DISPOSAL OF TREATED WOOD AFTER SERVICE

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Summary

Landfilling will soon be too expensive an option for disposal of treated wood taken out of service, whether rail ties, poles, or wood from backyard projects. Users and suppliers of the older preservatives, creosote and pentachlorophenol (penta), have begun to plan other disposal methods, mainly burning or reuse in less structural situations. The more recent waterborne category, especially chromated copper arsenate (CCA), has yet to create a noticeable disposal problem. The widespread nature of its use - huge numbers of small installations, such as residential decks - is probably the main reason. This will not be so for long: it is estimated that in 1993 over *3,000,000 tons* of treated wood will be retired from service in U.S.A. Such an immense quantity, if repeated year after year, will soon attract attention and public disapproval. A list of new uses for old treated wood - recycling - is needed, with promotion to attract the public's attention. This is especially the case for waterborne treatments, where burning is not a good solution; heavy metal fumes and ash are a problem still to be solved.

Paradoxically, reuse of treated wood will not detract from sales of new products, if novel applications for sound but less attractive retired wood can be developed and promoted; one trade organization is planning a campaign for 1994. Without urgent, industry-sponsored action, the reverse could hold true: if we do not find ways to use treated wood, other than landfilling and burning, public confidence may be lost in all treated products.

The examples in the paper reflect the USA industry, but the conclusions probably apply to the Canadian treating industry as well.

1. Background

Supply, Demand - Then What?

Since the very beginning of the industrial revolution, the 1770s, people probably worried about the future supply of raw materials. Will there be enough iron ore? Will the coal seams hold out for the next few years, decades, for my lifetime? Later came cement, aluminum, special steels, uranium, titanium, all dug out of the earth.

For at least 200 years, industrial man has wondered how long the good earth can go on yielding enough fuels, metals, gemstones, fissile materials, building materials to support mankind's development in wealth, comfort, and increasing populations. Today's intense forest and forest products debate is another example of the public's fear that "one day it will all be used up".

The areas of the world needing a steady stream of mineral materials typically ran out of easily extracted local supplies early on in the industrial revolution. This led to trade with, or exploitation of, distant lands which were mineral rich, but had no industries of their own.

Today, we still worry about the size of coal and oil reserves needed for energy in the future, along with natural gas and nuclear fuels. Oil has spawned huge new industries: plastics and synthetic textiles. The question "What will happen when oil supplies run out?" still nags at our industrialized minds.

Now there is something else to worry about: something that the early inventors, factory owners and merchant adventurers hardly considered. Where should we put all the junk we create - the industrial byproducts, cooling water, packaging materials, old cars, radioactive wastes, sewage plant effluents, half-used containers of hazardous materials? Ironically, we started by putting a lot of these in the very holes from which we had mined our industrial raw materials: quarries, iron, coal and gypsum mines, clay pits, as well as into our lakes, rivers, and oceans. The worry about space to put garbage did not seem to hit home until quite recently, perhaps the 1960s, when additional "natural" landfill sites began to get scarce in the developed countries.

With our current level of environmental awareness, we now know that landfills could produce environmental problems. They smelled bad, leaked nasty things into rivers and groundwater, harbored pests liked rats and gulls, and literally changed the scenery, as they grew into low brown hills with yellow machines crawling over them.

In the last decade, rigid rules have been drawn to segregate every day "sanitary" or "safe" trash from that known to contain hazardous elements. New landfill designs aim to eliminate seepage into groundwater, and "the nasties" are treated to make them immobile, before placing in the appropriate cell of a hazardous waste landfill.

As the need for more landfill space grew, so did local political action groups demanding they should be placed far from their neighborhoods. This became known as the NIMBY or "not in my backyard" attitude. As a result, waste disposal sites tend to be placed in areas of low population, thereby increasing transport costs, or in areas where the people are less able to defend their amenities through poverty, lack of confidence with the English language, or want of political power. The placing of waste disposal and heavy industrial sites at the poor end of town lead to the expression "environmental racism".

