

Coal Tars and Coal-Tar Pitches

CAS No. 8007-45-2 (Coal Tar)

No separate CAS No. is assigned to coal-tar pitches

Known to be human carcinogens

First listed in the *First Annual Report on Carcinogens* (1980)

Carcinogenicity

Coal tars and coal-tar pitches are *known to be human carcinogens* based on sufficient evidence of carcinogenicity from studies in humans.

Cancer Studies in Humans

Numerous studies, mostly case reports, have found that occupational exposure to coal tars or coal-tar pitches (coal-tar distillates) is associated with skin cancer, including scrotal cancer; workers in these studies have included patent-fuel (coal-briquette) workers, pitch loaders, workers in electrical trades, and optical-lens polishers (IARC 1985, 1987). A 1946 study in the United Kingdom found that patent-fuel workers were 500 times as likely as other workers to die of scrotal cancer. In addition, there have been many case reports of skin cancer among patients using therapeutic coal-tar preparations. Occupational exposure to coal tars or coal-tar pitches has also been associated with cancer at other tissue sites, including the lung, bladder, kidney, and digestive tract. Excesses of lung cancer were found in several epidemiological studies of workers exposed to coal-tar fumes in coal gasification and coke production, in studies of workers exposed to pitch fumes in aluminum production and calcium carbide production, and in a study of millwrights and welders exposed to coal-tar pitches and coal tars. The millwrights and welders also showed increased risks of digestive-tract cancer and leukemia. The risk of bladder cancer was increased in tar distillers and patent-fuel workers exposed to coal tars and coal-tar pitches and in aluminum production workers exposed to coal-tar pitches. The risk of kidney (renal-pelvis) cancer was increased in workers exposed to "petroleum or tar or pitch." Studies of roofers, who are exposed to coal-tar pitches, have found increased risks of cancer at other tissue sites in addition to skin, bladder, and lung cancer and leukemia, including cancer of the oral cavity, larynx, esophagus, and stomach; however, roofers are also exposed to other potentially carcinogenic agents, such as asphalt.

Cancer Studies in Experimental Animals

Dermal exposure to coal tars (including pharmaceutical and high-temperature coal tars) or coal-tar extracts caused skin tumors in mice and rabbits and lung cancer (but not skin tumors) in rats. Inhalation exposure to coal tar from coke ovens caused skin tumors in mice and lung tumors in mice and rats. An extract of a coal-tar fume condensate administered by intramuscular injection caused tumors at the injection site (sarcoma) in mice. Dermal exposure to coal-tar pitches or coal-tar pitch extracts caused benign and malignant skin tumors in mice (IARC 1985, 1987).

Studies on Mechanisms of Carcinogenesis

Both coal tars and coal-tar pitches contain a number of known and potential carcinogens, including benzene, naphthalene, and other polycyclic aromatic hydrocarbons (PAHs). Coal-tar pitch extracts showed both tumor-initiating and tumor-promoting activity in mouse skin (IARC 1985, 1987).

Properties

Coal tars are by-products of the destructive distillation (carbonization) of coal to produce coke or gas. The composition and properties of a coal tar depend primarily on the temperature of the carbonization and to a lesser extent on the nature (source) of the coal used as feedstock. In general, coal tars are complex combinations of hydrocarbons, phenols, and heterocyclic oxygen, sulfur, and nitrogen compounds. Over 400 compounds have been identified in coal tars, and as many as 10,000 may actually be present. The PAH content of coal tars increases with increasing carbonization temperature. Coal tars typically are black or almost-black viscous liquids or semisolids with a characteristic naphthalene-like odor (ATSDR 2002). They are slightly soluble in water, partially soluble in acetone, carbon disulfide, chloroform, diethyl ether, ethanol, methanol, petroleum ether, and sodium hydroxide, and soluble in benzene and nitrobenzene. Low-temperature coal tars (formed at temperatures below 700°C) are black, viscous liquids that are denser than water and contain a lower percentage (40% to 50%) of aromatic compounds than high-temperature coal tars (IARC 1985). Coal tars are highly flammable and corrosive, and toxic gases may be released when they burn. Their vapors can form explosive mixtures with air (HSDB 2009).

