

Coal Tars and 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 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. 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 tar or coal-tar pitches also has 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 tar 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, including the oral cavity, larynx, esophagus, and stomach, in addition to skin, bladder, and lung cancer and leukemia; however, roofers also are exposed to other potentially carcinogenic agents, such as asphalt (IARC 1985, 1987).

The findings in humans are supported by studies in experimental animals demonstrating that coal tars cause cancer in mice, rats, and rabbits and that coal-tar pitches cause cancer in mice. Dermal application of coal tars (including pharmaceutical coal tars and high-temperature coal tars) or coal-tar extracts caused skin tumors in mice and rabbits and malignant lung tumors (but not skin tumors) in rats. Inhalation exposure to coal tar from coke ovens caused skin and lung tumors in mice and lung tumors in rats. Intramuscular injection of an extract of a coal-tar fume condensate caused injection-site sarcomas in mice. Dermally applied coal-tar pitches or coal-tar pitch extracts caused benign and malignant skin tumors in mice. In separate studies, coal-tar pitch extracts showed both tumor-initiating and tumor-promoting activities in mouse skin. Both coal tars and coal-tar pitches contain a number of known and potential carcinogens, including benzene, naphthalene, and other polycyclic aromatic hydrocarbons (PAHs) (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 content of PAHs in coal tars increases as the carbonization temperature increases. 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, soluble in benzene and nitrobenzene, and partially soluble in acetone, carbon disulfide, chloroform, diethyl

ether, ethanol, methanol, petroleum ether, and sodium hydroxide. 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 (formed at temperatures above 700°C) (IARC 1985). Coal tars are highly flammable and corrosive, and toxic gases may be released from fires. Their vapors can form explosive mixtures with air (HSDB 2003).

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. The primary uses of coal tars are 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 (MEDLINEplus 2003). Coal tar also is 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 also are 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 (454,000 metric tons) was produced as a by-product of coke production (IARC 1985). The majority of coal tar is produced by the steel industry; therefore, its production depends on the demand for steel. U.S. coal-tar production was 168.6 million gallons (638 million liters) in 1986, 188.5 million gallons (713 million liters) in 1987 (ATSDR 2002), and 1.8 billion pounds (816,000 metric tons) in 1994 (USITC 1995). In 2003, six U.S. suppliers of coal tar and one supplier of coal-tar pitch were identified (ChemSources 2003).

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. Nearly 2% of the United States population was estimated to be 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 also may 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 also potentially are 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, there were 64 plants operating more than 13,000 coke ovens with about 10,000 workers in the United States (NIOSH 1973). This number was essentially unchanged by 1975 but had declined to 23 coke plants operating about 3,800 ovens in 1998 (EPA 2001). In the early 1970s there were an estimated 145,000 workers that were involved directly or indirectly with coal tar products (NIOSH 1977). The National Occupational Hazard Survey (1972–1974) estimated that 1,354 workers were exposed to coal-tar pitch, and the National Occupational Exposure Survey (1981–1983) estimated that 19,021 workers (including 98 women) were exposed to coal-tar pitch, 7,677 workers (including 78 women) to coal-tar pitch volatiles, and 7,274 workers (including 42 women) to coal tar (RTECS 2003). More recent occupational exposure surveys were not identified.

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 mg of benzo[*a*]pyrene in seven hours (IARC 1985). 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

EPA

Clean Air Act

NESHAP: Air emissions of HAPs from the handling of coal tar are regulated under certain source categories

Resource Conservation and Recovery Act

Certain wastes from the processing of coal tars are listed as hazardous wastes with waste codes - K141, K142, K143, K147, K148

FDA

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

Any hair dye containing coal tar must display a warning label

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

OSHA

Permissible Exposure Limit (PEL) = 0.2 mg/m³ (coal tar pitch volatiles - benzene-soluble fraction)

Guidelines

ACGIH

Threshold Limit Value - Time-Weighted Average Limit (TLV-TWA) = 0.2 mg/m³ (coal tar pitch volatiles as benzene soluble aerosol)

NIOSH

Immediately Dangerous to Life and Health (IDLH) = 80 mg/m³ (coal tar pitch volatiles)

Listed as a potential occupational carcinogen (coal tar pitch volatiles)

Recommended Exposure Limit (time-weighted-average workday) = 0.1 mg/m³ (coal tar pitch volatiles: cyclohexane-extractable fraction)

*No separate CAS registry number is assigned to coal tars or coal tar pitches.

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