Reference #4

EPA-450/4-84-007p
September 1987

Locating And Estimating Air Emissions From Sources Of Polycyclic Organic Matter (POM)

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office Of Air And Radiation
Office Of Air Quality Planning And Standards
Research Triangle Park, North Carolina 27711

the Soderberg processes. The test data in Table 69 illustrate that the majority of the POM emissions from the anode past process were particulate matter and not vapors. The POM emissions of the horizontal Soderberg process exhibit a similar behavior as evidenced by the Table 69 data. Conversely, POM emissions from the vertical Soderberg process were predominantly in vapor form instead of particulate.[145]

A list of all the POM compounds identified in emissions from the aluminum smelter is provided in Table 70.[145]

Source Locations

As of January 1985, there were 28 primary aluminum reduction plants in the United States operated by 10 different companies. Washington State has seven plants, the most of any State in the country. A complete list of all 29 facilities is given in Table 71.[146]

WOOD CHARCOAL PRODUCTION

Process Description

Charcoal, primarily used for outdoor cooking, is manufactured by the pyrolysis of carbonaceous raw materials, primarily medium to dense hardwoods such as beech, birch, maple, hickory, and oak. Softwoods, sawdust, nutshells, fruit pits, and vegetable wastes are also used in the pyrolysis process. The high temperature (450 to 510°C) pyrolysis of wood materials is a potential means of generating POM air emissions.[147]

Hardwood charcoal is manufactured by a four-step pyrolysis process. Heat is applied to the wood, and as the temperature rises to 100°C (212°F), water and highly volatile hydrocarbons are distilled off. The wood temperature remains at approximately 100°C until the moisture content of the wood has been removed, at which time the volume of distillate production declines and the wood temperature begins to climb. During the next stage, the wood temperature rises with heat input to approximately 275°C (527°F), and hydrocarbon distillate yield increases. As the third stage begins in the vicinity of 275°C, external application of heat is no longer required since the carbonization reactions become exothermic. During this stage, the wood temperature rises to 350°C (662°F), and the bulk of hydrocarbon distillates are produced. At approximately 350°C, exothermic pyrolysis ends, and during the final stage, heat is again applied, raising the wood temperature to 400 to 500°C (752 to 932°F) to remove more of the less volatile, tarry materials from the product charcoal.

Currently, there are predominantly two types of vessels used to manufacture wood charcoal, the Missouri-type batch kiln and the continuous Herreshoff furnace. The batch process and kiln account for about 45 percent of national wood charcoal production. The Missouri-type kiln shown in Figure 35 is typically constructed of concrete.[148] A Missouri-type batch kiln normally processes about 45 to 50 cords of wood in a 10- to 25-day cycle. A typical cycle may be structured as follows.

1 - 2 days	load wood
5 - 8 days	pyrolysis
10 - 14 days	cool
1 - 2 days	unload charcoal

After the wood is manually loaded in the kiln, a fire is started, usually at the bottom center of the kiln, by igniting easily combustible materials placed at this point during the loading. During ignition, a large amount of air is necessary for the rapid combustion of the starting fuels to insure the heat level needed for pyrolysis. This air is supplied through groundline ports in the kiln side walls or through temporary openings under the kiln door. In some cases, the kiln doors remain open until the burn is adequately started. Auxiliary ceiling ports in some kilns serve as temporary stacks and aid ignition by causing greater amounts of air to be drawn into the kiln through the air ports. They also aid removal of smoke from the kiln.[148]

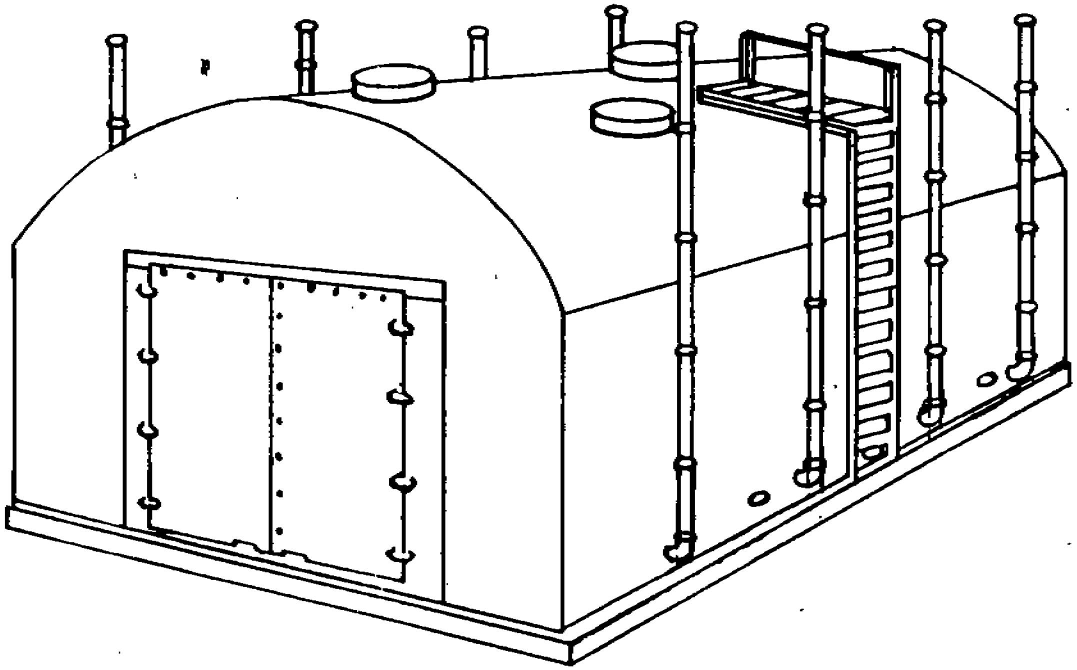

Figure 35. Missouri-type charcoal kiln.[148]

