

Effect of CCA Treated Utility Poles on the Urban Environment In Toledo Ohio



2/04

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Introduction

It is only in recent history that society has begun to think about the environment in the process of making goods. Not only are we looking at the direct effects of using the product, but also how the process and disposal of the good changes the environment. In Toledo, OH the creosote plant off the Anthony Wayne Expressway is a prime example of how in the past we did not consider the environmental effects of our actions. When the plant was closed down the EPA did consider making it a superfund site, the fact was that if you dared to walk around the grounds, chemical laden tar would ooze out from the ground. Times have changed though and environmental agencies would not tolerate such conditions. Instead, firms with potentially hazardous agents are encouraged to examine the life cycle of their product. A life cycle analysis examines every impact a product or good has on the environment, from the “cradle to the grave.” is often used. A life cycle analysis for the utility pole was performed to see the impacts, especially in densely populated and older urban neighborhoods. In this case, we need draw upon the literature that examines treated wood as it is made, in use, and when it was disposed, and to apply this knowledge and framework to a consideration of the conditions in the City of Toledo, OH.

Copper, Chromium, and Arsenic treated wood are the main focus for this study because of the recent EPA analysis identifying leaching of those chemicals from treated wood, and their subsequent ban of its use in residential settings. It has been estimated that there are 117,000 utility poles in the Toledo area, and 38% of all utility poles are waterborne treated, and of that 95% are treated with waterborne CCA. We will calculate how much arsenic is released per utility pole over a forty year span and consider the environmental impacts by the utility poles in the Toledo area.

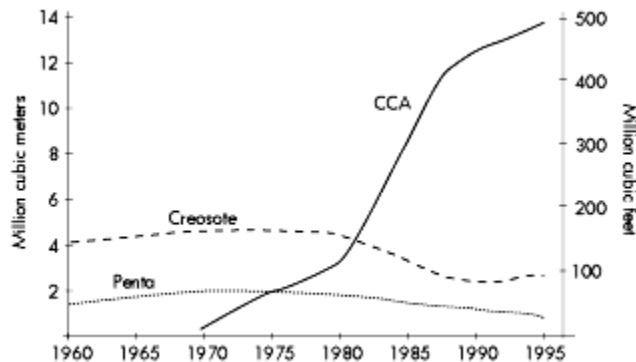
Background

The utility pole is a common fixture in every city. According to the American Wood Preservers Association, it is estimated that there are 134 million utility poles in the United States. All are preserved with chemicals to stop rotting and infestation of insects. If these chemicals leach into the soil and air, there will be an impact on the environment. The question is, how much of an impact do they have on the urban and rural environments? The chemicals embedded into the wood are known to cause problems to humans at high exposure levels, but what about normal use of utility poles and other treated wood?

There are three main types of preservatives for treating wood used as utility poles, Copper Chromium Arsenate (CCA), pentachlorophenols (PCP) and creosote. Because all three leach into the environment, they all have the potential to affect humans; CCA contains the poison arsenic, PCP is known to cause birth defects and fetal damage, and creosote is a carcinogen. CCA is a waterborne chemical and has some advantages, it leaches the least and it is inexpensive compared to other types of waterborne preservatives. Since the 1980s the use of CCA has dramatically increased. In 1964, 0.3% of all poles were treated with waterborne chemicals. (See Figure.1) In 1996, 95% of all waterborne wood preservatives were CCA and 38% of all poles were

treated with these waterborne preservatives. [10]

Figure 1. Annual consumption of treated wood by preservative type



Source: "The Recycling Potential of Preservative Treated Wood" by Colin C. Felton and Rodney C. De Groot, Forest Products Journal Vol. 46, No. 7/8; and American Wood Preservers Institute.