Incinerators

Incinerators reduce waste to a small fraction of its starting volume. They produce beneficial heat for community or industrial use, along with the unwanted "greenhouse gas" carbon dioxide.

Recycling

Recycling of glass, steel, aluminum, plastics, and paper has started in a small way to reduce the demand for the basic raw materials and the total quantity of waste to be landfilled.

Wood Treating Industry

Our own industry also has its roots in the industrial revolution, and has been buffeted by some of the same heavy weather as the waste disposal industry. "Treated Wood Saves Trees" is a slogan of the American Wood Preservers Institute. It reminds the public that treated wood, used in a decay hazardous situation, will typically give five or six times the useful life of untreated wood used the same way. That's good, and we can take pride in it.

However, rotting, untreated wood is good in one regard. Decay causes loss of shape and mass. Wood left lying around after removal from service would eventually "just disappear". Properly treated wood does not do that, at least not quickly. It keeps its shape and weight, causing us to make an important choice when its original service life is over - reuse it or dump it.

To those in the waterborne part of the industry, which mainly uses CCA, the disposal of treated wood has not caused much worry yet. Not so with the railroads and the major utilities, which have been very troubled over the disposal of used railroad ties and utility poles whose main service life was over. In North America, the waterborne preservative industry is only about 25 years old, whereas creosote and penta in oil have been used for much longer.

For simplicity in this paper, I will concentrate on the three preservatives most commonly used in North America: creosote, pentachlorophenol (penta), and chromated copper arsenate (CCA). Building on the experience, the U.S. railroad and utility companies already have with the disposal problem, I will suggest what may happen in the future with waterborne preservatives, and what treaters should be doing about it.

Life Cycles: What are they?

In the old days you bought something, used it, and threw it out when it was finished. Nice and simple: but the problem - crisis really - of what to do with waste is changing. Now the big users of materials, often the biggest producers of waste, are having to think seriously about the whole life cycle of their raw materials and products, which is putting heavy emphasis on recycling, energy recovery, and secondary uses. Starting simply with the recovery of coke bottles and cans, this has developed into much more sophisticated programs in many communities, and has attained very high degrees of recycling in a few cases; waste oil is one example.

There are many, many definitions of *life cycle* developed by theorists since the 1960s (see for example, Smith S.R., et. al.). Many use terms and concepts that are difficult for most people to understand.

One way to talk of *life cycle* simply and practically is in terms of the *life cycle cost* of a product. Take utility poles, for example (after Webb and Davis, 1992). Think of one treated wood pole, needed by a utility company:

Life cycle costs (to the utility)	=	Costs of acquiring and delivering the pole
	+	Costs of installing it in service
	+	Cost of any maintenance
	+	Costs of removing it from service
	+	Costs of transporting and disposal
	+	Costs or liabilities after disposal

Obviously the *life cycle* cost of the pole is considerably higher than the *purchase price* of the pole itself, F.O.B. at a treater's yard. Similarly, when comparing different types of pole, whether different preservative treatments, or wood versus concrete, steel, or reinforced plastic, the simple F.O.B. buying prices may not rank in the same order as the projected life cycle costs. Note the word *projected*: no one ever knows the *real* life cycle cost at the time of buying a pole, as the *actual* service life and *actual* disposal costs will only be learned later.

One aim of research into the reuse of treated wood after its first service life should be to make a financial contribution, to defray part of the total life cycle cost. For example, if a used pole can be *sold* for reuse, conversion to other uses, or for fuel, this will *reduce* the total life cycle cost. If the utility has to *pay* for the pole to be taken away, this will *add to* the life cycle cost. And if the pole is eventually put into a landfill, where liabilities for any future leakage of preservative into groundwater remain with the utility, then obviously the life cycle cost is potentially increased, but by an unknown amount.

This is the way the big users of treated wood now view costs; not in terms of the purchase price and expected service life only, but taking into account each element of the total life cycle cost.

