Polychlorinated Biphenyls (PCBs) CAS No. 1336-36-3

Reasonably anticipated to be a human carcinogen
First Listed in the *Second Annual Report on Carcinogens* (1981)

Carcinogenicity

Several mixtures of polychlorinated biphenyls, including Aroclor 1260 (11096-82-5), Aroclor 1254 (11097-69-1), and Kanechlor 500 (37317-41-2), are *reasonably anticipated to be human carcinogens* based on sufficient evidence of carcinogenicity in experimental animals (IARC 1978, 1982, 1987, Norback and Weltman 1985). When administered in the diet, Aroclor 1260 induced liver tumors including trabecular cell carcinomas, neoplastic nodules, simple cholangiomas, and cystic cholangiomas in rats of both sexes, and hepatocellular carcinomas and liver adenocarcinomas in female rats. When rats that had undergone a partial hepatectomy were administered Aroclor 1260 in the diet, liver tumors were induced, including neoplastic nodules in both sexes and simple and cystic cholangiomas, trabecular cell carcinomas, and adenocarcinomas in females. When administered in the diet, Aroclor 1254 induced hepatomas in male mice and Kanechlor 500 induced hepatocellular carcinomas in male mice (Norback & Weltman 1985, IARC 1978).

There is inadequate evidence for the carcinogenicity of PCBs in humans (IARC 1982). A slight increase in the incidence of cancer, particularly melanoma of the skin, has been reported in a small group of men exposed occupationally to Aroclor 1254. A study of 1,310 workers with at least 6 months of exposure to polychlorinated biphenyls in a capacitor manufacturing plant showed an excess of all cancers among male workers. The excess was mainly due to cancers of the digestive system and of the lymphatic and hematopoietic tissues (IARC 1982).

Properties

Theoretically, there are 209 possible polychlorinated biphenyl isomers, although not all are found in manufactured products. Polychlorinated biphenyls vary in appearance from mobile, oily liquids to white, crystalline solids to hard, noncrystalline resins. They are thermally stable, resistant to oxidation, acids, bases, and other chemical agents, and have excellent dielectric properties. Chlorobiphenyls are colorless crystals in the pure form. Commercial products are liquids because the melting point is depressed when polychlorinated biphenyls are mixed. Polychlorinated biphenyls are practically insoluble in water and soluble in oils and organic solvents. Technical-grade polychlorinated biphenyls have varying proportions of the different chlorobenzene isomers with small amount of polychlorinated dibenzofurans and polychlorinated naphthalenes as contaminants (IARC 1978).

Use

Since 1974, all uses of polychlorinated biphenyls in the United States have been confined to closed systems such as electrical capacitors and transformers, vacuum pumps, and gas-transmission turbines. Before 1972, polychlorinated biphenyls were used in transformer cooling liquids, heat-transfer and hydraulic fluids, vacuum pump fluids, lubricants, plasticizers, fillers in investment casting waxes, surface coatings and sealants, pesticide extenders, and carbonless copy paper (IARC 1978, Merck 1996). Currently, polychlorinated biphenyls are used by individual petitioners granted exemptions for use as a mounting medium in microscopy, as an immersion oil in low fluorescence microscopy, as an optical liquid, and for research and development (ATSDR 2000).

Production

Polychlorinated biphenyls are no longer produced in the United States, except for limited research and development applications; import and export of the compounds have not been permitted since 1979. In 1974, the Monsanto Chemical Company, which manufactured 99% of the polychlorinated biphenyls used by U.S. industry, produced an estimated 40 million lb of polychlorinated biphenyls (ATSDR 2000). Domestic production reached a peak volume of 86 million lb in 1970 and decreased to approximately 41 million lb by 1974. Polychlorinated biphenyls were first produced commercially in the United States in 1929 (IARC 1978).

Exposure

The primary routes of potential human exposure to polychlorinated biphenyls are ingestion, inhalation, and dermal contact. The release of polychlorinated biphenyls from prior industrial uses and the persistence of the compounds in the environment have resulted in widespread contamination of water and soil, with subsequent potential exposure of the general population. Polychlorinated biphenyls have been identified at 10 hazardous waste sites designated in the National Contingency Plan. EPA's Toxic Chemical Release Inventory listed 18 industrial facilities that produced, processed, or otherwise used polychlorinated biphenyls in 1999. The facilities reported releases of polychlorinated biphenyls to the land which were estimated to total 10,630,427 lb. (TRI99 2001). Polychlorinated biphenyls have been found in runoff, sediments, soil, creek water, leachate, in an underground oil-water layer, and in pond effluent. Concentrations ranged from 4 to 440,000 µg/L. The National Organics Monitoring Survey conducted from 1976 to 1977 found polychlorinated biphenyls in 6% of ground water used for drinking water at levels of 0.1 µg/L. A major source of exposure is through the diet; fish, cheese, eggs, and contaminated animal feed are the major U.S. commodities in which polychlorinated biphenyls have been found. Residues of polychlorinated biphenyls have been detected in human milk and fat samples collected from the general U.S. population (IARC 1978). In 1978, the average daily human food intake was estimated to be 0.027 µg/kg per day, but declined to <0.001 µg/kg per day in 1991 (ATSDR 2000).

