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Polychlorinated biphenyls (PCBs)(Arochlors)

1336-36-3

Hazard Summary

Polychlorinated biphenyls (PCBs) are a group of chemicals that contain 209 individual compounds (known as congeners) with varying harmful effects. Information on specific congener toxicity is very limited. Most toxicity testing has been done on specific commercial mixtures; however, PCB mixtures found in the environment will differ in composition from the commercial mixtures because of partitioning, biotransformation, and bioaccumulation. The U.S. Environmental Protection Agency (EPA) treats all PCBs as being potentially hazardous based on results from some formulations. However, this can have large uncertainty for any given mixture situation.

PCBs are no longer produced or used in the United States today; the major source of exposure to PCBs today is the redistribution of PCBs already present in soil and water. Chronic (long-term) exposure to some PCB formulations by inhalation in humans results in respiratory tract symptoms, gastrointestinal effects, mild liver effects, and effects on the skin and eyes such as chloracne, skin rashes, and eye irritation. Epidemiological studies indicate an association between dietary PCB exposures and developmental effects. Human studies provide inconclusive, yet suggestive, evidence of an association between PCBs exposure and cancer. Animal studies have reported an increase in liver tumors in rats and mice exposed orally to all tested PCB formulations. EPA has classified PCBs as a Group B2, probable human carcinogen.

Please Note: The main sources of information for this fact sheet are EPA's Integrated Risk Information System (IRIS) (6), which contains information on the carcinogenic effects of PCBs including the unit cancer risk for oral exposure, and the Agency for Toxic Substances and Disease Registry's (ATSDR's) Toxicological Profile for PCBs. (1)

Uses

- Before 1974, PCBs were used in capacitors, transformers, plasticizers, surface coatings, inks, adhesives, pesticide extenders, and carbonless duplicating paper. After 1974, use of PCBs was restricted to the production of capacitors and transformers, and after 1979 PCBs were no longer used in the production of capacitors and transformers. (1)

Sources and Potential Exposure

- PCBs are no longer produced in the United States and are no longer used in the manufacture of new products; the major source of air exposure to PCBs today is the redistribution of PCBs already present in soil and water. Smaller amounts of PCBs may be released to the air from disposal sites containing transformers, capacitors, and other PCB wastes, incineration of PCB-containing wastes, and improper disposal of the compounds to open areas. (1)
- PCBs have been detected in indoor air at concentrations of an order of magnitude greater than ambient air. It has been suggested that certain electrical appliances and devices, such as fluorescent lighting ballasts, which have PCB-containing components, may emit PCBs to the indoor air. (1)
- In the past, PCBs were released to wastewater from its industrial uses. Today, PCBs are still detected in water due to the environmental recycling of the compound. Most of the PCBs in water are bound to the soil and sediments and may be released to the water slowly over a long period of time. These PCBs may enter the food chain through ingestion by aquatic organisms and fish. (1)

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- PCBs have been detected in food; they bioaccumulate through the food chain, with some of the highest concentrations found in fish. (1)
- PCBs have been listed as a pollutant of concern to EPA's Great Waters Program due to their persistence in the environment, potential to bioaccumulate, and toxicity to humans and the environment. (3)

Assessing Personal Exposure

- Laboratory analyses can detect PCBs in blood, body fat, and breast milk. (1)

Health Hazard Information

Acute Effects:

- No reports of effects in humans following acute (short-term) exposure to PCBs are available. (1)
- Animal studies have reported acute effects on the liver, kidney, and central nervous system (CNS) from oral exposure to PCBs. (1)
- Acute animal tests in rats have shown PCBs to have moderate acute toxicity from oral exposure. (1,4)

Chronic Effects (Noncancer):

- Chronic inhalation exposure of workers to PCBs has been reported to result in respiratory tract symptoms, such as cough and tightness of the chest, gastrointestinal effects including anorexia, weight loss, nausea, vomiting, and abdominal pain, mild liver effects, and effects on the skin and eyes, such as chloracne, skin rashes, and eye irritation. (1,5)
- EPA has not established a Reference Concentration (RfC) for all PCB mixtures. (6)
- The RfD for Aroclor 1016 is 0.00007 milligrams per kilogram body weight per day (mg/kg/d) based on reduced birth weights in monkeys. The RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious noncancer effects during a lifetime. It is not a direct estimator of risk, but rather a reference point to gauge the potential effects. At exposures increasingly greater than the RfD, the potential for adverse health effects increases. Lifetime exposure above the RfD does not imply that an adverse health effect would necessarily occur. (7)
- EPA has medium confidence in the RfD based on: (1) medium confidence in the study on which the RfD was based because this was a well-conducted study, but only one group of monkeys was examined; and (2) medium confidence in the database because an extensive amount of data are available but mixtures of PCBs in the environment do not match the pattern of congeners found in Arochlor 1016. (7)
- The RfD for Aroclor 1254 is 0.00002 mg/kg/d based on immunological effects in monkeys. (8)
- EPA has medium confidence in the RfD based on: (1) medium confidence in the study on which the RfD was based because groups of monkeys were tested at four dose levels and a lowest observed adverse effect level (LOAEL) was established; and (2) medium confidence in the database because an extensive number of laboratory animal and human studies were available for review, but human data are available for PCB mixtures in general but not specifically for Aroclor 1254. (8)
- EPA has not established an RfC for Aroclor 1016 or Aroclor 1254. (7,8)