3. Disposal in landfills

Availability of landfills

Communities of all sizes are finding it increasingly difficult to site new landfills and evermore costly to build them with the latest environmental safeguards. The problems are intensified with hazardous waste landfills. These are not uniformly distributed around the country, and it looks as if very few new ones will be permitted. NIMBY applies here with a vengeance! One problem facing landfills is that bulky organic materials do not necessarily decompose as anticipated. Earlier, landfills were viewed as large compost heaps, where the volume of garbage would continuously shrink through biodegradation, with slow release of carbon dioxide, making room for fresh garbage on top. Perhaps because the moisture relationships or oxygen levels are not always conducive to this, the bulk reduction does not always occur. It's not surprising if operators of landfills are reluctant to take treated wood, which is designed not to lose shape or mass over very long periods. All these factors work to increase the fee the landfill charges its customers, and $US 150, or more, has been quoted *per utility pole.*

To get a better idea of the size of the disposal problem, we need to estimate the flow of treated wood coming out of service.

Quantity of treated wood leaving service

Consider three major product groups: creosoted rail ties, creosote or penta treated utility poles, and sawn materials treated with CCA. Hard historical production numbers for whole segments of an industry are rarely available: the author has attempted to report "ball park" figures for the three categories, which may be good enough for the present purpose. It is even more difficult to find good service lives, although the many railroads and utilities keep their own records of installations, *in-situ* remediations, and removals. Each set of data will have a bell-curve distribution. Imagine the problem of reducing this data into a simple number for the "average years of life" per tie or pole, county-wide. With CCA, no meaningful service life records were found at all: the only choice was to "guesstimate".

In each example the disposal quantity is converted to a common unit - tons (2,000 pounds) - for uniformity.

(a) *Creosoted rail ties*

Conlon, 1992, talking of the US railroad industry, estimated that 10 to 15 million ties are replaced annually, with the following destinies:

62% given or sold for reuse by others
15% burned for energy, etc.
23% landfilled

This means landfills were asked to take approximately 10 million cubic feet, or 240,000 tons of used treated ties in 1992.

(b) *Creosote or penta treated poles.*

According to Malecki, 1992, the following number of utility poles were in service in the USA.

Power industry	=	60 million poles
Telephone industry	=	12 million poles
Total utilities	=	72 million poles

Most of these poles were creosoted or penta treated, but CCA has been gaining in market share in the last 20 years, *Figure 1.*

Malecki quoted the average service life of utility poles as 35 years, and concluded that the weight of poles being removed from service each year approaches 1,500,000 tons.

If we take the weight of the rail ties and of the poles in the above examples, we see a total weight of 1,740,000 tons might be destined for landfilling in one year from these two sources alone.

(c) *Waterborne (CCA) treated lumber and timbers*

The assumption is made here that the average service life of CCA treated wood is 20 years, as the principle use is in home and yard improvements where fashion, style and appearance are important. These factors, not structural strength or decay, may turn out to be the main criteria for removal.

In 1993, the author estimates that about 5 billion board feet of sawn wood will be treated with CCA in the USA. Unlike the treated pole market, which held a fairly steady consumption level over the last 20 years, the CCA market has grown dramatically in that time (Mickelwright, 1988), *Figure 2.*

In 1973, the total production of sawn CCA treated wood was estimated at about 1 billion board feet. Keeping things very simple, can speculate that the whole 1973 production may be retired in this year, 1993. Assuming it all goes to landfills:

Landfilling volume (CCA-1993)	=	1,000,000,000 board feet
At about 65 cubic feet per 1000 board feet	=	65,000,000 cubic feet
At about 40 lbs per cubic feet	=	1,300,000 tons CCA treated wood

The reader may well ask "if *1.3 million tons* of discarded CCA treated wood was going into US landfills *this year*, would we not sense a reaction from someone - landfill operator, garbage collector, health department?" It could be that the estimate of 20 years of life is too short: properly CCA-treated wood will retain its strength a lot longer than that. It could be that the disposal is done in such small consignments, by individual home-owners, that nobody has yet noticed the *total* quantity reaching the landfills. Whatever the average "first life" - 20 years or more - the *diffuse* nature of disposal probably best explains the lack of concern over treated sawn wood.