Coal-tar pitches are shiny, dark-brown to black residues produced during the distillation of coal tars. They contain various PAHs, their methyl and polymethyl derivatives, and heteronuclear compounds (IARC 1985).

Use

Coal tars and coal-tar pitches have many uses in industry and in consumer products. Coal tars are used primarily for the production of refined chemicals and coal-tar products, such as creosote, coal-tar pitch, and crude naphthalene and anthracene oils from the distillation of crude coal tar. Coal tar has been used as a fuel in open-hearth furnaces and blast furnaces in the steel industry, as a binder and filler in surface-coating formulations, and as a modifier for epoxy-resin surface coatings. U.S. Pharmacopeia-grade coal tar is approved for use in denatured alcohol (IARC 1985). Coal-tar preparations have been used for many years to treat various skin conditions, such as eczema, psoriasis, seborrheic dermatitis, and dandruff. Both prescription and nonprescription preparations are available and include cleansing bars, creams, gels, lotions, ointments, shampoos, and other topical solutions and suspensions (DermNet NZ 2010). Coal tar is also registered as an active ingredient in pesticides with the U.S. Environmental Protection Agency (EPA 2003).

Coal-tar pitches are used primarily as the binder for aluminum-smelting electrodes (IARC 1984). They are also used in roofing materials, to impregnate and strengthen refractory brick (for lining industrial furnaces), and in surface coatings, such as pipe-coating enamels and black varnishes used as protective coatings for industrial steelwork and as antifouling paints for boats. Hard pitch is used as a binder for foundry cores. Coke-oven pitch is used to produce pitch coke, which is used as the carbon component of electrodes, carbon brushes, and carbon and graphite articles. Distillation fractions and residues from high-temperature coal tars are used for road paving and construction and in the production of naphthalene, recovery of benzene, production of anthracene paste, briquetting of smokeless solid fuel, impregnation of electrodes and fibers, and manufacture of electrodes and graphite (IARC 1985).

Production

Coal tar was first produced in the United States in 1913, when over 1.0 billion pounds was produced as a by-product of coke production (IARC 1985). Because the majority of coal tar is produced by the steel

Report on Carcinogens, Twelfth Edition (2011)

industry, its production depends on the demand for steel. U.S. coal-tar production was 168.6 million gallons in 1986, 188.5 million gallons in 1987 (ATSDR 2002), and 1.8 billion pounds in 1994 (USITC 1995). In 2009, six U.S. suppliers of coal tar and one U.S. supplier of coal-tar pitch were identified (ChemSources 2009).

Exposure

The primary routes of potential human exposure to coal tars and coal-tar products are inhalation, ingestion, and dermal contact. The general population may be exposed to coal tar through its use in treating skin disorders. It has been estimated that nearly 2% of the United States population is affected by psoriasis, one of the conditions for which coal-tar ointments (containing 1% to 10% coal tar) are prescribed (IARC 1985). Others may be exposed through the use of coal-tar shampoos to treat dandruff or coal-tar ointments to treat eczema. The general population may also be exposed to coal tars present as environmental contaminants (ATSDR 2002).