Ignition patterns are generally similar for all types of kilns. During the first 5 to 15 minutes, temperatures in the ignition area will rise rapidly to about 540°C (1004°F). After much of the fuel has been burned, the temperatures will quickly drop, often to as low as 150°C (302°F). The extent of the temperature drop is closely related to conditions of air supply and to the moisture content of the charge. With the establishment of a suitable ignition zone, however, the temperature gradually increases to about 280°C (536°F), and the ignition period is considered complete.[148]

Satisfactory carbonization depends primarily on the maintenance of proper burning conditions in the pyrolysis zone. Sufficient heat must be generated first to dry the wood and then to maintain temperatures necessary for efficient carbonization. At the same time, the burning must be limited so that only sufficient heat is present to produce good charcoal. Temperature control is attained by varying the size of the air port openings providing air for combustion of wood volatiles.[148]

For the production of good-quality charcoal, kiln temperatures from about 450 to 510°C (842 to 950°F) are required. Prolonged higher temperatures will reduce the yield of charcoal without necessarily upgrading it for recreational use. If, on the other hand, pyrolysis temperatures remain low, the charcoal may be too smoky for domestic use, and larger than normal amounts of brands (partially charred wood) will be produced.[148]

The direction and rate of spread of the pyrolysis zone is associated with a number of factors, such as location of air ports and stacks, volume and velocity of the incoming air, wood size and moisture content, piling of the charge, and design of the kiln. Pyrolysis generally proceeds at a faster rate at the upper part of the charge, where higher temperatures are available for longer periods of time. Less rapid pyrolysis takes place near the kiln floor, where the average temperature usually is lowest. In the Missouri-type kiln, combustion and carbonization progresses from the top of the kiln to the floor and from the center to the walls.[148]

Burn progress can be determined by the color of the smoke from the kiln or by determining the temperature along the vertical distance of the steel doors. The pyrolysis is completed when fire has reached the floor of the kiln as determined by view ports (air intake ports) at the floor level. This may also be indicated by a marked decrease in the volume of smoke and a color change from grayish yellow to bluish white.[148]

When pyrolysis has been completed, all air ports are sealed for the start of the cooling cycle. After the ports are sealed, the stacks remain open until smoking has practically stopped to prevent the development of gas pressure in the kiln. Stacks can usually be sealed from 1 to 2 hours after the air ports are closed. The kiln is allowed to cool for about 10 to 14 days before removing the charcoal. Yields of approximately 25 percent are achieved.[148]

The required pyrolysis time and resultant POM emissions from a Missouri-type batch kiln vary with kiln capacity, operational practices, wood type, and wood moisture content. Process reaction gases containing POM are exhausted from the kiln in stacks that run along the side walls of the vessel.[147,148] The charcoal product of a batch kiln process is either sold directly or made into briquettes prior to selling.

Continuous charcoal production is accomplished in Herreshoff multiple hearth furnaces. The use of continuous multiple hearth units for charcoal production has increased because of the following advantages of the units.

- Lower labor requirements than kiln operations where manual loading and unloading is needed. Only one man per shift is required for continuous facilities.
- Consistent yield and quality charcoal with easy control of product volatile and fixed carbon content.
- Feed of multiple forms of wood waste.
- Off-gases easily collected for further processing.

The typical feedstock capacity of continuous wood charcoal furnaces is 2.5 Mg (2.75 tons)/hour.

The operational principles of the Herreshoff furnace (shown in Figure 36) are relatively simple. Passing up through the center of the furnace is a shaft to which are attached two to four rabble arms for each hearth. As the shaft turns, the hogged wood material resting on the hearth floors is continually agitated, exposing fresh material to the hot gases being evolved. A further function of the rabble arms is to move material through the furnace. On alternate hearths, the teeth are canted to spiral the material from the shaft toward the outside wall of the furnace or from the outside wall toward the center shaft. Around the center shaft is an annular space through which material drops on alternate hearths, while on the remaining hearths material drops through holes in the outer periphery of the hearth floor. In this way, material fed at the top of the furnace moves alternately across the hearths at increasing temperatures until it discharges from the floor of the bottom hearth. Charcoal exiting from the furnace is cooled by water sprays and water jacketing on a cooler. These sprays are controlled automatically by a temperature regulator set for a given charcoal temperature. As with batch kilns, the charcoal product of continuous kilns is either sold directly or further processed to briquettes for sale.[148]