But will this continue? Think ahead to the year 2013, when the 1993 production level of 5 billion board feet might retire from first service:

Landfilling volume (2013)	=	5,000,000,000 billion board feet
At 65 cubic feet per 1000 board feet	=	325,000,000 billion cubic feet
At 40 lbs per cubic feet	=	6,500,000 tons

My calculations are of course simplistic; we don't know for certain the volumes or weights of waste wood our industry will create for future generations to deal with.

To summarize the scale of the problem, it seems that, in 1993, the three treated product groups together could yield over 3 million tons of solid waste. Using that popular unit of size, the football field, if all this wood was tightly packed on the playing area of the standard field, the stack would reach a height of some 2,700 feet: *over half a mile high*!

We can conclude that a very major problem is already recognized with rail ties and utility poles leaving service, and that the CCA industry has not yet seen the huge potential landfill quantities which could dwarf the totals for the whole industry today, and almost certainly cause a serious resistance from landfill operators. Those of us who don't see a problem now will surely be forced to focus on it in the future.

Soil and water quality at landfills

This subject has been widely discussed by others (e.g. Webb and Davis, 1992; Suzuki and Sonobe, 1993; Voss and Willeitner, 1993; Malecki, 1992; Conlon, 1992.) There has also been much debate about treated wood: can it go in a regular sanitary landfill, or must it go in a hazardous waste landfill with much higher dumping fees? Fortunately for the industry, all three preservative treatments, in the form of whole ties, poles, or lumber easily pass the U.S. Environmental Protection Authority's Toxic Characteristic Leaching Protocol (TCLP), which is taken as the toxicity determinant for safe landfilling. The other three determinants: reactivity, corrosivity, and explosivity do not apply to treated wood, so the inference is that treated wood can safely be placed in a sanitary landfill in the USA. Despite satisfying these federal requirements, individual states have ruled that some or all types of treated wood should only go to hazardous waste landfills. In these states, the treating industry is vigorously contesting the rulings.

4. Treated wood as a resource

Burning with energy recovery

Open burning of used treated wood was a common and favored way of disposing of wood items. Even in remote parts of the country, this is now reported so unpopular that it is rarely practiced. Wood treated with creosote or oily preservatives does have considerable energy potential, and this can be released by controlled burning in an industrial furnace.

Koppers Industries operates a "recycling to energy" program (Webb and Davis, 1992). The cogeneration plant in Muncy, Pennsylvania, is reported to burn 110,000 tons of creosote treated wood products per year, giving 10,000 lbs of steam per hour, and up to 10 megawatts of power, sold to a local utility. Elsewhere, Conlon (1992) reported that the Muncy plant can burn about 900,000 creosoted rail ties in a year, each tie releasing between 6300 and 8600 BTUs of energy. In addition, the Muncy, PA plant sells excess treated wood chips for use in municipal energy plants. Koppers Industries also operates commercial steam generators, using creosoted and penta treated wood as fuel, in Florence, South Carolina and Montgomery, Alabama. The company is reportedly planning plants in Virginia and California.

To give a measure of the value of treated wood as a fuel, Forshaw estimated the energy available if the entire 1990 USA production of creosote and penta treated poles was burned for fuel. He calculated that the year's production of poles was equivalent to almost 75 million barrels of oil, worth some $US 102,000,000 (Forshaw, 1992).

Smith, G.E. (1992) describes the development and successful full scale trial of crushed industrial flooring blocks as fuel. The crushed blocks (presumed treated with creosote) were blended with coal in a Huntsville, Missouri power plant, where they successfully reduced particulate and sulphur emissions and lowered oxygen gas consumption. He speculated that crushed, metal-free railroad tie fuel could be blended at up to 15% with coal, with little effect on the power plant's operations, except for the better quality of stack emissions.

Cement kilns in several parts of the USA are partly fueled with creosote or penta treated wood. The inside of a cement kiln is claimed to be an ideal environment for breakdown of polynuclear hydrocarbons, furans, and dioxins. The wood need not be ground into small chips (Berlin, 1992).