Occupational exposure to coal tars and coal-tar pitches may occur at foundries and during coke production, coal gasification, and aluminum production. Coal gasification and iron and steel foundry workers potentially are also exposed to coal-tar pitch volatiles, including a variety of PAHs (IARC 1984). Coke ovens are the primary source of coal tar (NIOSH 1977). In 1970, the United States had 64 coking plants operating more than 13,000 coke ovens, with about 10,000 workers (NIOSH 1973). The numbers of plants and ovens remained essentially the same through 1975 but by 1998 had declined to 23 coking plants operating about 3,800 ovens (EPA 2001). In the early 1970s, an estimated 145,000 workers were directly or indirectly involved with coal-tar products (NIOSH 1977). The National Occupational Hazard Survey (conducted from 1972 to 1974) estimated that 1,354 workers potentially were exposed to coal-tar pitch (NIOSH 1976). The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 7,274 workers (including 42 women) potentially were exposed to coal tar, 19,021 workers (including 98 women) to coal-tar pitch, and 7,677 workers (including 78 women) to coal-tar-pitch volatiles (NIOSH 1990). No more recent occupational exposure surveys were found.

Workers potentially exposed to coal-tar pitches include those producing or using pavement tar, roofing tar, coal-tar pitch, coal-tar paints, coal-tar enamels, other coal-tar coatings, or refractory bricks. The concentrations of PAHs in ambient air ranged from 0 to 200 $\mu\text{g}/\text{m}^3$ near roof-tarring operations and from 0 to 3,700 $\mu\text{g}/\text{m}^3$ near pavement-tarring operations. Another study found that coal-tar pitch workers at a U.S. roofing site inhaled up to 53 μg of benzo[*a*]pyrene in seven hours (Hammond *et al.* 1976). The potential for skin exposure may be considerable; because of the heat, workers often wear little clothing, thereby exposing large portions of the body to coal tars or coal-tar pitches. In the skin oil of nine roofing workers (potentially exposed to coal-tar pitch and bitumen), 0.000048 to 0.036 μg of PAHs were detected in a 36-cm² area of the forehead (Wolff *et al.* 1982).

Regulations

Coast Guard, Department of Homeland Security

Minimum requirements have been established for safe transport of coal-tar pitches on ships and barges.

Department of Transportation (DOT)

Flammable coal-tar distillates are considered a hazardous material, and special requirements have been set for marking, labeling, and transporting these materials.

Environmental Protection Agency (EPA)

Clean Air Act

National Emissions Standards for Hazardous Air Pollutants: Air emissions of hazardous air pollutants from the handling of coal tar are regulated under certain source categories.

Resource Conservation and Recovery Act

Listed Hazardous Waste: Waste codes for which the listing is based wholly or partly on the presence of certain coal-tar residues = K141, K142, K147, K148.

Coal-tar creosote is listed as a hazardous constituent of waste.

Food and Drug Administration (FDA)

Any drug products containing coal tar at levels of 0.5% to 5% must contain a label specifying the identity and concentration of the coal tar.

Any hair dye containing coal tar must display a warning label stating that the product contains an ingredient that has been determined to cause cancer in laboratory animals.

Certain dermal products containing coal tar must provide warning labels of specific precautions for that product.

The use of coal tar in several over-the-counter drugs is no longer recognized as safe and effective for the specified uses.

Occupational Safety and Health Administration (OSHA)

While this section accurately identifies OSHA's legally enforceable PELs for this substance in 2010, specific PELs may not reflect the more current studies and may not adequately protect workers.

Permissible exposure limit = 0.2 mg/m³ for coal-tar-pitch volatiles – benzene-soluble fraction.

Guidelines

American Conference of Governmental Industrial Hygienists (ACGIH)

Threshold limit value – time-weighted average (TLV-TWA) = 0.2 mg/m³ for coal-tar-pitch volatiles as benzene-soluble aerosol.

National Institute for Occupational Safety and Health (NIOSH)

Recommended exposure limit (time-weighted-average workday) = 0.1 mg/m³ for coal-tar-pitch volatiles and coal-tar products – cyclohexane-extractable fraction.

Immediately dangerous to life and health (IDLH) limit = 80 mg/m³ for coal-tar-pitch volatiles.

Coal-tar-pitch volatiles are listed as potential occupational carcinogens.

A comprehensive set of guidelines has been established to prevent occupational exposures to hazardous drugs in health-care settings.