Initial heat for startup is provided by oil- or gas-fired burners mounted in the sides of the hearths. When furnace temperature has been attained, the auxiliary fuel ceases, and combustion air is used to ignite the evolving wood gases to maintain furnace temperature. Furnace temperatures range between 480 and 650°C (896 to 1202°F). Exhaust gases from the charcoal production process are vented to the atmosphere or to controls through stacks located on top of the furnace, are used as a heat source for predrying of feed material and drying of briquettes produced at an adjacent vessel, or are burned in a waste heat boiler to produce steam.[147]

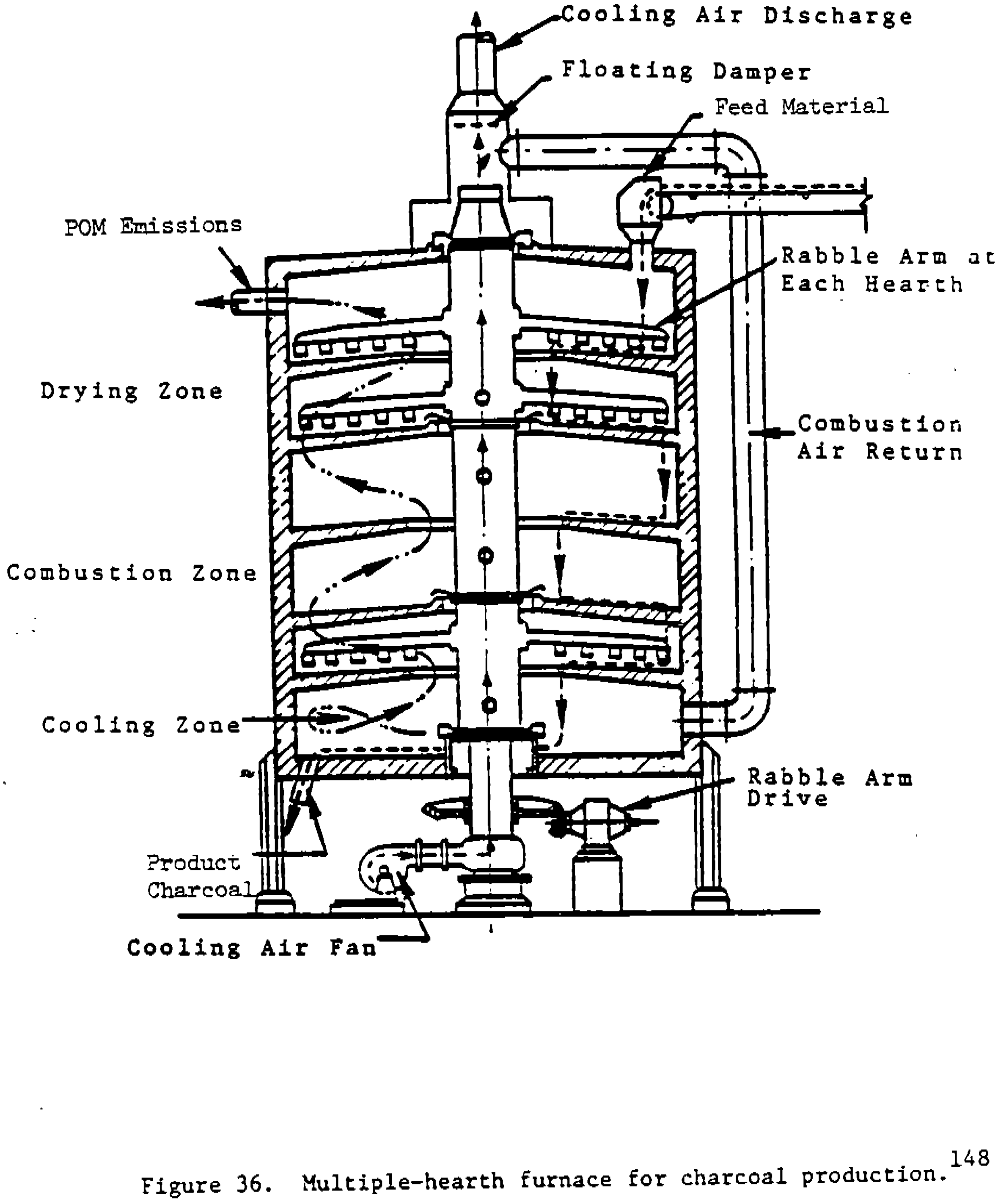

Figure 36. Multiple-hearth furnace for charcoal production.[148]

A 1978 U. S. EPA investigation into wood charcoal production indicated that many of the batch kilns are relatively old and many, particularly smaller kilns, are uncontrolled.[147,148] In general, the control of emissions, including POM, from batch wood charcoal kilns is complicated by the cyclical nature of the process. Throughout the cycle, both emission composition and flow rate change. Direct-fired afterburners for the destruction of hydrocarbons have been suggested to be the most feasible control system; however, these devices would require an auxiliary fuel such as natural gas. Economic analyses have indicated that for typical batch kilns, the operation of afterburners for emissions control would cause firms to lose money.[148] With the combustion of auxiliary fuel of any type, a potential is also created for additional POM emissions. No information is available on the proportion of batch kilns with afterburner controls or the effect of afterburner use on POM emissions.[147]

Continuous wood charcoal furnaces are predominantly controlled by direct-fired afterburners.[147,148] Auxiliary fuel firing is required in continuous furnace afterburners only during start-up or process upsets because of the generally higher heating value of continuous furnace exhaust gases. One facility has been found to be using an incinerator to control furnace emissions.[148]