Burning - air quality aspects

Recent literature indicates few air quality problems from the burning of wood treated with creosote or penta in oil. Many writers refer to the "right" temperature being needed to cause total breakdown of harmful components, but this seems achievable in cement kilns, industrial furnaces and power plants.

With CCA treated wood, there is more cause for concern. One reason is that arsenic compounds often volatilize at high temperatures, and might leave the furnace with the smoke. The other is that those inorganic substances which do *not* volatilize will obviously remain in the ash, and need careful consideration when ash is removed from the furnace.

In USA, the Environmental Protection Authority bans the burning of CCA treated wood in open fires, and in furnaces not specifically designed and tested for the purpose. However, users of treated wood can put offcuts into sanitary waste destined for landfilling or community incineration. Industrial users of treated wood, with bigger quantities of sawdust, offcuts, and reject products find much more difficulty with disposal.

Work has been done to find safer ways to burn CCA treated wood. Cornfield *et. al* (1983) were able to discount arsine gas as a product of the burning of CCA wood, and Pasek and McIntyre (1992) demonstrated only a low volatility of the arsenic component at high temperatures, if oxygen in the furnace was carefully controlled. The authors speculated that this method may become practical as a clean way of fully recovering the chromium, copper, and arsenic for reuse, as well as extracting the thermal energy content of the fiber.

Reconstituted wood products

There is little mention in the literature of treated wood after one service life being converted into new shapes for reuse, other than by simply cutting a pole into shorter lengths for posts, etc. However, Webb and Davis, 1992, and Conlon, 1992, referred to a process for rebuilding railroad ties from used ties, which was carried out commercially for some time. Apparently, ties were demetaled and broken into chips, then cemented together using resin, to form new rail ties. The process is not used today.

Reuse

A good example of the reuse of out-of-service products is the large aftermarket that has developed for railroad ties. Typically, ties are retained by the railroads as long as they can be used in the track. When removed from main lines, ties are often reused in secondary lines. When that service is over, the tie is no longer needed. By an often complicated route through contractors, wholesalers, and retailers, many of these ties end up in landscaping roles, both domestic and commercial. In this way, many of them appear to give a long and useful second, third, or fourth life.

Kempton, 1992, refers to the reuse of poles. In southern states, it is apparently common for poles to be cross-cut and reused for fence posts, and in some western areas the center, heartwood parts of the poles may be reusable as lumber. Old creosoted and penta treated poles are also used in commercial parking lots as barriers, etc.

A research study of Cladosporium and Arthrobacter species (both isolated from contaminated wood preserving sites) showed the ability of these two organisms to reduce the polynuclear aromatic hydrocarbon content of creosoted wood (Samuel and Borazjani, 1992).

Recently, one line of research and development has linked microbes with solvent stripping to remove creosote and penta from treated wood, leaving 99.9999% clean fiber in the form of wood chips. Pilot plant studies were apparently so successful that the chip produced will enjoy a premium price over virgin chip, principally through the higher cellulose/ton shipped due to a lower moisture content in the cleaned chips.

The process uses and recycles water and solvents, but has no liquid or vapor waste streams, other than recovered wood preservatives, which are reported to be reusable.

A company, Microterra, Inc., has been formed to exploit the biorecycling process, and intends to open the first 300 ton/day plant in Tallulah, Louisiana in February 1994 (Portier and Kressbach, 1992). There are plans for three more plants later in 1994, in northern New Jersey, northern California, and the Ontario/Quebec area of Canada. In all, Microterra, Inc. sees the need for nine plants in North America, to provide a reasonably local service to utilities and railroads, who will pay to have their retired treated products processed. European joint ventures are also under negotiation.

Microterra claims another chemical-based technology for waterborne treatments, and 97% removal of CCA from treated chips is achievable.

Reuse of CCA treated material does not seem to have developed a pattern yet, probably because of the newness of this sector of the industry, and the lack of concentration of retired wood in any one place.