Reproductive/Developmental Effects:

- An epidemiological study of women occupationally exposed to high levels of PCBs suggested a relationship between PCB exposure and reduced birth weight and shortened gestational age of their babies; however, limitations of the study limit the strength of the conclusion. (1)
- Two series of human studies that investigated exposure to PCBs through the consumption of contaminated fish suggest that exposure to PCBs may cause developmental effects in humans. Both studies reported an association between consumption of fish with high PCB levels by pregnant women and an increased

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incidence of neurodevelopmental effects, such as motor deficits at birth, impaired psychomotor index, impaired visual recognition, and deficits in short-term memory in infants. (1)

- Human studies are not conclusive on the reproductive effects of PCBs. One study of men who were occupationally exposed to PCBs showed no fertility abnormalities, while another study of men with low sperm counts found elevated levels of PCBs in the blood and an association between certain PCB compounds in semen and decreased sperm motility. (1)
- Animal studies have reported developmental effects, such as learning deficits, impaired immune functions, focal liver necrosis, and cellular alterations of the thyroid, in the offspring of animals exposed orally to PCBs. Reproductive effects, such as decreased fertility, decreased conception, and prolonged menstruation have also been noted in animal studies of dietary PCB exposures. (1)

Cancer Risk:

- Human studies provide inconclusive, yet suggestive evidence of an association between PCBs' exposure and liver cancer. Several studies have reported an increase in liver cancer among persons occupationally exposed to some PCB formulations. However, the studies are inconclusive due to confounding exposures and lack of exposure quantification. (1,6)
- Oral exposure studies in animals show an increase in liver tumors in rats and mice and thyroid tumors in male rats exposed to several commercial mixtures of PCBs and to several specific congeners. (1,6)
- No animal inhalation studies are available on the health effects of PCBs. PCBs are absorbed through inhalation though, indicating that there may be concern for this route of exposure. (1)
- EPA has classified PCBs as a Group B2, probable human carcinogen. (6)
- EPA uses mathematical models, based on animal studies, to estimate the probability of a person developing cancer from inhaling air containing a specified concentration of a chemical. EPA calculated an upper bound inhalation unit cancer risk estimate of 1.0×10^{-4} $(\mu g/m^3)^{-1}$ for inhalation of evaporated PCB congeners. EPA estimates that, if an individual were to continuously breathe air containing PCBs at an average of 0.01 $\mu g/m^3$ (1×10^{-5} mg/m^3) over his or her entire lifetime, that person would theoretically have no more than a one-in-a-million increased chance of developing cancer as a direct result of breathing air containing this chemical. Similarly, EPA estimates that breathing air containing 0.1 $\mu g/m^3$ (1×10^{-4} mg/m^3) would result in not greater than a one-in-a-hundred thousand increased chance of developing cancer, and air containing 1.0 $\mu g/m^3$ (1×10^{-3} mg/m^3) would result in not greater than a one-in-ten thousand increased chance of developing cancer. For a detailed discussion of confidence in the potency estimates, please see IRIS. (6)
- EPA has calculated an upperbound oral cancer slope factor of 0.4 $(mg/kg/d)^{-1}$ for ingestion of water soluble congeners, an upperbound oral cancer slope factor of 2.0 $(mg/kg/d)^{-1}$ for food chain exposure, and an upperbound oral cancer slope factor of 0.07 $(mg/kg/d)^{-1}$ for PCB exposures where congeners with more than 4 chlorines comprise less than 0.5 percent of the total. (6)

Physical Properties

- PCBs are a class of industrial chemical that contain 209 individual compounds or congeners. (1)
- PCBs made in the United States were marketed under the trade name Aroclor and most are identified by a four-digit numbering code in which the first two digits indicate that the parent molecule is a biphenyl and for the 1200 series Aroclors the last two digits indicate the chlorine content by weight. For example, Aroclor 1260 has 60 percent chlorine. (1)
- Commercial tradenames for PCBs not manufactured in the United States include Kanechlor, Clophen, Fenclor, and Phenoclor. (1)
- PCBs are either oily liquids or solids and are colorless to light yellow in color with no known smell or taste. (1)
- The average molecular weight for one particular PCB (Aroclor 1260) is 375.7 g/mol; the vapor pressure is 4.05×10^{-5} mm Hg at 25 C; the octanol/water partition coefficient (log K_{ow}) is 6.8. (1)