Emission Factors

Polycyclic organic matter emission factor data are available in the literature only for a Missouri-type batch kiln.[147] Five sampling runs were made and total uncontrolled POM emissions averaged 3.5 g/Mg (0.007 lb/ton) of charcoal produced. Reference 147 indicates that the POM samples from these tests were obtained using a modified Method 5 procedure and sample analysis was performed by gas chromatography. Benz(c)phenanthrene and benzo(a)pyrene were identified as constituents of total POM emissions. Four other POM compounds, dibenz(a,h)anthracene, 3-dimethylcholanthrene, 7,12-dimethylbenz(a)anthracene, and 3,4,5,6-dibenzocarbazole, were specifically analyzed for but were not detected in any of the samples.[147]

The authors of Reference 147 noted that the results of the batch kiln emission tests might be of questionable value due to the difficulty of sampling the kiln and "the improvisational sampling techniques" used. No estimate of the accuracy of the test results was provided.

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Source Locations

Wood charcoal manufacturing facilities are located in 24 States primarily in Missouri, Arkansas, and in several southeastern States.[148] A list of wood charcoal producers in the United States is provided in Table 72.[148]

CREOSOTE WOOD TREATMENT

Process Description

Creosote impregnation plants, also called wood treatment plants, have been identified as potential air emission sources of POM because creosote contains significant quantities of POM compounds. Creosote is a product of the fractional distillation of coal tar, which is a by-product of bituminous coal coking. The principal use of creosote is as a wood preservative. It is used to treat crossties, switch ties, utility poles, crossarms, marine and foundation pilings, construction lumber, fence posts, and plywood.[144]

Treatment is accomplished by either pressure or non-pressure processes. To initiate either process, wood products are debarked and conditioned. Conditioning, primarily moisture removal, is performed by air seasoning or kiln drying in the majority of plants. Depending on the particular preservative to be applied, conditioning may also be performed by steaming the wood in the treatment retort, heating the wood in oil under reduced pressure, or exposing it to hot vapors of organic solvents (vapor drying). To expedite certain treatment processes, the wood may be pierced by knives (a process called incising) to provide avenues for penetration of the preservative solutions.[149]

TABLE 72. CHARCOAL PRODUCERS IN THE UNITED STATES[148,a]

State	City or County	Producer
Alabama	Dothan	Kingsford Company
	Tuscumbia	Malone Charcoal Company
	Muscle Shoals	McKinney Lumber and Plywood
Arkansas	Jasper	Jasper Charcoal Company
	Huntsville	Keeter Charcoal Company
	Omaha	Keeter Charcoal Company
	Green Forest	Keeter Charcoal Company
	Yellville	Martin Charcoal*Company
	Paris	Ozark Charcoal Company
	Scranton	Scranton Charcoal Company
	Waldron	Waldron Charcoal Company
	Harrison	Newberry Charcoal Company
	Paris	Paris Charcoal Company
	Paris	Arkansas Charcoal Company
	Hot Springs	Weyerhaeuser Company
	George	George Charcoal Company
	Hatfield	Arkansas Charcoal Company
	Waldron	Waldron Charcoal Company
	Mountain View	Hinesley and Everett Enterprises
California	Elk Grove	C. B. Hobbs Corporation
	Santa Clara	C. B. Hobbs Corporation
	Milipitas	C. B. Hobbs Corporation
Florida	Ocala	Pioneer Charcoal
Georgia	Atlanta	Husky Industries
Kansas	Chetopa	Jayhawk Charcoal Company
Kentucky	Burnside	Kingsford Company
Illinois	Chicago	Great Lakes Carbon Corporation
Maryland	White Church	Kingsford Company
	Oakland	Kingsford Company
Minnesota	Isanti	Husky Briquetting, Inc.
Mississippi	Bruce	Blackjack Charcoal Company
	Pachuta	Hood Charcoal Company
	Pachuta	Masonite Corporation, Charcoal Division
	Beaumont	Ronnies Hickory Chips

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[a] In 1978

TABLE 72. CHARCOAL PRODUCERS IN THE UNITED STATES[148] (Continued)

State	City or County	Producer
Missouri	Barry	Harris Enterprises
	Purdy	Heaser Charcoal Company
	Boone	Charles Chrisman Charcoal
	Centralia	L and A Dailing Charcoal Company
	Carter	Big Springs Industrial
	Carter	Carter County Charcoal
	Ellsinore	Leach Brothers Charcoal
	Ellsinore	Rozark Farms
	Van Buren	Big Springs Charcoal
	Van Buren	Big Springs Charcoal
	Cole	Stegeman Charcoal Company
	Henley	Louis Stegeman Charcoal Company
	Jefferson City	Rich Stegeman Charcoal Company
	Steelville	Hardwood Charcoal Company
	Wesco	Fordell Development Corporation
	Greenfield	Pringle Charcoal Company
	Salem	Carty Charcoal
	Salem	Floyd Charcoal Company
	Salem	C and H Charcoal
	Dent	Langworthy Charcoal Company
	Dent	Lennox Charcoal Company
	Salem	Wieberg Charcoal Company
	Salem	Hobson Charcoal Company
	Gasconade	Hickory Charcoal Company
	Owensville	Gene's Charcoal
	Wheatland	J and E Charcoal Company
	Howell	Missouri Charcoal Company
	Mount View	Craig Charcoal Company
	West Plains	Nubbin Ridge Charcoal Company
	Mount View	Bays Sawmill and Charcoal
	Peace Valley	Peace Valley Kilns
	Mount View	Old Hickory Charcoal Company
	Mount View	Carr Forest Products
	Kansas City	Standard Milling Company
	Hocomo	Bakersfield Charcoal Company
	Laclede	Independent Stave Company
	Laclede	Timber Products Company
	Vienna	Wulff Charcoal Company
	High Gate	Kingsford Company
	Belle	Kingsford Company
	Belle	W. B. Stockton
	Belle	H and D Charcoal
	Hayden	Curtis and Hayes Charcoal
	Iberia	Louis Stegeman Charcoal