There are three types of CCA, depending on the percentage of each chemical in the treating agent. They are designated by the letters A-C. Type C is the kind used for utility poles and typically has 18.5% Copper (Cu), 47.5% Chromium (Cr), and 34% Arsenic (As). There are also different retention values depending on how the treated wood product is going to be used. The retention value is the amount of CCA per volume of treated wood, low retention values are used in treating wood for private use while higher retention values are used in utility poles and poles that will be used in aquatic environments. To preserve against decay and fungi the retention value has to be 3.0 kg/m^3 , but most utility poles are made to achieve a target retention value of 9.6 kg/m^3 . [3]

In February 2002, the Environmental Protection Agency (EPA) stated that no CCA treated wood would be permitted for residential use after December 2003. This was in response to a growing concern that children playing on swing sets made of CCA treated wood were absorbing arsenic through their skin. Many people have also built decks and other outdoor objects that are a part of their everyday life from the CCA treated wood. There is no evidence that absorption of arsenic through the skin is a major problem. But, there have been documented cases about families burning CCA treated wood and showing signs of arsenic poisoning such as black outs, seizures, hair loss, nosebleeds, skin rashes, and extreme fatigue. [4] The families did not die, but plants and other small animals did. Children playing on the CCA treated wood have not shown signs of arsenic poisoning, but there is the possibility it is still being absorbed into their systems. The low doses of arsenic will not cause immediate problems, but in lab studies it has been shown that continuous low doses of arsenic does lead to a higher occurrence of cancer.

This report intends to discern how the environment is affected by the utility pole. Presented here is an elementary life cycle of a utility pole, the analysis of data on the leaching of CCA, and how much of an impact it is having on the urban environment. This report specifically examines the city of Toledo, OH and how the data on CCA relates to it.

Analysis and Major Findings

A life cycle analysis involves looking at every aspect of a product's life. This includes everything that goes into a product, and how the product is exposed to other things. The stages in the life of a utility pole that are addressed here are production, service of pole, and how it is disposed. This study looks at the CCA associated with utility poles and how it affects the environment.

The sustainability of using CCA treated wood for outdoor use is an issue that needs to be assessed. Sustainability involves "environmentally compatible development"; developing technology that neither poses a problem now, nor will pose a problem for future generations. Sustainability is an important issue if we are to minimize damage to the environment. The utility pole is in every city and whether or not it is hurting the environment now, or will in the future, should be examined.

Copper, chromium, and arsenic can enter the body through ingestion, dermal contact, and inhalation. In 2001, the EPA reduced the permissible level of arsenic that can be in the drinking water from 50 parts per billion to 10 parts per billion. States are expected to comply by 2006. The no observed adverse effect level of dermal contact with arsenic is 580 g/m³. This means the average human can place a concentration of 580 grams of arsenic per 1 cubic meter of skin and not see any signs of the arsenic affecting them. The level of chromium ingestion that does not pose a threat is 0.1 mg/L. Of all these chemicals, arsenic is the main concern because it can be so lethal at low doses. As shown in table 1, arsenic has the lowest doses acceptable for all three contact pathways. For these reasons, the focus of this study will be the leaching of arsenic into the environment.

Table 1. Copper, Chromium, and Arsenic Toxicity by Doses

	Dermal	Inhalation	Ingestion
Copper	-	0.1 mg/ m ³	1.3 mg/L
Chromium	-	52-1000 µg/ m ³	0.1 mg/L
Arsenic	580 g/m ³	10 µg/ m ³	0.01 mg/L

The specifications of an average utility pole will be used in future calculations and are presented here:

Volume: 0.35 m³ [2]

Bottom diameter: 25-40 cm [2]

Length: 8-14 m [2]

Life span: 40 years [9]

They are important in calculating concentration levels and other data. The life span is when the average utility pole is taken out of service for weathering reasons.

As stated, an elementary life cycle analysis was done on the utility pole. There are three main stages in the utility pole cycle: fixation, in use, and disposal. During all of these stages, the CCA is discharged into the environment.

Fixation:

Wood used in outdoor projects must be chemically protected to reduce such problems as insect infestation, damage by animals, rotting due to microorganisms, and water damage. The CCA is embedded into utility poles to prevent the poles from becoming soft so that service people can climb them. The process of imbedding preserving chemicals into the wood is known as fixation.