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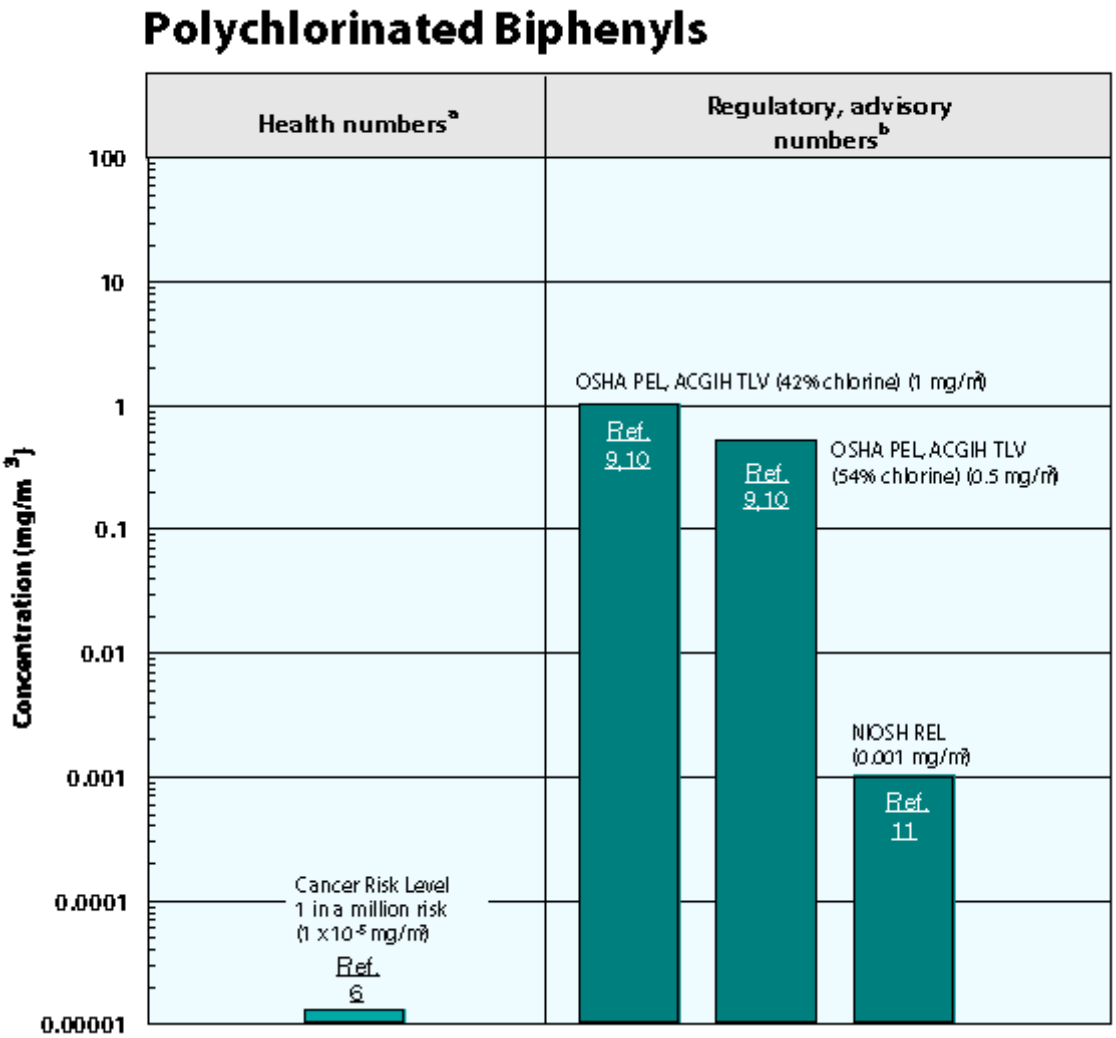
- PCB mixtures found in environmental media (air, water, sediment, foods) will differ in composition from the commercial mixtures due to differential partitioning, biotransformation, and bioaccumulation among the individual compounds. (1)

Conversion Factors:
To convert concentrations in air (at 25°C) from ppm to mg/m^3: mg/m^3 = (ppm) × (molecular weight of the compound)/(24.45). For Aroclor 1260: 1 ppm = 15.4 mg/m^3. To convert concentrations in air from $\mu g/m^3$ to mg/m^3: mg/m^3 = ($\mu g/m^3$) × (1 mg/1,000 µg).

Health Data from Inhalation Exposure



ACGIH TLV--American Conference of Governmental and Industrial Hygienists' threshold limit value expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effects.
NIOSH REL--National Institute of Occupational Safety and Health's recommended exposure limit; NIOSH-recommended exposure limit for an 8- or 10-h time-weighted-average exposure and/or ceiling.
OSHA PEL--Occupational Safety and Health Administration's permissible exposure limit expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-h workday or a 40-h workweek.

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The health and regulatory values cited in this factsheet were obtained in December 1999.

[a] Health numbers are toxicological numbers from animal testing or risk assessment values developed by EPA.

[b] Regulatory numbers are values that have been incorporated in Government regulations, while advisory numbers are nonregulatory values provided by the Government or other groups as advice. OSHA numbers are regulatory, whereas NIOSH and ACGIH numbers are advisory.

References

Summary created in April 1992, updated in January 2000

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