TABLE 72. CHARCOAL PRODUCERS IN THE UNITED STATES[148] (Continued)

State	City or County	Producer
Missouri (continued)	Miller	Kalaf Charcoal
	St. Elizabeth	Kirkweg Charcoal Company
	Neosho	Neosho Charcoal Products
	Oregon	Greer Springs Company
	Meta	Barnhart Charcoal
	Osage	J and M Charcoal Company
	Osage	Kelly Charcoal Company
	Freeburg	Al Luecke Charcoal Company
	Osage	McDonald Charcoal Company
	Osage	Ridenhour Charcoal Company
	Meta	Ripka Charcoal and Lumber
	Osage	Sugar Creek Charcoal Company
	Freeburg	Wieberg Charcoal Company
	Freeburg	Ben Berhorst
	Meta	Charkol, Inc.
	Belle	Gene Noblett Charcoal Company
	Meta	Standard Milling Company
	Gainesville	Ozark Forest Charcoal
	Ozark	Wallace Charcoal Company
	St. James	Parry Charcoal Company
	Lake Spring	Lenox Charcoal
	Vienna	Tackett Charcoal Company
	Lesterville	Black River Charcoal Company
	Reynolds	Copeland Charcoal Company
	Winona	Dailey Charcoal
	Shannon	George Helmuth Charcoal
	Shannon	Royal Forest Charcoal
	Birch Tree	Kerr Charcoal
	Summersville	Craig Charcoal
	Round Springs	Roaring Springs Corporation
	Round Springs	Round Springs Charcoal
	Round Springs	Robert Hamilton
	Gladden	Timber Charcoal Company
	Branson	S and S Charcoal Company
	Bradleyville	Horner Charcoal Company
	Branson	Keeter Charcoal Company
	Raymondville	Thomason Charcoal Company
	Licking	Wulff Charcoal Company
	Plato	H. O. Charcoal Company
	Seymour	Oak-lite Corporation
	St. Louis	Cupples Company, Manufacturers
New Jersey	Teterboro	Degussa, Inc.

TABLE 72. CHARCOAL PRODUCERS IN THE UNITED STATES[148] (Continued)

State	City or County	Producer
North Dakota	Dickinson	Husky Industries
Ohio	Oak Hill	Victory Charcoal Company
	Lucas	Sun Oil Company
	West Marion	Great Lakes Carbon
	McArthur	Roseville Charcoal
Oklahoma	Heavener	Forest Products Charcoal Company
	Talihina	Forest Products Charcoal Company
	Clayton	Forest Products Charcoal Company
	Talihina	Talihina Charcoal Company
	Bull Hollow	Cherokee Forest Industries
Oregon	Springfield	Kingsford Company
	White City	Georgia Pacific Corporation
Pennsylvania	Brookville	Humphrey Charcoal
South Carolina	Lake City	T. S. Ragsdale Company, Inc.
Tennessee	Jamestown	Royal Oak Charcoal Company
	Red Bank	Cumberland Kingsford
	Cookeville	Royal Oak Charcoal Company
	Tullahoma	Tennessee Dickel Distilling
	Red Boiling Springs	Cumberland Charcoal Corporation
	Spencer	Royal Oak Charcoal Company
	Memphis	Arkansas Charcoal Company
	Lynchburg	Jack Daniels Distillery
Texas	Flatonia	B and B Charcoal
	Houston	Pine-O-Pine Company
	Jacksonville	Campfire Charcoal Company
	Jacksonville	Char Time Charcoal
	San Antonio	National Charcoal Company
Virginia	Kenbridge	Imperial Briquet Corporation
West Virginia	Belington	Kingsford Charcoal
	Beryl	Kingsford Charcoal
	Maysville	Kingsford Charcoal
	Parsons	Kingsford Charcoal
	Swiss	Roseville Charcoal
	Bentree	Roseville Charcoal

TABLE 72. CHARCOAL PRODUCERS IN THE UNITED STATES[148] (Continued)

State	City or County	Producer
Wisconsin	Hixton	Husky Industries

NOTE: This listing is subject to change as market conditions change, facility ownership changes, plants are closed down, etc. The reader should verify the existence of particular facilities by consulting current listings and/or the plants themselves. The level of POM emissions from any given facility is a function of variables such as capacity, throughput, and control measures, and should be determined through direct contacts with plant personnel.