Figure 2. The Bethel Process of CCA Fixation

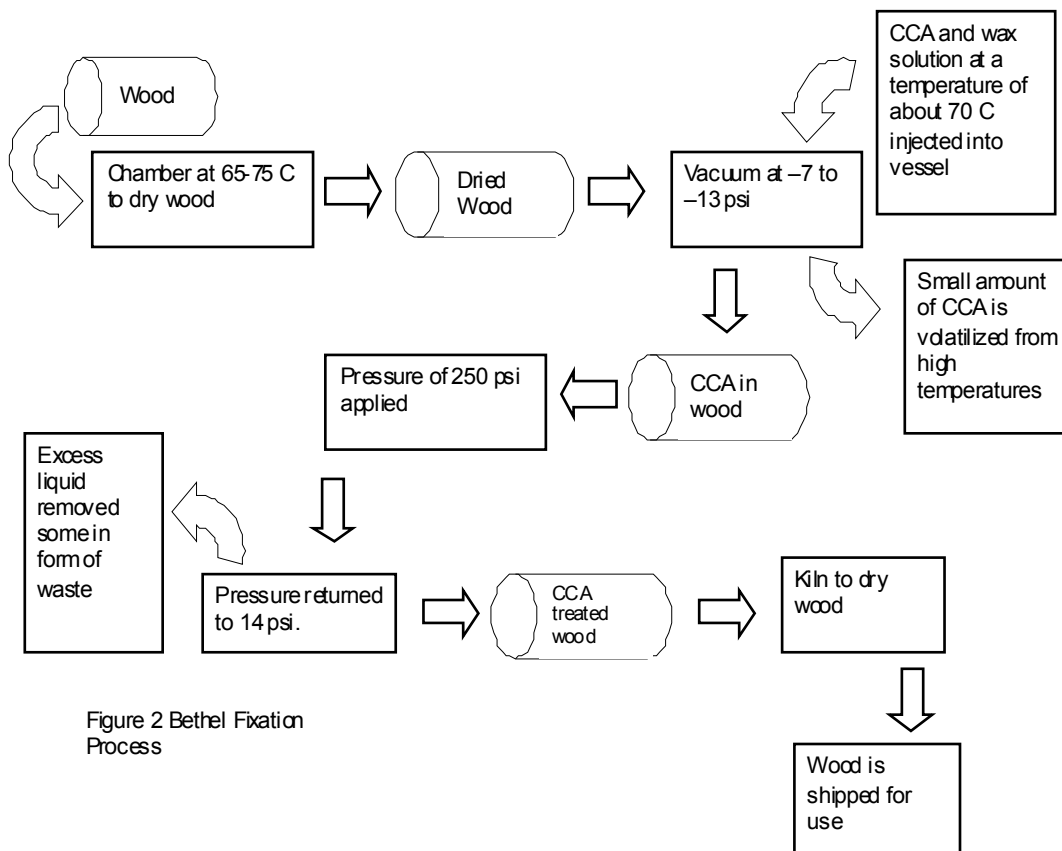


Figure 2 Bethel Fixation Process

The Bethel Process of preserving wood, patented in 1838 (described above in Figure 2), is the most common method of delivering the CCA into the wood. During the process, the wood is dried so that the moisture content is lowered considerably. Then the wood is placed in a vacuum chamber, drawing the aid out of the wood. A mixture of CCA, was, and water is then delivered into the wood, under pressures that can reach 250 psi. Next, the pressure is reduced back to atmospheric pressure (14 psi) and the wood is transferred to a kiln and dried to reduce the moisture content. [8] The success

of the process is affected by temperature and duration of the fixation process.

Wastes are produced during this process, primarily as CCA is released into the environment in the form of wastewater. Wastewater can be disposed of on-site or transported to a hazardous waste facility. The EPA defines any soil or water waste that is above 5.0 parts per million for arsenic or chromium to be hazardous and as such must be taken to a hazardous waste disposal site.

In Use:

There have been many studies conducted examining the leaching of CCA treated wood during use. J.A. Hingston et al. [6] stated that none of these tests really converges on a definite answer to the CCA leaching problem. All the tests were run under different conditions and with different methods. Most tests take a piece of CCA-treated wood and put it in certain conditions to simulate the environment. These conditions can include water that has different pH and salinity levels. Different exposure to amounts of water and temperature affect the amount of CCA leached. Each started with different concentrations of the copper, chromium, and arsenic in the initial CCA. There were different species of wood compared also particleboard was compared to unprocessed wood. Size of the blocks of wood changes the amount leached. Hingston [6] showed that although all the tests were done under different conditions and show different leaching amounts, the tests all show a significant decrease in amount of chemical leached from 12 hours to 90 days.

CCA treated wood used in aquatic environments have the largest leaching rate. The amount of leaching from utility poles can be modeled according to exponential decay:

$$\text{Cu loss } (\mu\text{g cm}^{-2} \text{ day}^{-1}) = ae^{-bt}$$

Where a and b are constants that are found but inserting actual data into the equation, t is the time in days, and e is the inverse of natural log (approximately 2.71828). By taking test results from leaching rates over different periods, we can develop a general equation for CCA leached over time.