Occupational Safety and Health Administration (OSHA)

A comprehensive set of guidelines has been established to prevent occupational exposures to hazardous drugs in health-care settings.

References

- ATSDR. 2002. *Toxicological Profile for Wood Creosote, Coal Tar Creosote, Coal Tar, Coal Tar Pitch, and Coal Tar Pitch Volatiles*. Agency for Toxic Substances and Disease Registry. <http://www.atsdr.cdc.gov/toxprofiles/tp85.pdf>. 354 pp.
- ChemSources. 2009. *Chem Sources - Chemical Search*. Chemical Sources International. <http://www.chemsources.com/chemonline.html> and search on coal tar and coal tar pitch. Last accessed: 10/22/09.
- DermNet NZ. 2010. *Coal Tar*. New Zealand Dermatological Society. Last updated: 8/27/10. <http://www.dermnetnz.org/treatments/coaltar.html>.
- EPA. 2001. *National Emissions Standards for Hazardous Air Pollutants (NESHAP) for Coke Ovens: Pushing Quenching, and Battery Stacks – Background Information for Proposed Standards*. EPA-453/R-01-006. Research Triangle Park, NC: U.S. Environmental Protection Agency.
- EPA. 2003. Pesticide reregistration performance measures and goals. *Fed Regist* 68(146): 44767-44776.
- Hammond EC, Selikoff IJ, Lawther PL, Seidman H. 1976. Inhalation of benzopyrene and cancer in man. *Ann NY Acad Sci* 271: 116-124.
- HSDB. 2009. *Hazardous Substances Data Bank*. National Library of Medicine. <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB> and search on CAS number. Last accessed: 10/22/09.
- IARC. 1984. *Polynuclear Aromatic Compounds, Part 3. Industrial Exposures in Aluminum Production, Coal Gasification, Coke Production, and Iron and Steel Founding*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 34. Lyon, France: International Agency for Research on Cancer. 219 pp.
- IARC. 1985. Coal-tars and derived products. In *Polynuclear Aromatic Compounds, Part 4, Bitumens, Coal-tars and Derived Products, Shale-oils and Soots*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 35. Lyon, France: International Agency for Research on Cancer. pp. 83-159.
- IARC. 1987. Coal-tar pitches and coal-tars. In *Overall Evaluations of Carcinogenicity. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans*, suppl 7. Lyon, France: International Agency for Research on Cancer. pp. 174-176.
- NIOSH. 1973. *Criteria for a Recommended Standard: Occupational Exposure to Coke Oven Emissions*. DHEW (NIOSH) Publication No. 73-11016. National Institute for Occupational Safety and Health. <http://www.cdc.gov/niosh/73-11016.html>.
- NIOSH. 1976. *National Occupational Hazard Survey (1972-74)*. DHEW (NIOSH) Publication No. 78-114. Cincinnati, OH: National Institute for Occupational Safety and Health.
- NIOSH. 1977. *Criteria for a Recommended Standard: Occupational Exposure to Coal Tar Products*. DHEW (NIOSH) Publication No. 78-107. National Institute for Occupational Safety and Health. <http://www.cdc.gov/niosh/78-107.html>.

Report on Carcinogens, Twelfth Edition (2011)

NIOSH. 1990. *National Occupational Exposure Survey (1981-83)*. National Institute for Occupational Safety and Health. Last updated: 7/1/90 <http://www.cdc.gov/noes/noes1/90610sic.html>, <http://www.cdc.gov/noes/noes1/90620sic.html>, <http://www.cdc.gov/noes/noes1/t0535sic.html>

USITC. 1995. *Synthetic Organic Chemicals, United States Production and Sales, 1994*. USITC Publication No 2933. Washington, DC: U.S. Government Printing Office.

Wolff MS, Taffe B, Boesch R, Selikoff I. 1982. Detection of polycyclic aromatic hydrocarbons in skin oil obtained from roofing workers. *Chemosphere* 11(6): 595-599.