Pressurized processes are used to preserve 95 percent of all treated wood. These processes involve the application of pneumatic or hydrostatic pressure to expedite the movement of preservative liquid into wood. In the normal application of preservatives (e.g., creosote), wood is first loaded on trams and introduced into the pressure vessel. Once in the pressure vessel, wood can be creosote pressure treated by either the full-cell or the empty-cell process.[149]

In the full-cell process, an initial vacuum is applied to the charge for a period of about 30 minutes. At the end of this period, and while still maintaining the vacuum, the vessel is filled with creosote. The vacuum is then released and pressures of 50 to 250 psi are applied to the system. Pressure is maintained until the required gross absorption of preservative has been achieved. At the end of the pressure cycle, the pressure is reduced to atmospheric levels and the preservative liquid in the vessel is returned to storage. The treated wood will often be subjected to a final vacuum to remove excess preservative on the surface of the wood. Once completed, the vacuum is released, the door of the vessel is opened, and the treated stock is removed. Creosote retentions achieved by the full-cell process vary from 320 to 480 kg/m^3 (20 to 30 lbs/ft^3).[149]

In the empty-cell process, the treatment retort is filled with preservative while either at ambient pressure conditions or under an initial air pressure of 15 to 75 psi. The remainder of the treating process is the same as that described for the full-cell process. Depending on the specifications of the customer, wood preservative retentions achieved by the empty-cell process range from 96 to 208 kg/m^3 (6 to 12 lbs/ft^3).[149]

In both the full-cell and empty-cell processes, creosote may be applied in an undiluted form or diluted with coal tar or petroleum. Temperatures of application for creosote and its solutions range from 99 to 110°C (210 to 230°F).

Products such as marine pilings are always treated by the full-cell process. Utility poles, crossties, and fence posts are routinely treated by the empty-cell process. The amount of preservative retention needed and the treatment process required are determined by the biological hazard to which the treated wood will be subjected in service.

Non-pressurized wood treatment processes are used both commercially and by individual consumers for home, farm, and garden wood preservation. Generally, wood treated by non-pressure processes must be seasoned to a moisture content of 30 percent or less prior to treatment to provide the best results.[149]

Most commercial non-pressure creosote treatments are applied by cold-soak or thermal processes. In both processes, wood is exposed to the preservative in an open vessel. The principle behind the cold-soak process simply entails soaking seasoned wood in the preservative for a fixed period of time, or until a predetermined gross retention has been achieved. The thermal process involves exposing wood to hot creosote for 6 to 12 hours followed by exposure to the preservative at ambient temperature for 2 hours.[149]

Home and other non-commercial creosote treatments are typically performed by brush, dip, or spray methods. In these cases, creosote or creosote-based solutions are manually applied at ambient conditions to wood and allowed to dry. The amount of retention that is achieved is a function of wood type, wood moisture content, and wood porosity.[149]

The creosote wood treatment source category appears to a source of primarily fugitive POM emissions that are associated with the actual treatment process and the handling of creosote raw materials and treated products. Fugitive emissions from treatment occur when the treatment vessel is opened at the end of the cycle. The duration of such emissions from each vessel is relatively short because vessels are only opened once or twice during each working shift.[144,150]

A second source of fugitive POM emissions is during creosote transfer from an incoming tanker or rail car to plant storage facilities. The method and frequency of delivery is a function of plant size and location. Generally, the larger the facility the more and greater the creosote loads will be. Increased frequency and quantity means increased potential for emissions. Transfer of the preservative, whether from rail car or tanker, is normally accomplished using a closed piping system. In such a system, the greatest chance for fugitive emissions is at the origin where creosote is leaving the tanker or rail car and at the end of the transfer where creosote is entering the storage vessel.[144,150]

A third potential source of fugitive emissions of POM compounds from creosote wood treatment plants is evaporative losses from treated wood. If treated products are stored in a building, emissions of this type would be largely confined and would not be released to the outside air.[144,150]

No information concerning currently used or potential control equipment for POM emissions from creosote treatment processes was identified in the literature.

Emission Factors

No POM emissions or emission factor data were found in the literature for creosote impregnation plants. The existence of POM emissions in these facilities has been indicated by area samples of air in and around the plants and by personal breathing zone air samples that contained POM compounds. These samples were taken to assess worker exposure to POM compounds. In one facility, worker breathing zone samples had a benzo(a)pyrene range of 0.80 to 84 ug/m^3.[144] An area sample at the impregnation vessel had a benzo(a)pyrene content of 3.6 ug/m^3.[144] Both of these benzo(a)pyrene data points represent collected particulate matter only.

At a second creosote impregnation facility, personal breathing zone air samples were taken to measure both particulate and gaseous POM compounds. Breathing zone samples associated with handling creosote treated railroad ties contained a total POM concentration of 981.2 ug/m^3, of which 97 percent was collected as gaseous POM.[150] These results imply that gaseous POM emissions from treatment plants may be greater than particulate POM releases, and that creosote plants with only particulate POM levels may be greatly underestimating actual POM concentrations in plant air. These implications should be taken into consideration when attempting to estimate emissions from a creosote wood treating process.