Data from a study [6] on the leaching of the different chemicals in treated wood is presented in Table 2. The flux is the change in the amount of CCA leached. All studies have shown that the CCA flux is in great amounts initially but then falls dramatically.

Table 2. Copper, Chromium and Arsenic Leached over Different Periods

	12 hour flux ($\mu\text{g cm}^{-2} \text{ day}^{-1}$)	90 day flux ($\mu\text{g cm}^{-2} \text{ day}^{-1}$)
Copper	4.3-5.6	0.5-0.6
Chromium	0.03-0.1	0.003-0.006
Arsenic	3.3-8.2	0.4-0.5

[6]

The information from this study will be used for data analysis because the conditions of the experiment correlated most with the environment a utility pole would be found in. The study also took into account stresses in the environment.

Using the equation given for leaching and the data for different periods of leaching, a model equation can be formed to find how much CCA moves into the environment. This was done by solving the equations simultaneously. (see Appendix 1)

$$\begin{aligned} \text{Cu loss } (\mu\text{g cm}^{-2} \text{ day}^{-1}) &= 5.011e^{-0.0245t(\text{day})} \\ \text{Cr loss } (\mu\text{g cm}^{-2} \text{ day}^{-1}) &= 0.0658e^{-0.0298t(\text{day})} \\ \text{As loss } (\mu\text{g cm}^{-2} \text{ day}^{-1}) &= 5.85e^{-0.0285t(\text{day})} \end{aligned}$$

As shown here, the chemicals do not leach at the same rate; arsenic leaches the fastest, and Cr the slowest.

By integrating these equations with respect to t for a period of 40 years (average life of utility pole), the result is the loss of the chemical in $\mu\text{g cm}^{-2}$. Integration allows for addition of the leaching over the entire 40 years, rather than just the amount leached on the first day or the fortieth day. Then by multiplying by the surface area of the utility pole in the ground, the total amount lost over 40 years can be found. (See Appendix 2)

0.0039 μg Cu lost over 40 years from one utility pole.
 0.0002 g Cr lost over 40 years from one utility pole.
 0.019 g As over 40 years from one utility pole.
 0.033 g total CCA lost over 40 years from one utility pole.

As shown here, the arsenic does have the highest impact compared to the other chemicals. There is approximately 0.02 grams of arsenic released into the environment over a 40-year period. Arsenic does occur naturally from mineral deposits in the soil. The mean number in Ohio for the concentration of arsenic is about 6 ppm.

In Toledo

It is estimated that there are 117,000 utility poles in the Toledo area.¹ 38% of all

¹ The Toledo Edison Electric Company estimates that in Toledo and the immediate area (Sylvania, Maumee, Perrysburg, Oregon, Northwood) there are over 117,000 utility poles. (The amounts of utility poles in different areas were found by counting utility poles within one-mile spans.)

utility poles are waterborne treated, and 95% of them are treated with waterborne CCA.

The U.S. Census for 2000, states that there are 84.08 square miles in the Toledo area. This means that on average there is 9.4 g arsenic per square mile. The limit of dermal contact with arsenic is 580 g/m³. Converting the 9.4 g/mi² to g/m² and multiplying the area by 1 meter to give cubic meters, reveals that an average of 3.6 µg As/m³ is in Toledo's soil. This is well below the dermal contact limits. Arsenic is a naturally occurring element in the soil. The average natural level in Ohio is about 6 g As/m³ soil. It can be concluded that the amount of arsenic leached from a utility pole does not greatly affect the amount of arsenic in the soil. Using the results from the previous calculations about how much arsenic is released into the environment, and multiplying all the factors together, an estimate on the amount of arsenic that has been released into the environment can be calculated. (See Appendix 3) Over the past 40 years there has over 790 g of arsenic released into the environment by the utility poles. Yet the CCA poles have not been leaking for 40 years and their density and impact vary based on certain patterned factors.