As final examples, a commercial company, M.T. Incineration, has reported a process using liquid metal at 1760 degrees fahrenheit as a breakdown medium for chlorinated organics and metal-containing wastes. This may be applicable to treated wood. Products of the incineration are *synthesis gas* (a fuel composed of carbon monoxide and hydrogen), *metal scrap* containing any metals present in the feed stock, some of which may be valuable and can be recovered, and *vitrified solids*, which can be used as abrasives or as aggregate (*anon*, 1993). Conlon, 1992, also referred to a process which produced gas from creosoted wood chips.

5. Industry's response - is it enough?

Coalitions

In 1992, the major USA trade and research organizations representing railroads, power, telephone utilities and piling interests formed a "Treated Wood Lifecycle Management Coalition". This was partly modeled on the earlier "Used Oil Recycling Coalition" which has gone a long way to eliminate irresponsible dumping of oils, and to foster their redistillation into new products (Green, 1992). Political lobbying has helped obtain a workable legislative environment for successful collection, reprocessing, and resale of oil from vehicle service stations, quick lubrication companies, fleet operators, and end users, to the extent of hundreds of millions of gallons per year.

The recently formed Treated Wood Lifecycle Management Coalition is sponsored by large treaters and preservative suppliers, and associations such as:

American Short Line Railroad Association
American Wood Preservers Institute
Association of American Railroads
Edison Electric Institute
International Marina Institute
National Rural Electric Cooperative Association
National Timber Piling Council
Railroad Tie Association
U.S. Telephone Association

At present, the coalition deals almost exclusively with creosote and penta treated products, as these products and the large industries they serve are the ones giving rise to such large quantities of used treated wood in one place.

The Southern Pine Marketing Council (SPMC) has elevated "Total Use of Treated Wood" to its number two priority program for 1994. Their aim is to eliminate the landfill option by offering ideas and "How-to" information which will:

- use off-cuts from the builder or handyman's main projects to make other useful or fun objects.

- suggest a variety of practical uses for treated wood from decks, etc., which are demolished.

This is an excellent idea, and should be taken further by more of the trade support organizations.

It is understandable that people should prefer freshly treated wood for decks, where good appearance is a major factor. But, there is a host of projects for which "once used" material will work as well as new: composting bins, path edging and steps, cold frames, raised beds, suspended floors for sheds, etc.

Municipalities might offer to collect discarded decking for park projects: boardwalks, nature trails, shelters, picnic tables, seats, signs, fencing, and petting zoos.

Returning to newly treated wood. For too long "the deck" has been the number one consumer of sawn treated wood, for vertical supports, framework, boards, steps, balusters, rails, etc. The retail side of the treating industry in USA has matured and levelled out, because so many decks have now been built. There will be good sales for new decks for a long time, but we can't expect the number of deck installations to grow annually as they did in the 1980s. A new fashion *has to be created* by people with vision, a good deal of energy and determination, and a lot of money to promote their idea. To date, this has not happened.

Treated wood is a publicly accepted material for life in the 1990s. To protect this, the public's confidence in the product has to be nurtured, and this is the first priority of the SPMC 1994 program. AWPI's ambitious "Project 2000" plan is also being finalized; its purpose is to reinforce confidence among specifiers and environmentalists that treated wood, properly used, is the sensible, safe and nature-friendly material-of-choice for nearly all low-rise land, freshwater, and marine construction projects.

6. Conclusions

Large industrial uses have wisely grouped together to develop alternatives to landfilling for used, treated wood. Because of the nature and size of their businesses, railroad and utility companies have had to respond first, as they face the disposal challenge today.

Many ties and poles find secondary uses. Landfilling and decomposition by burning, which makes maximum use of recovered heat, are widely used methods. Burning as fuel is acceptable for the creosoted and penta-treated wood which was the most common type installed in the past.

