Mineral Oils: Untreated and Mildly Treated

CAS No.: none assigned

Known to be human carcinogens

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

Carcinogenicity

Untreated and mildly treated mineral oils are *known to be human carcinogens* based on sufficient evidence of carcinogenicity from studies in humans.

Cancer Studies in Humans

The carcinogenicity of exposure to untreated and mildly treated mineral oils has been evaluated in numerous studies in a variety of occupations, including metal working, jute processing, mulespinning, newspaper press operation, and other newspaper work. Exposure to mineral oils was consistently and strongly associated with an increased risk of cancer of the scrotum and skin (squamous-cell carcinoma) for many occupations, including metal worker, mulespinner, and jute processor. An analysis of a series of 344 cases of scrotal cancer occurring from 1936 to 1976 in the West Midlands region of England reported that 62% of the men had been exposed to mineral oils. Epidemiological studies (case-control, cohort, and proportional mortality studies) in metal workers have reported excesses of gastrointestinal, sinonasal, and bladder cancer, in addition to skin and scrotal cancer. Some but not all studies (case-control, cohort, and proportional mortality studies) of workers in the printing industry have reported significantly increased incidences of death from cancer of the lung, rectum, buccal cavity, and pharynx. The International Agency for Research on Cancer concluded that there was sufficient evidence for the carcinogenicity of untreated and mildly treated mineral oils in humans (IARC 1984, 1987).

Cancer Studies in Experimental Animals

There is sufficient evidence for the carcinogenicity of some untreated and mildly treated mineral oils from studies in experimental animals. Evaluation of the carcinogenicity of mineral oils in experimental animals has mainly involved experiments in which petroleum-derived base oils and formulated products were applied repeatedly to the skin of mice; however, some types of mineral oil preparations were studied in other species and by other routes of exposure. Vacuum-distillate fractions, acid-treated oils, mildly solvent-refined oils, mildly treated hydrotreated oils, aromatic oils (including solvent extracts and high-boiling-point fractions of catalytically cracked oils), and some cutting oils caused skin tumors in mice. High-boiling-point fractions of cracked oils also caused skin tumors in rabbits and monkeys (IARC 1984, 1987).

Properties

Mineral oils include lubricant base oils and products derived from them. The physical properties of lubricant oils vary widely, but generally are defined by crude oil source, carbon number distribution, boiling range, and viscosity. Mineral oils, which are refined from petroleum crude oils, are complex mixtures of straight- and branched-chain paraffinic, naphthenic, and aromatic hydrocarbons with 15 or more carbons and boiling points in the range of 300°C to 600°C; boiling points of up to 815°C have been reported for heavier oils. The viscosity of lubricant oils is described as "light" or "heavy" depending upon whether the maximum viscosity at 37.8°C is less than or equal to 20.5 mm^2/sec (centistokes). The density of mineral oils at 15°C ranges from 0.820 kg/L for light paraffinic base and process oils to just over 1.0 kg/L for high aromatic base and process oils. The complete description of a mineral oil must include the nature of the final treatment step, which determines whether the material is mildly or severely treated during the refining process. Medicinal white mineral oils, which are pharmaceutical- and food-grade materials, are highly refined and free of all aromatic and unsaturated compounds. As highly refined oils, these products are not covered under this listing (IARC 1984).

Mineral oils are insoluble in water and alcohol, but soluble in benzene, chloroform, ether, carbon disulfide, and petroleum ether. Paraffinic crude oils are characterized by high wax content, high natural viscosity index (the rate of change of viscosity over a given temperature range), and relatively low aromatic hydrocarbon content. Naphthenic crude oils are generally low in wax content and relatively high in cycloparaffins and aromatic hydrocarbons. All crude oils contain some polycyclic aromatic hydrocarbons, and the proportions and types of these compounds in finished base oils are determined primarily by the refining processes (IARC 1984). Mineral oils generally do not present a fire hazard and must be preheated before ignition will occur (HSDB 2009).

Use

Mineral oils are used primarily as lubricant base oils to produce further refined oil products, including engine oils, automotive and industrial gear oils, transmission fluids, hydraulic fluids, circulating and hydraulic oils, bearing oils, machine oils, machine-tool oils, compressor and refrigerator oils, steam-engine oils, textile machine oils, air-tool oils, metalworking oils (cutting oils, roll oils, can-forming oils, and drawing oils), rust-preventative oils, heat-treating oils, transformer oils, greases, medicinal and technical-grade white oils, and processing oils (product extenders, processing aids, carriers and diluents, water repellents, surface-active agents, batching oils, mold-release oils, and wash oils). These oils are used in manufacturing (78.5% of the oils produced), mining (5.0%), construction (1.8%), and miscellaneous industries (14.7%). About 57% of the lubricating oils produced are used by the automotive industry, and the remaining 43% by other industries. In the automotive industry, lubricating oils are used as multigrade engine oils (23% of the lubricating oils produced), monograde engine oils (22%), transmission and hydraulic fluids (8%), gear oils (2%), and aviation oils (1%). In other industries, lubricating oils are used as general industrial diesel engine oils (19%), process oils (13%), metalworking oils (4%), railroad diesel engine oils (3%), and marine diesel engine oils (2%) (IARC 1984).

