. K. Kirk. 1994. Remediation of Pentachlorophenol and Creosote Contaminated Soils Using Wood-Degrading Fungi. The International Research Group on Wood Preservation, Section 5. Environmental Aspects. Document IRG/WP 94-50021. 9p.

Micklewright, J. T. 1998. Wood Preservation Statistics - 1997. Prepared for the American Wood-Preservers' Association (AWPA), Granbury, TX.

Mississippi State University. 1975. Unpublished Data in the Files of the Mississippi Forest Products Laboratory, Mississippi State University, State College, Mississippi.

Seesman, P. A.; R. R. Colwell and A. Zachary. 1977. Biodegradation of Creosote/Naphthalene-Treated Wood in the Marine Environment. AWPA Proceedings, 73:54-63.

von Rumker; R. E. W. Lawless and A. F. Minersa. 1975. Case Study No. 20. Creosote. In Production Distribution and Environmental Impact Potential of Selected Pesticides. U.S. Environmental Protection Agency Report No. 540/1-74001.

Wade, M. J.; M. S. Connor; K. M. Jop; R. E. Hillman and H. J. Costa. 1987. Summary Evaluation of the Environmental Impact Resulting from the Use of Creosoted Pilings in the Historic Restoration of Pier #2 at the Charlestown Navy Yard. A Report U.S. Dept. Of Interior, National Park Service, prepared by Battelle Ocean Sciences, Duxbury, MA.

Webb, D. A. and L. R. Gjovik. 1988. Treated Wood Products, Their Effect on the Environment. AWPA Proceedings No. 81:254-259.