Toxaphene
CAS No. 8001-35-2

Reasonably anticipated to be a human carcinogen

Carcinogenicity
Toxaphene is reasonably anticipated to be a human carcinogen based on sufficient evidence of carcinogenicity from studies in experimental animals.

Cancer Studies in Experimental Animals
Dietary exposure to toxaphene caused tumors in two rodent species and at two different tissue sites. In mice of both sexes, it increased the combined incidence of benign and malignant liver tumors (hepatocellular adenoma and carcinoma), and in rats of both sexes, it caused benign tumors of the thyroid gland (follicular-cell adenoma) (IARC 1979, 2001, NCI 1979).

Cancer Studies in Humans
The data available from epidemiological studies are inadequate to evaluate the relationship between human cancer and exposure specifically to toxaphene. Since toxaphene was listed in the Second Annual Report on Carcinogens, additional epidemiological studies have been identified. Two case-control studies, one for non-Hodgkin lymphoma and one for leukemia, found no association with toxaphene exposure (IARC 2001).

Properties
Toxaphene is a manufactured insecticide containing a complex mixture of at least 670 chemicals, including chlorobornanes, chlorocamphenes, and other bicyclic chloroorganic compounds (ATSDR 1996). The relative proportions of the major components of the pesticide are essentially the same in different formulations. Toxaphene exists at room temperature as a yellow-to-amber waxy solid with a pleasant, piney odor (HSDB 2010). It is practically insoluble in water but is freely soluble in aromatic hydrocarbons, such as benzene and xylene, and is readily soluble in aliphatic organic solvents, such as carbon tetrachloride, ethylene dichloride, kerosene, or mineral oil (ATSDR 1996). Toxaphene is stable under normal room temperatures and pressures (Akron 2010). Physical and chemical properties of toxaphene are listed in the following table.

<table>
<thead>
<tr>
<th>Property</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular weight</td>
<td>414 (average)*</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>1.65 at 25°C</td>
</tr>
<tr>
<td>Melting point</td>
<td>65°C to 90°C</td>
</tr>
<tr>
<td>Boiling point</td>
<td>decomposes*</td>
</tr>
<tr>
<td>Log K&lt;sub&gt;ow&lt;/sub&gt;</td>
<td>5.9 (median)*</td>
</tr>
<tr>
<td>Water solubility</td>
<td>0.00055 g/L at 20°C*</td>
</tr>
<tr>
<td>Vapor pressure</td>
<td>6.69 × 10&lt;sup&gt;-6&lt;/sup&gt; mm Hg at 20°C*</td>
</tr>
<tr>
<td>Vapor density relative to air</td>
<td>14.3*</td>
</tr>
</tbody>
</table>


Use
Toxaphene was used primarily as an insecticide for cotton; therefore, most of it was used in the southern United States from Texas to Georgia (HSDB 2010). It was also used to a lesser extent on other crops (e.g., corn, small grains, fruits, vegetables, and soybeans), to control ectoparasites (e.g., lice, flies, ticks, mange, and scab mites) on livestock, and to kill undesirable fish species in lakes and streams (ATSDR 1996). Use of toxaphene in the United States has been recorded since 1966 (HSDB 2010); during the early to mid 1970s, toxaphene became the most heavily used pesticide in the United States. The U.S. Environmental Protection Agency cancelled most of the pesticide registrations for toxaphene in 1982, and all uses were banned in 1990 (ATSDR 1996). After 1982, existing stocks of toxaphene could be used only in selected markets or on a case-by-case emergency basis as determined by EPA, and after 1990, remaining stocks could not be sold or used in the United States.

Annual use of toxaphene in the United States was over 34 million pounds from 1966 to 1976 (HSDB 2010), declining to 6.6 million pounds in 1982. By 1989, toxaphene was no longer used in the United States. During the peak years, approximately 85% of all toxaphene was used on cotton, 7% was used to control insect pests on livestock and poultry, 5% was used on other field crops, 3% was used on soybeans, and less than 1% was used on sorghum (IARC 1979). Toxaphene use continues in some countries, and it may be manufactured in the United States for export to those countries (ATSDR 1996). Cumulative global usage of toxaphene was interpolated to be 670 million kilograms (1.5 billion pounds) between 1970 and 1995 (Voldner and Li 1995).

Production
Commercial production of toxaphene in the United States began in 1947, and four U.S. companies have produced toxaphene commercially (IARC 1979, ATSDR 1996, HSDB 2010). Technical toxaphene can be produced commercially by reacting chlorine gas with technical camphene in the presence of ultraviolet radiation and catalysts, yielding chlorinated camphene containing 67% to 69% chlorine by weight. Between 1964 and 1982, an estimated 234,000 metric tons (over 500 million pounds) of toxaphene was produced in the United States (HSDB 2010). Between 25% and 35% of the annual production was exported. Production peaked in 1975 at 59.4 million pounds, declining more than 90% by 1982 (ATSDR 1996). In 2010, toxaphene was available from 11 suppliers worldwide, including 7 U.S. suppliers (Chem Sources 2010).

Exposure
The routes of potential human exposure to toxaphene are ingestion, dermal contact, and inhalation (HSDB 2010). Toxaphene was the most widely used pesticide in the United States in the 1970s (Bidelman et al. 1998). Because toxaphene is no longer used in the United States, current exposure is due mainly to its persistence in the environment (ATSDR 1996).