Fires in and/or explosion of electrical capacitors results in contamination of nearby areas. This occurrence can result in possible human exposure through inhalation of airborne polychlorinated biphenyls or dermal contact with contaminated surfaces. Proper prevention and management of these fires can greatly reduce human exposure (EPA 1984). EPA estimated that approximately 12 million persons within 12 miles of three existing and nine projected commercial incinerators may possibly be exposed to releases of polychlorinated biphenyls in the air. In 1977, NIOSH estimated that 12,000 workers had potential occupational exposure as a result of polychlorinated biphenyls in the work environment (NIOSH 1977). Additional exposure information may be found in the ATSDR Toxicological Profile for Polychlorinated Biphenyls (ATSDR 2000).

Regulations

DOT

PCBs are considered hazardous substances and marine pollutants and special requirements have been set for marking, labeling, and transporting these materials

EPA

Clean Air Act
- NESHAP: Listed as a Hazardous Air Pollutant (HAP)
- Urban Air Toxics Strategy: Identified as one of 33 HAPs that present the greatest threat to public health in urban areas

Clean Water Act
- Effluent Guidelines: Listed as a Toxic Pollutant
- Water Quality Criteria: Based on fish/shellfish and water consumption = 0.000064 µg/L; based on fish/shellfish consumption only = 0.000064 µg/L

Comprehensive Environmental Response, Compensation, and Liability Act
- Reportable Quantity (RQ) = 1 lb

Emergency Planning and Community Right-To-Know Act
Toxics Release Inventory: Listed substance subject to reporting requirements
Resource Conservation and Recovery Act
Listed as a Hazardous Constituent of Waste
Safe Drinking Water Act
Maximum Contaminant Level (MCL) = 0.0005 mg/L
Toxic Substances Control Act
Extensive regulations governing the manufacturing, processing, distribution in commerce, use, and disposal of PCBs have been developed

FDA

Maximum permissible level in bottled water = 0.0005 mg/L
Action level for PCBs in red meat is 3 ppm
Specific provisions are set to prevent PCBs contamination of food packaging material and a temporary tolerance level is set at 10 ppm
Specific provisions are set to prevent PCBs contamination in the production, handling, and storage of animal feed
Temporary tolerances for PCBs in milk, dairy products, poultry, and infant food range from 0.2-10 ppm
Temporary tolerances for PCBs in animal feed range from 0.2-2 ppm

OSHA

Permissible Exposure Limit (PEL) = 0.5 mg/m^3 (chlordiphenyl 54% chlorine); 1.0 mg/m^3 (chlordiphenyl 42% chlorine)

Guidelines

NIOSH

Immediately Dangerous to Life and Health (IDLH) = 5 mg/m^3
Recommended Exposure Limit (REL) = 0.001 mg/m^3
Listed as a potential occupational carcinogen

References

ATSDR. 2000. Toxicological Profile for Polychlorinated Biphenyls. Update. (Final Draft). NTIS Accession No. PB2000-108027. Atlanta, GA: Agency for Toxic Substances and Disease Registry. 935 pp.

Budavari, S., ed. 1996. The Merck Index. 12th ed. Whitehall, NJ, Merck & Company, Inc.

EPA. 1984. PCDDs and PCDFs from PCBs Transformer and Capacitor Fires. Washington, D.C.: U.S. Environmental Protection Agency, Office of Research and Development / Industrial Environmental Research Laboratory. 118 pp.

IARC. 1978. Polychlorinated Biphenyls and Polybrominated Biphenyls. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 18. Lyon, France: International Agency for Research on Cancer. 140 pp.

IARC. 1982. Chemicals, Industrial Processes and Industries Associated with Cancer in Humans. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, Supplement 4. Lyon, France: International Agency for Research on Cancer. 292 pp.

IARC. 1987. Overall Evaluations of Carcinogenicity. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, Supplement 7. Lyon, France: International Agency for Research on Cancer. 440 pp.

NIOSH. 1977. A Recommended Standard for Occupational Exposure to Polychlorinated Biphenyls. Cincinnati, OH: Department of Health, Education and Welfare. 8.

Norback, D. H. and R. H. Weltman. 1985. Polychlorinated biphenyl induction of hepatocellular carcinoma in the Sprague-Dawley rat. Environ Health Perspect 60: 97-105.

TRI99. 2001. Toxic Chemical Release Inventory 1999. Data contained in the Toxic Chemical Release Inventory (TRI). National Library of Medicine. http://www.epa.gov/triexplorer/.