Source Locations

Creosote wood treatment plants are located across the country, but they are predominantly found in the Southeast. Information compiled by the American Wood-Preservers Association and the American Wood Preservers Institute indicates that there are roughly 185 creosote treatment plants nationwide. A list identifying these facilities is given in Table 73.[151]

~~OIL SHALE RETORTING~~

~~Process Description~~

~~Oil shale retorting has been identified in the literature as a POM emissions source category. Retorting produces POM emissions because it involves high temperature contact with hydrocarbons and hydrocarbon-containing rock and because hydrocarbon-containing off-gases from retorting are typically incinerated.[152,153] Oil shale retorting is performed by two major processes, above-ground or surface retorting and below-ground or *in situ* retorting. In surface retorting, oil shale is mined and brought to the surface, crushed, and heated either externally or internally to extract oil from the shale rock. In externally heated operations, an external furnace is used to continuously apply heat to the shale retort. In an internally heated system, the oil shale furnishes its own heat because part of its organic matter is burned inside the retort.~~

TABLE 73. LIST OF CREOSOTE WOOD IMPREGNATION PLANTS IN THE UNITED STATES[151,a]

Company	Location
Acme Wood Preserving, Inc.	Princeton, WV
Alabama Wood Treating Corporation	Mobile, AL[a]
American Creosote Works, Inc.	Pensacola, FL Jackson, TN[a] Louisville, MS
American Wood Division of Powe Timber Company	Richton, MS
Annadale Plantation	Georgetown, SC
Appalachian Timber Services, Inc.	Sutton, WV White Plains, KY
Arizona Pacific Wood Preserving	Eloy, AZ
Atlantic Wood Industries, Inc.	Portsmouth, VA Hainesport, NJ Port Wentworth, GA
B and M Wood Products, Inc.	Manor, GA
Baldwin Pole and Piling Company	Bay Minette, AL
Baxley Creosoting Company, Inc.	Baxley, GA
J. H. Baxter and Company	The Dalles, OR Eugene, OR Weed, CA Laramie, WY
Benton Creosoting Works	Benton, LA
Birmingham Wood Preserving Company	Birmingham, AL
Broderick Wood Products Company	Denver, CO
Brown Wood Preserving Company, Inc.	Brownville, AL Louisville, KY
Burke-Parsons-Bowlby Corporation	Stanton, KY Dubois, NV Goshen, VA Spencer, WV
Burlington Northern, Inc.	Brainerd, MN Paradise, MT Somers, MT
Cahaba Pressure Treated Forest Products	Brierfield, AL

[a] In 1984

TABLE 73. LIST OF CREOSOTE WOOD IMPREGNATION PLANTS IN THE UNITED STATES[151] (Continued)

Company	Location
Carolina Creosote Corporation, Inc.	Leland, NC
Carolina Wood Preserving Company, Inc.	Scotland Neck, NC
Cascade Pole Company	Tacoma, WA[a]
Century Forest Industries	Lufkin, TX
Champion International Corporation	Cass Lake, MN Whitewood, SD
Colfax Creosoting Company	Pineville, LA
Conroe Creosoting Company	Conroe, TX
F. E. Cooper Lumber Corporation	Johnstown, PA
Crown Zellerback Treated Wood Products	Urania, LA Gulfport, MS
Dant and Russell, Inc.	North Planes, OR
Duke City Lumber Company	Livingston, TX
Dura-Wood Treating Company	Alexandria, LA
Easterday Tie and Timber Company	Jackson, TN
El Dorado Pole and Piling Company, Inc.	El Dorado, AR
Eppinger and Russell Company	Chesapeake, VA Brunswick, GA Brookhaven, FL
Escambia Treating Company	Camilla, GA
Evr-Wood Treating Company, Inc.	Jennings, LA
Fernwood Industries	Fernwood, MS
Florida Fence Post Company, Inc.	Ona, FL
Fordyce Wood Preservers	Fordyce, AR
Frank Brooks Manufacturing Company	Billingham, WA
G. C. L. Tie and Treating Corporation	Sidney, NY
Garland Creosoting Company	Longview, TX
Gateway Forest Products, Inc.	Mather, PA
General Timber, Inc.	Sanford, NC

TABLE 73. LIST OF CREOSOTE WOOD IMPREGNATION PLANTS IN THE UNITED STATES[151] (Continued)

Company	Location
General Wood Preserving Company, Inc.	Leland, NC
Glacier Park Company	Somers, MT
Glenville Wood Preserving Company, Inc.	Glenville, GA
Great Lake Timber Company	Ft. Duschene, UT
Hart Creosoting Company	Jasper, TX
Huxford Pole and Timber Company, Inc.	Huxford, AL
Holcomb Creosote Company	Yadkinville, NC
Hoosier Treating Company	Gosport, IN
Indiana Wood Treating Corporation	Bloomingdale, IN
International Paper Company	De Ridder, LA
	Joplin, MO
	Longview, WA
	Navasota, TX[a]
	Wiggins, MS
Jasper Creosoting Company	Jasper, TX
Jennison-Wright Corporation	Granite City, IL
	Toledo, OH
Joslyn Manufacturing and Supply Company	Richton, MS
Julian Lumber Company	Antlers, OK
Kerr-McGee Chemical Corporation	Avoca, PA
	Indianapolis, IN
	Kansas City, MO
	Madison, IL
	Meridian, MS
	Bossier City, LA
	Springfield, MO
	Texarkana, TX
	Columbus, MS
Koppers Company, Inc.	Carbondale, IL
	Denver, CO
	Florence, SC
	Gainesville, FL[a]
	Galesburg, IL
	Green Spring, WV