Production

In 1981, about 19 billion pounds of mineral oil products were used in the United States (NPRA 1981), including 16.2 billion pounds of lubricating oils, 1.5 billion pounds of waxes, 814 million pounds of aromatic oils, and 462 million pounds of greases. In 2009, mineral oils were available from 28 U.S. suppliers (ChemSources 2009). In 1984, the United States imported 17,000 kg (37,000 lb) and exported 75,000 kg (165,000 lb) of mineral oil (type not specified) (HSDB 2009). No more recent data specific to U.S. imports or exports of mineral oils were found.

Exposure

The primary routes of potential human exposure to mineral oils are inhalation, ingestion, and dermal contact. The major hydrocarbon constituents of lubricant base oils and derived products occur naturally in crude petroleum. The general population potentially is exposed to unused and used mineral oils that occur naturally or are present as environmental contaminants. About 2 billion liters (528

million gallons) of used lubricating oils are released into the environment every year, including 750 million liters (198 million gallons) used as road oil or in asphalt (IARC 1984).

Occupational exposure to mineral oils may occur among workers employed in the manufacture of automobiles, airplanes and parts, steel products, screws, pipes, precision parts, and transformers, as well as workers employed in brass and aluminum production, engine repair, copper mining, and newspaper and commercial printing (IARC 1984). The National Occupational Exposure Survey (conducted from 1981 to 1983) estimated that 1,009,473 workers, including 392,294 women, potentially were exposed to mineral oils (NIOSH 1990). The National Institute for Occupational Safety and Health reported the presence of mineral oils in the occupational environment of several plants in the 1970s. The concentration of cutting-oil mist was reported to be 0.37 to 0.55 mg/m^3 for polishing of aircraft engine blades, 0.4 to 6.0 mg/m^3 for machining of rough iron castings into automotive parts, 1.1 to 20 mg/m^3 for manufacture of aircraft components, 0.3 to 1.3 mg/m^3 for manufacture of automotive parts, from less than 0.03 to 0.8 mg/m^3 for fabrication of precision metal parts, and from less than 0.035 to 3.1 mg/m^3 for milling and machining operations. The concentration of transformer oil in air was reported to be 0.1 to 1.4 mg/m^3 for the manufacture and overhauling of large transformers (IARC 1984).

Regulations

Consumer Product Safety Commission (CPSC)

Products containing 10% or more of petroleum distillates require special labeling because of aspiration hazard.

Special packaging is required for certain household products containing 10% or more petroleum distillates and with a viscosity less than 100 Saybolt Universal seconds.

Environmental Protection Agency (EPA)

Clean Water Act

Procedures, methods, equipment, and other requirements have been established to prevent the discharge of all types of oils (including mineral oil) from all types of non-transportation-related facilities.

Products of mineral oil origin at levels that will cause interference are banned from discharge to publicly owned treatment works.

Food and Drug Administration (FDA, an HHS agency)

Some over-the-counter drugs and products containing mineral oil must contain a warning label.

Restrictions on the use of mineral oil in food preparation and in packaging materials are prescribed in 21 CFR 172, 173, and 175-179.

When used as a lubricant with incidental food contact, mineral oil levels shall not exceed 10 ppm.

Drugs for internal use containing mineral oil must have a warning label.

Limitations on the use of mineral oil in drugs for use in animal feed are prescribed in 21 CFR 558.

Limits on the use of mineral oil as an additive in feed and drinking water of animals are prescribed in 21 CFR 573.

Occupational Safety and Health Administration (OSHA, Dept. of Labor)

While this section accurately identifies OSHA's legally enforceable PELs for this substance in 2018, specific PELs may not reflect the more current studies and may not adequately protect workers.

Permissible exposure limit (PEL) = 5 mg/m^3 for mineral-oil mist.

Guidelines

American Conference of Governmental Industrial Hygienists (ACGIH)

Threshold limit value – time-weighted average (TLV-TWA) = 5 mg/m^3 for mineral-oil mist.

National Institute for Occupational Safety and Health (NIOSH, CDC, HHS)

Recommended exposure limit (REL) = 5 mg/m^3 for mineral-oil mist.

Short-term exposure limit (STEL) = 10 mg/m^3 for mineral-oil mist.

Immediately dangerous to life and health (IDLH) limit = 2,500 mg/m^3 for mineral-oil mist.

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, Dept. of Labor)

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References

ChemSources. 2009. *Chem Sources - Chemical Search*. Chemical Sources International. http://www.chemsources.com/chemonline.html and search on mineral oil. Last accessed: 10/22/09.

HSDB. 2009. *Hazardous Substances Data Bank*. National Library of Medicine. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB and search on mineral oil. Last accessed: 10/22/09.

IARC. 1973. Mineral oils. In *Certain Polycyclic Aromatic Hydrocarbons and Heterocyclic Compounds*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 3. Lyon, France: International Agency for Research on Cancer. pp. 30-33.

IARC. 1984. Mineral oils (lubricant base oils and derived products). In *Polynuclear Aromatic Compounds, Part 2. Carbon Blacks, Mineral Oils and Some Nitroarenes*. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 33. Lyon, France: International Agency for Research on Cancer. pp. 87-168.

IARC. 1987. Mineral oils: untreated and mildly-treated oils (Group 1), highly-refined oils (Group 3). 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. 252-254.

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/m0603sic.html.

NPRA. 1981. *Report on U.S. Lubricating Oil Sales*. Washington, DC: National Petroleum Refiners Association.