In the future, the balance of preservative types in retired wood will change, with waterbornes (mainly CCA) steadily increasing in share. Burning is not such a good choice at present for CCA materials; more research is needed. Recycling is preferable over destruction by fire if the retired wood can be used for second-generation projects where function outrates appearance. Without major research and publicity to develop and promote new uses for old wood, the huge quantity likely to come out of service in the next 20 years will stockpile, and will draw the unwanted attention of the media and municipal officials to a disposal problem that should never have occurred.

This must not happen. A new level of collaboration by treaters is called for. Otherwise, the laudable initiatives planned by SPMC and AWPI will be funded by just a minority of lumber production and treating companies, and so lack the commitment, enthusiasm and synergy of *we're all-in-it-together* crusades. "Will Treaters Save Treated Wood"? Hopefully yes, but we should go even further with recycling and reuse initiatives, to completely avoid the landfill option, and then be able to declare that "Recycling Treated Wood Saves Treaters".

7. Literature

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8. Figures

Note: The data for the two trend graphs was taken from a number of industrial sources, with data gaps filled by the author.

Figure 1: US Utility Poles
Market Share by Main Preservative

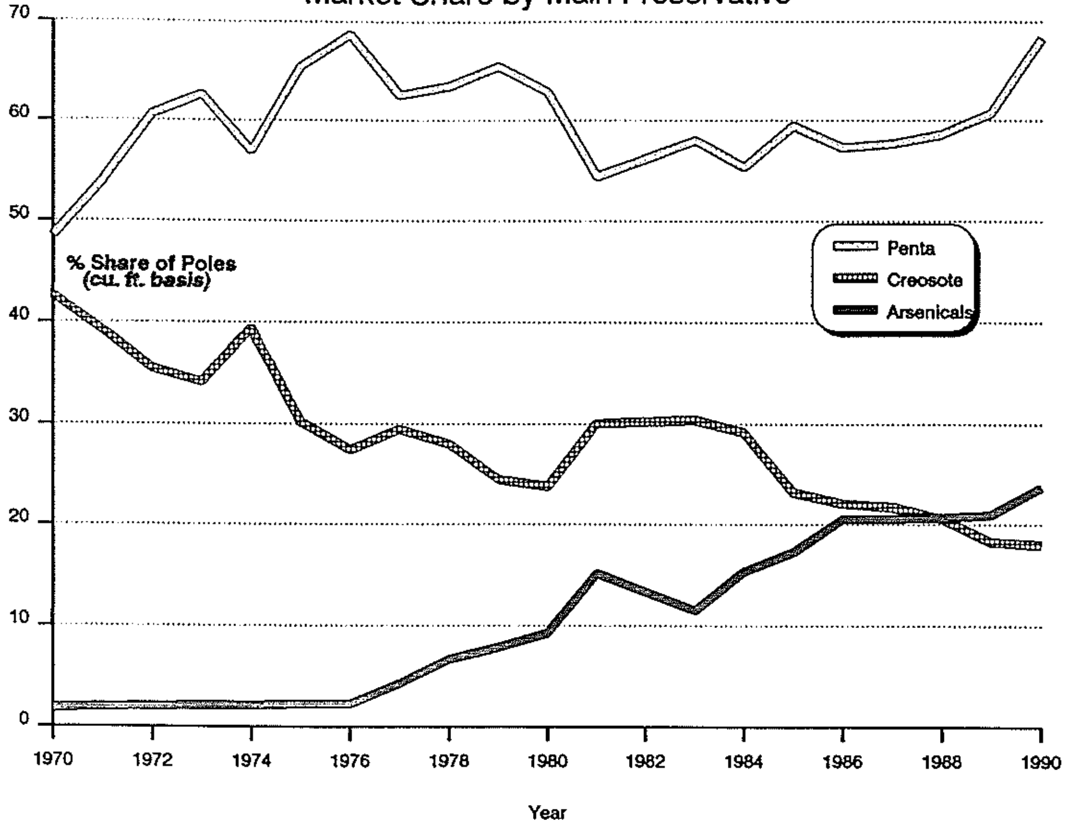

Figure 2: Production Trends for Two Categories
of Treated Wood, USA, 1973-1990