The U.S. Food and Drug Administration estimated the average daily intake of toxaphene at 0.003 μg/kg of body weight from 1986 to 1991 and 0.007 to 0.02 μg/kg from 1986 to 1991. The highest estimated intakes were for children aged 2 years. In other studies conducted between 1981 and 1986, toxaphene was detected in fewer than half of 14,492 samples of foods either domestically produced or imported from 79 countries, but less than 1% of those samples contained toxaphene at levels exceeding regulatory limits (HSDB 2010). In the FDA Total Diet Study, conducted from 1991–93 through 2003–04, toxaphene was detected in 14 foods. It was found most frequently and at the highest mean concentrations in peanut butter (0.02018 ppm) and dry-roasted peanuts (0.02609 ppm) (FDA 2003). Specific toxaphene congeners have been measured in pooled human serum from three cities in the United States: Atlanta, Georgia, Chicago, Illinois, and Cincinnati, Ohio (Barr et al. 2004). In northernmost Canada, toxaphene became the most heavily used pesticide in the United States. The U.S. Environmental Protection Agency cancelled most of the pesticide registrations for toxaphene in 1982, and all uses were banned in 1990 (ATSDR 1996). After 1982, existing stocks of toxaphene could be used only in selected markets or on a case-by-case emergency basis as determined by EPA, and after 1990, remaining stocks could not be sold or used in the United States.

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Toxaphene was detected in fish from Alaska's Yukon River Basin in 2002 and that over 25% of the remaining toxaphene had moved to the atmosphere to Indiana and the upper Great Lakes (James and Hites 1999, Carlson and Swackhamer 2006). Toxaphene was measured in precipitation over Lake Ontario from 1994 to 1998, indicating loading of toxaphene to the atmosphere (Hinck et al. 2000). A systematic air-sampling study conducted in 2002–03 supported the premise that most toxaphene in the atmosphere in the northern United States had volatilized from southern cotton fields, where it had been heavily applied before 1982, and had been transported in the atmosphere to Indiana and the upper Great Lakes (James and Hites 2002, Jantunen and Bidleman 2003, Hoh and Hites 2004).

Toxaphene was measured in fish in the Great Lakes and in Lake Tahoe; the highest concentrations were found in lake trout (a species with high lipid content) in Lake Superior (Andrews et al. 1993, Datta et al. 1999, Carlson and Swackhamer 2006). Toxaphene was also found in other locations and in other species, including farm-raised and wild salmon. Fish in subarctic lakes were found to contain toxaphene at levels of concern for human health (Kidd et al. 1995). Toxaphene was also detected in fish from Alaska's Yukon River Basin (Hinck et al. 2006) and in marine mammals in the Alaskan Arctic at levels similar to those found in Northern Canada and Greenland. The native Arctic Alaskan population thus may be exposed to toxaphene through subsistence consumption of marine mammals (Becker et al. 1997, Becker 2000, Hoekstra et al. 2002).

In the past, the risk of occupational exposure to toxaphene was greatest for manufacturers of toxaphene, cotton farmers, and pesticide applicators (HSDB 2010). No estimates are available of the number of people potentially exposed through past agricultural use and handling, but the number may be substantial, because of toxaphene's importance as an agricultural pesticide in the 1970s (ATSDR 1996).

**Regulations**

Department of Transportation (DOT)

Toxaphene is considered a hazardous material, and special requirements have been set for marking, labeling, and transporting this material.

**Environmental Protection Agency (EPA)**

Clean Air Act

National Emission Standards for Hazardous Air Pollutants: Listed as a hazardous air pollutant.

Clean Water Act

Effluent Guidelines: Listed as a toxic pollutant.

Designated a hazardous substance.

Water Quality Criteria: Based on fish or shellfish and water consumption = 0.00070 μg/L; based on fish or shellfish consumption only = 0.00071 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.

Reportable quantity (RQ) = 1 lb.

Threshold planning quantity (TPQ) = 500 lb for the solid in powdered form of particle size < 100 μm or in solution or molten form = 10,000 lb for all other forms.

Federal Insecticide, Fungicide, and Rodenticide Act

Registrations for all uses of toxaphene have been canceled.

Resource Conservation and Recovery Act

Listed as a hazardous waste.

Safe Drinking Water Act

Maximum contaminant level (MCL) = 0.003 mg/L.

Food and Drug Administration (FDA)

Maximum permissible level in bottled water = 0.003 mg/L.

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 (PEL) = 0.5 mg/m³, Potential for dermal absorption.

**Guidelines**

**National Institutes of Occupational Safety and Health (NIOSH)**

Immediately dangerous to life and health (IDLH) limit = 200 mg/m³. Potential for dermal absorption. Listed as a potential occupational carcinogen.

**References**


**Listed as a hazardous constituent of waste.**

**Listed as a hazardous air pollutant.**

**Listed as a hazardous waste.**

**Listed Hazardous Waste: Waste codes for which the listing is based wholly or partly on the presence of toxaphene** = P123, K041, K098.

**Maximum contaminant level in bottled water** = 0.003 mg/L.

**Occupational safety and Health Administration (OSHA)**

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