Creosote: A Prescription For The Future, Part I

History, Use & Health Effects Of Creosote

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Editor's Note: The below represents the first in a two-part series on creosote and creosote-preserved wood. Initially planned for presentation at the annual conference of the American Wood Protection Association, this and the second installment, scheduled to appear in the September/October edition of Crossties*, will be included in American Wood Protection Association's "Book of Standards." These papers will also be presented at the upcoming Railway Tie Association Conference.*

Creosote-preserved wood has been used for more than 200 years, and it remains an important structural material today. This paper will describe the liquid preservative creosote, a coal tar distillate, as being a complex mixture of organic chemical compounds. The focus will be on providing information about the history, use and health effects of creosote.

Creosote is a pesticide with the potential to be toxic to humans. However, it is only slightly more toxic than table salt and significantly less toxic than aspirin and caffeine. Exposure to vapors can increase skin sensitivity to sunlight, a characteristic called photosensitivity.

Introduction

Creosote-preserved wood is commonly used for railroad ties, utility poles, marine structures, bridges and agricultural fencing. It is not used for decks or other residential construction. This paper is intended to provide a general understanding of what creosote is and precautions appropriate for working with creosote-preserved wood.

Wood is a great building material. It is strong, lightweight, can be cut or shaped in the field as needed, inexpensive, and literally grows on trees, so is renewable. However, when exposed to weather, it decays.

The use of creosote to treat wood products first occurred in 1717 in England. Dr. William Crook's patented process used creosote to protect ships' wood planking from decay and worms. Modern pressure creosote treatment for wood started in 1838 with John Bethall's patented process.

In the era of the railroads' rapid expansion around 1900, railroad tracks were initially built on untreated wooden ties. However, those ties rotted within just a few years, requiring frequent replacement. Such replacement not only used a lot of trees but was also very expensive and likely resulted in more frequent derailments.

At that time, coal tar was a common waste product derived from manufacturing coke used to make steel and from town gas plants that produced synthetic gas from coal used for heat and lighting. Distilled from coal tar, creosote was used to treat the wooden ties and extend their service lives by about 10 times (from three to 30 years). Thus began the common use of creosote preserved wood.

More than 100 years later, creosote is still used to preserve wooden railroad ties as well as utility poles, marine and foundation piles, fence posts, and bridge and other transportation-related structures.

Creosote-preserved wood has served a critical role in the modern development of North America over the last century, including continental expansion of the railroads, ports, highways, and electric and communication utilities. Society has benefited from this infrastructure that has largely been built on creosote-preserved wood.[1]

While creosote has been in use for a long time, it is still relevant and valuable today. Approximately 95 percent of new ties purchased by North American railroads in 2017 were creosote preserved wood.

Freight railroads continue to prefer creosote-preserved wooden ties to ones made of concrete, steel or plastic. Creosote-preserved wood is also still commonly used for utility poles; marine structures such as piles, peers, retaining walls and dolphins; and foundation piles to support buildings and other structures.

What Is Creosote?

Creosote is derived from coal tar that is produced when coal is heated in coke ovens at high temperature and without oxygen to form solid coke, which is nearly pure carbon.

The coke is used to convert iron ore into steel for pipe, rails, cars and all sorts of equipment. Vapors from the coke oven are condensed to form coal tar. The coal tar is further processed by distillation in which it is heated and separated into portions based on their boiling temperature ranges.

The portion with the highest boiling temperature, generally above 1,000°F, is used to make pitch for roofing tar and making aluminum. The portion with the lowest boiling temperature, below about 400°F, is used as feedstock to make chemicals for a variety of other products. The middle range portion is used as creosote or to make carbon black, which is used in truck and automobile tires. So, through this rather complicated process, creosote is derived from coal.

Creosote is not a single chemical; rather, it is a complex mix of many organic (carbon-based) chemicals all deriving from coal via the processes described above.

Creosote is a black or dark brown thick liquid at room temperature. Creosote can contain hundreds of individually identifiable chemicals, but its chemistry is mostly defined by the polycyclic aromatic hydrocarbons (PAHs) that represent approximately 60 percent of its mass.

Although only a very small fraction of creosote will evaporate, the smell of naphthalene is what is noticed. Naphthalene, ▶

[1] *Smith, S.T. (2019). 2018 Railroad Tie Survey. Journal of Transportation. Technologies, 9, 276-286. https://doi.org/10.4236/jtts.2019.93017.*

Table 1

Oral Toxicity Of Common Substances Compared To Creosote				
Substance	**Oral LD50 grams/kg**	**U.S. EPA Toxicity Category**	**Human Dose (based on 70 kg)**	**Teaspoons**
Sugar	30	Cat IV	2100 g	500
Baking Soda	4.5	Cat III	300 g	53
Sodium Chloride (table salt)	3	Cat III	200 g	33

which was used to make moth balls, is something people can smell at extremely low concentrations.

Should People Worry About Creosote's Toxicity?

The study of toxicology all began with the following quote from Paracelsus, the Father of Toxicology, made sometime around 1493 to 1541: "All substances are poisons; there is none which is not a poison. The right dose differentiates a poison from a remedy."

A common way to compare the hazards of various substances is to compare the Oral Toxicity or Oral LD50 values. Typically, laboratory animals such as rats are exposed as surrogates for humans. The Oral LD50 is a single dose administered through the mouth directly into the stomach via a stomach tube, the result being the death of half the exposed population of laboratory animals.

Creosote's Oral LD50 is 2,197 mg/kg[2] of body weight, which is considered a low to moderate toxicity, and the U.S. Environmental Protection Agency (EPA) classifies as a Toxicity Category III (where the least toxic is Category IV). See Table 1 for toxicity comparisons of commonly found household items.

Conclusions

Based on the evaluation of some common materials, creosote is only slightly more toxic to humans via oral ingestion than table salt and significantly less toxic than caffeine and aspirin.

Table 2

Creosote	**2.2**	**Cat III**	**154 g**	**27**
Aspirin (acetyl salicylic acid)	1.0	Cat III	70 g	12
Caffeine	0.2	Cat II	14 g	2.5

It is important to note that the exercise in the above table is based on single acute oral exposures, and no one should ever attempt to ingest creosote, which can lead to gastrointestinal irritation such as vomiting, discomfort and light-headedness. The comparisons offer an explanation of the dose and its relationship to toxicity and seek only to explain that the dose dictates the toxicity. ■

[2] *Wisler, JA. Acute Oral Toxicity in Rats of North American P1/P13 Creosote, CTM. International Research and Development Corporation, Mattawan, MI. Laboratory Project No. 671-001. Creosote Council II unpublished report. November 9, 1993.*