As is shown below (Table 3), there is a relationship between the number of poles, age of property, and average selling price of property in the neighborhood. Older neighborhoods have more poles per mile. As new neighborhoods are being built, the electrical lines are put underground, and so those areas have fewer utility poles. The areas with a lower average age of the properties are usually the ones that are farther away from downtown Toledo. Houses with a higher selling value have fewer utility poles. Census averages indicated that people of lower income live in houses with lower selling prices, and thus low-income people will have higher exposure to utility poles.

Table 3. Comparison of Utility Poles to Different Housing Areas

Number of Poles per mile	Average Age of Property in Area (years)	Average selling Price of House in Area
72-90	102	\$56,000
60-68	41	\$135,000
59-63	24	\$214,000
0+	24-41	\$135,000-214,000

There are more utility poles in neighborhoods or areas with longer average age of the property boundaries. Although some local properties were plated over one hundred fifty years old, CCA has not been accumulating on those properties for that long. CCA did not become a popular treatment until the 1980s. The copper, chromium, and arsenic ions of CCA move into the surface water and eventually move to the ground water. The City of Toledo tests its water for arsenic, chromium and copper. All of these chemicals are monitored, and levels are kept within EPA standards. Thus, while more CCA leaches from utility poles in older urban neighborhoods due to density and age, it involves minimal direct human contact, the leached chemicals move to sites (sewers) where it is treated by the City, and results in discharges within EPA standards.

By multiplying the number of utility poles in the Toledo area by the percentage of wood treated with CCA by the amount of CCA/utility pole, it is estimated that there will

be 40,000 kg of CCA to be disposed of in the Toledo area. This amount will start to be processed over the next 10 years. Depending on how many new poles treated with CCA replace the old poles will determine how that number will change. Given the Environmental oversight of the utility firms, it is probable that CCA treated wood will be disposed in an environmentally appropriate manner.

Suburban areas, where there is much more personal use of CCA treated wood for outdoor fixtures like swing sets or porches, may experience the most effects from CCA treated wood. Most people will rarely touch the utility pole in their yard, but they might touch their decks or swing sets every day. Because CCA is a waterborne chemical, there is a higher risk of CCA leaching when the wood is continually wet from rainfall or other sources and so when used to make something such as a deck, it has been advised that the wood is sealed. Many people do not seal their deck or swing sets. Weather treated wood should never be burned, especially while indoors or without ventilation since the human body will absorb the arsenic through continuous inhalation of the smoke faster than any other method. Thus, greater CCA exposure, in terms of both net amount leached and the amount of direct human contact is probably occurring in suburban areas and among individuals that are more affluent.

Disposal

Disposal is the final stage in the life of utility pole and is the most undesirable part of using CCA treated wood. In Florida in 1996, 110,000 m³ of treated wood was disposed of and also 300 metric tons of CCA [10]. Because CCA only recently started being used widely as a wood preserver in utility poles, disposal of them will become a much greater problem in the future.

Utility poles can be taken out of service for many reasons, including damage from storms or cars, changing of utility lines, and the weathering affects that have caused the pole to become unusable. In the former of these reasons, parts of the pole can be reused. They may be reused as a utility pole in a different area or wood that is "clean" (not containing CCA) can be used for other wood products. Cooper [3] set up criteria for the quality of utility pole when reusing them:

Table 4. Criteria for Reuse of Utility Poles

Proposed Use	Criteria
Re-use as a pole	Less than 10 years old, good condition, greater than 10.7 m long
Cedar roof shakes or shingles	Western red cedar only, top diameter 30 cm or greater, few knots
4.9 m saw log	Top diameter 15 cm or greater, sound, minimal hardware
2.4 m saw log	Top diameter 15 cm or greater, sound, minimal hardware
Round Building poles or posts	2 m or longer, sound
Firewood	Untreated northern white cedar or western red cedar
Landfill disposal	Excessive rot or mechanical damage, excessive hardware, heavy preservative bleeding

[3]

This study covered all types of utility poles, and all preservative types. After acquiring utility poles that companies took out of service, Cooper [3] evaluated them. The results from their criteria show that 8% can be re-used as poles, 15% can be used as shingles, 35% can be used as saw logs, 22% can be reused as posts or firewood, and 10% were deemed for landfill disposal only.

There is so much CCA left in the treated wood that one has to be careful of the way they are disposing of it. There are many ways of disposing of utility poles. With our current technology, the most common and most environmentally sound method is burial. This is done in areas lined with a material that will not let the CCA leach into the general environment.