TABLE 73. LIST OF CREOSOTE WOOD IMPREGNATION PLANTS IN THE UNITED STATES[151] (Continued)

Company	Location
Koppers Company, Inc. (continued)	Grenada, MS Guthrie, KY Houston, TX Kansas City, MO Montgomery, AL Montgomery, AR Montgomery, PA[a] Nashua, NH North Little Rock, AR Oroville, CA Orrville, OH Port Newark, NJ Richmond, VA Salem, VA Salisbury, MD Superior, WI[a]
The Langley Company	Valdosta, GA
Lufkin Creosoting Company, Inc.	Lufkin, TX
Madisonville Creosote Works, Inc.	Madisonville, LA
Manor Timber Company, Inc.	Manor, GA[a]
Marion Pressure Treating Company	Marion, LA
Marshall Wood Preserving Company	Marshall, TX
McArthur Lumber and Post Company, Inc.	McArthur, OH
McCormick and Baxter Creosoting Company	Portland, OR Stockton, CA
McCrawie Brothers Wood Preserving Company	Willacoochee, GA
L. D. McFarland Company	Eugene, OR[a]
McFarland Cascade	Olympia, WA Tacoma, WA
H. P. McGinley, Inc.	McAlisterville, PA
Mellott Wood Preserving Company	Needmore, PA
W. C. Meredith Company, Inc.	East Point, GA
T. R. Miller Mill Company, Inc.	Brewton, AL
Mississippi Wood Preserving Company	Brookhaven, MS

TABLE 73. LIST OF CREOSOTE WOOD IMPREGNATION PLANTS IN THE UNITED STATES[151] (Continued)

Company	Location
Mixon Brothers Wood Preserving, Inc.	Idabel, OK
Moultrie Wood Preserving Company	Moultrie, GA
New South Forest Industries	Red Hill, SC
Osser Company	Bellingham, WA
Oliver Treated Products Company, Inc.	Hammond, LA
Ouachita-Nevada Treating Company	Reader, AR
Pacific Wood Preserving of Bakersfield	Bakersfield, CA
Pacific Wood Treating Corporation	Ridgefield, WA
Pearl River Wood Preserving Corporation	Picayune, MS
Perma Treat Corporation	Durham, CT
Prentiss Creosote and Forest Products, Inc.	Prentiss, MS[a]
R and K Creosote Company, Inc.	Natalbany, LA
Reddell Creosoted Forest Products, Inc.	Reddell, LA
San Diego Wood Preserving	National City, CA
Santa Fe Centralized Tie Plant	Somerville, TX
Seaman Timber Company, Inc.	Montevallo, AL
Sheridan Pressure Treating Lumber	Sheridan, OR
Shollenbanger Wood Treating	Bernalilco, NM
W. J. Smith Wood Preserving Company	Denison, TX
Southern Pine Wood Preserving Company	Wiggins, MS
Southern Wood Piedmont Company	Augusta, GA Baldwin, FL Chattanooga, TN East Point, GA Gulf, NC Macon, GA Spartanburg, SC Waverly, OH Wilmington, NC
Stallworth Timber Company, Inc.	Beatrice, AL
Standard Wood Preservers of Shreveport, Inc.	Shreveport, LA[a]

TABLE 73. LIST OF CREOSOTE WOOD IMPREGNATION PLANTS IN THE UNITED STATES[151] (Continued)

Company	Location
St. Regis Paper Company	Cass Lake, MN Whitewood, SD
Superior Tie and Timber	Vivian, LA
Superior Wood Treating, Inc.	Louisville, MS
Sweeney Wood Products	Lapoint, UT[b]
J. C. Taylor Lumber Sales	Sheridan, OR
Texarkana Wood Preservative Company	Texarkana, TX
Texas Electric Cooperatives, Inc.	Jasper, TX
Thompson Industries	Russellville, AR
Thomasson Lumber Company	Philadelphia, MS
Timco, Inc.	Wiggins, MS
Union Lumber Company	Homerville, GA
Utah Power and Light	Idaho Falls, ID
Vermont Correctional Industries	Windsor, VT
Virginia Wood Preserving	Laurel, VA
Webster Wood Preserving Company	Bangor, WI
Western Tar Products Corporation	Terre Haute, IN
Western Wood Preserving Company	Sumner, WA
Wood Preservers, Inc.	Warsaw, VA
Wood Treating, Inc.	Picayune, MS
Wyckoff Company	Bainbridge Island, WA Seattle, WA

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[a] Plants use non-pressure treating techniques in addition to pressure treating processes.

[b] Plants use only non-pressure treating processes.

NOTE: This listing is subject to change as market conditions change, facility ownership changes, plants are closed down, etc. The reader should verify the existence of particular facilities by consulting current listings and/or the plants themselves. The level of POM emissions from any given facility is a function of variables such as capacity, throughput, and control measures, and should be determined through direct contacts with plant personnel.