Sometimes CCA treated wood is mixed in with regular wood products to be incinerated. This is very harmful to the environment. The copper and chromium accumulate in the wood ash, while the arsenic is vaporized and ends up in the atmosphere. The amount of arsenic vaporized varies, but has been reported to be between 8 and 95% [6]. The EPA has set standards on the amount of certain chemicals that can be released into the atmosphere called Toxic Characteristic Leaching Procedure (TCLP). In a recent study, CCA treated wood made up 10.7% of the wood being incinerated for fuel. The results of this exceeded the TCLP limits on arsenic by a factor of 26. [4] CCA treated wood should never be burned, especially in private houses.

Currently, Helsen et al. [5] are researching low temperature pyrolysis as a useful technique of getting rid of CCA treated wood. This allows the wood to be burned for fuel and still remove a high percentage of the copper, chromium, and arsenic. In their design the wood is pyrolyzed at low temperatures and with no oxidizing agents, this allows the recovery of copper chromium and arsenic to be high. Pyrolysis is the transformation of a compound caused by heat. When pyrolysis occurs, the wood is ground up and converted into a CCA rich charcoal. The CCA can then be separated out of the charcoal by grinding up the charcoal and by utilizing the different densities of

the substances in centrifuges and filters. This produces a substance that is 100% pure charcoal, and can be used elsewhere. During the process there were four waste streams monitored: the pyrolysis residue (charcoal), liquid product which is used in cooling the gas from the pyrolysis reactor, the gas separated from the cold water, and the filter which filtered the gas. The water is recycled throughout the entire process.

Helson et al [5] started the experiment with wood treated with type C CCA: 32.5% Cu, 41.1% Cr, 26.4% As.

Table 5. Results of Low Temperature Pyrolysis Tests

	Cr (%)	Cu (%)	As (%)
CCA treated wood	100	100	100
Pyrolysis Residue	98.0	97.9	82.3
Liquid product	0.071	4.2	2.9
Filter	0.016	0.014	0.12
Gas	1.91	-2.11	14.7

(Gas values were found through subtraction) [5]

If this process could be practically applied to disposal of treated wood, the CCA could be recovered and used again. The pyrolysis residue could be resold as charcoal.

Bioremediation and treatment with other chemicals are also options. Kartal [7] did a study trying to find a way to remove the CCA from the wood so that it can be reused as particleboard or other composite wood product. In the study, they used the organism *Bacillus licheniformis* that changes the chemical make-up of the CCA into a water-soluble form and allows to CCA to be removed more easily. They also used acid extraction to try to remove the CCA with oxalic acid. When the wood was first made into particleboard and then treated, there was a significant change in the amount in each component of CCA.

Table 6. Leaching of Particle Board

	% Cu leached	% Cr leached	% As leached
CCA treated particle board	2.60	2.37	21.95
Acid treated particle board	35.18	54.71	74.57
Bio-remediated particle board	37.62	31.05	34.58

[7]

This could be put to use in waste disposal sites. The leached particleboard could be reused for other purposes. But as we can see, just normal leaching of the arsenic is high. Using the acid, large amounts of the arsenic and chromium are removed.

In Toledo

Multiplying the number of utility poles in the Toledo area by the percentage of wood treated with CCA by the amount of CCA/utility pole, it is estimated that there will be 40,000 kg of CCA to be disposed of in the Toledo area from utility poles. (see Appendix 4) This amount will start to be processed over the next 10 years. Toledo Edison indicated that they are turning to alternative sources for the utility poles and are phasing the CCA poles out of use.

Implications of the Findings

The existence of utility poles, even in older urban neighborhoods where they are more densely sited and have been in place for longer periods, does not pose a meaningful health hazard for residents nor a significant burden for the local water treatment facility. They amount of poles used will probably not increase significantly in the region, given the trend toward burying lines in new suburban areas. And, while Toledo Edison will need to pay for the proper disposition and/or disposal of poles, this should be a minor expense relative to their total cost of operation.

Conclusion

Urban America has a higher amount of utility poles than the rural environment. But the amount of CCA in the urban environment is still below the EPA limits. Suburban areas, where there is much more personal use of CCA treated wood for outdoors fixtures like swing sets or porches, might experience the most effects from CCA treated wood. On a daily basis, most people will not touch the utility pole in their yard, but they might use their decks or swing sets every day. Because CCA is a waterborne chemical, there is a higher risk of CCA leaching when the wood is continually wet from rainfall or other sources. If CCA treated wood is used to make something such as a deck, it has been advised that the wood is sealed. Weather treated wood should never be burned, especially while indoors or without ventilation. The human body will absorb the arsenic through continuous inhalation of the smoke from CCA treated wood faster than any other method. Although our current disposal methods are adequate, other methods of disposing chemically treated wood need to be explored. Buried toxic chemicals are still in the environment and need to be removed.

Appendices

Appendix 1

(For value ranges, a mean value was used.)

As loss

$$A = ke^{rt}$$

$$5.75 = ke^{0.5t}$$

$$0.45 = ke^{90t}$$

Solve for k and r simultaneously

$$r = -0.0285$$

$$k = 5.85$$

Appendix 2

Integration

There are 14600 days in 40 years.

$$\int_0^{14600} 5.85e^{-0.0285t} dt$$

$$\left[(-0.0285)(5.85)e^{-0.0285t} \right]_0^{14600}$$

$$(-0.0285)(5.85)e^{-0.0285(14600)} - (-0.0285)(5.85)e^{-0.0285(0)}$$

$$\text{As loss} = 0.1667 \mu\text{g cm}^{-2}$$

Surface Area

$$SA = 2\pi rl + \pi r^2$$

$$r = 16.25 \text{ cm}$$

$$l = 11\text{m} = 1100 \text{ cm}$$

$$SA = 113141.5 \text{ cm}^2$$

$$(SA) (\text{As loss}) = (113141.5 \text{ cm}^2) (0.1667 \mu\text{g cm}^{-2}) = 18860.7 \mu\text{g As over 40 years}$$

The same method was applied for the other chemicals

Appendix 3

117,000 Poles in Toledo \times 0.38 waterborne treated \times 0.95 type CCA \times 18860.7 μg

total CCA lost over 40 years = 0.796 kg As released

Appendix 4

There was 110,000 m³ of treated wood and 300 metric tons of CCA disposed of in Florida in 1996.

$$\left[\frac{110,000 m^3}{0.35 m^3} \right] \left[\frac{Pole}{0.35 m^3} \right] = 314286 poles$$

$$300 \text{ metric tons} = 3 \times 10^8 g$$

$$\frac{3 \times 10^8 g}{314286 poles} = 954.5 g_{CCA} / pole$$

117,000 Poles in Toledo × 0.38 waterborne treated × 0.95 type CCA × 954.5 g CCA/pole = 40315.21 kg CCA to be disposed of.

References

- [1] "Arsenic-Based Pesticide to Be Removed." 13 February 2002: On-line. Internet 18 February 2002 Available www.wire.ap.org.
- [2] Barnisin, Jr. M. A., Wood Preserving. US Patent 6,426,118. (2001).
- [3] Cooper, P., Ung, T., Aucoin, J., Chris T. The potential for re-use of preservative-treated utility poles removed from service. Waste Management and Research (1996)14 p.263-279.
- [4] "Disposal: The Achilles' Heal of CCA-Treated Wood" Environmental Building News. (1997) Vol 6 No. 3 Online: 19 February 2002 Available www.buildinggreen.com/features/tw/treated_wood.html.
- [5] Helsen, L., Van den Bulck, E., Hery, J.S. Total recycling of CCA treated wood waste by low-temperature pyrolysis. Waste Management (1998)18 p.571-578 .
- [6] Hingston, J.A., Collins, C.D., Murphy, R.J., Lester, J.N. Leaching of chromated copper arsenate wood preservatives: a review. Environmental Pollution (2001) 111 p.53-66.
- [7] Kartal, S. N., Clausen, C.A. Leachability and decay resistance of particleboard made from acid extracted and bioremediated CCA-treated wood. International Biodeterioration and Biodegradation (2001) 47 p.183-191.
- [8] Preston, A. F., Cui, F., Zahora, A. R., Wood Treatment Process. US Patent 6,274,199 (1999).
- [9] Solo-Gabriele, H., Townsend, T. Disposal practices and management alternatives for CCA-treated wood. Waste Management and Research (1999) 17 p.378-389.
- [10] Solo-Gabriele, H., Townsend, T. Messick, B., Calitu, V. Characteristics of chromated copper arsenic-treated wood ash. Journal of Hazardous Materials (2002) B89 p.213-232.