

5. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

5.1 PRODUCTION

Toxaphene does not occur naturally (Canada Department of National Health and Welfare 1978; EPA 1976a; IARC 1979). It is a complex mixture of at least 670 chlorinated terpenes (Jansson and Wideqvist 1983). 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 67–69% chlorine by weight (EPA 1976a; Korte et al. 1979; Vetter and Scherer 1998). It has been available in various forms: a solid containing 100% technical toxaphene; a 90% solution in xylene or oil; a 40% wettable powder; 5–20 and 40% dusts; 10 and 20% granules; 4, 6, and 9% emulsifiable concentrates; 1% baits; a 2:1 toxaphene; DDT emulsion; and a 14% dust containing 7% DDT (IARC 1979; IUPAC 1979; Penumarthy et al. 1976).

In 1982, EPA canceled the registrations of toxaphene for most uses as a pesticide or pesticide ingredient, except for certain uses under specific terms and conditions (EPA 1982a, 1993; USDA 1995). All registered uses were banned in 1990 (EPA 1990b), and existing stocks of the pesticide were not allowed to be sold or used in the United States after March 1, 1990 (USDA 1995). In 1976, toxaphene was produced primarily by Hercules Incorporated, Wilmington, Delaware (Penumarthy et al. 1976). Production by a total of three U.S. companies (Hercules Incorporated, Tenneco, and Vicksburg Chemical Co., a division of Vertac) during 1976 totaled 19 million kg, which was a 29% decline from the production level of 27 million kg in 1975 (IARC 1979). Montgomery and Welkom (1990) listed Hercules Incorporated, Brunswick, Georgia, and Sonford Chemical Company, Port Neches, Texas, as selected manufacturers of toxaphene; however, no production estimates were provided. Total U.S. production in 1977 was estimated to be 18.1 million kg (HSDB 2010). In 1982, it was estimated that 3.7 million pounds (<2 million kg) were produced in the United States (EPA 1987a). This represents a decline of more than 90% from 1972, when toxaphene was the most heavily manufactured insecticide in the United States, with a production volume of 23,000 tons (21 million kg) (Grayson 1981). The Toxics Release Inventory (TRI) lists facilities in Arizona, Idaho, South Carolina, and Texas that were involved in toxaphene production during 2012 (TRI12 2013) for industrial applications. No other information regarding recent production of toxaphene in the United States was found.

Especially in the United States, the definition of "technical toxaphene" was patterned after the Hercules Incorporated product (Hercules Code Number 3956) marketed under the trademark name of "Toxaphene." Hercules Incorporated has essentially let the name of toxaphene lapse into the public

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domain so that many products with similar properties are referred to as toxaphene (Worthing and Walker 1987). Other companies used slightly different manufacturing processes, leading to a chlorinated camphene mixture with degrees of total chlorination and a distribution of specific congeners that are not the same as the Hercules Incorporated product. For instance, the toxaphene-like product commonly marketed under names like "Stroban(e)" had a slightly lowered degree of chlorination and used slightly different camphene or pinene feedstocks (Walter and Ballschmiter 1991).

Since the early 2000s, efforts have been underway to eliminate the production and use of toxaphene worldwide. The Stockholm Convention, an international treaty designed to restrict the production and use of various chemical substances among its member nations, includes toxaphene on a list of persistent organic pollutants or POPs (Stockholm Convention 2008). Under the rules of the convention, production or use of toxaphene is completely banned and exemptions are not available. The convention, which initially went into effect in 2005, listed over 150 participating nations as of June, 2010.

While most attention has been focused on the intentional production of polychlorinated camphenes (PCCs) as pesticide agents, there is evidence that PCC congeners may be an unintentional byproduct of manufacturing processes that use chlorination, such as those for paper and pulp (Rantio et al. 1993).

Because toxaphene is a Priority Pollutant under the Clean Water Act, it is required to be included in the TRI (EPA 2005). All registered uses of toxaphene on food commodities were canceled by 1990 (EPA 1982a, 1990b), and the sale and use of existing stocks of the pesticide in the United States were prohibited after March 1, 1990 (USDA 1995). Therefore, current information included in the TRI regarding the processing or use of toxaphene at industrial facilities is expected to be related to the storage and disposal of toxaphene supplies or the use of this substance in onsite processing and as a manufacturing aid. These facilities are not expected to be involved in production or import of toxaphene for pesticidal use in the United States. Table 5-1 summarizes the number of facilities in each state that processed or used toxaphene in 2012, the ranges of maximum amounts on site, if reported, and the activities and uses as reported in the TRI (TRI12 2013). The data listed in this table should be used with caution since only certain types of facilities are required to report. This is not an exhaustive list.

5.2 IMPORT/EXPORT

In 1972, a total of 8,000 metric tons (7.25 million kg) of toxaphene, or 35% of the annual production, was exported (EPA 1974; SRI 1993; USITC 1991). The TRI lists four states containing facilities that were

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Table 5-1. Facilities that Produce, Process, or Use Toxaphene

State ^a	Number of facilities	Minimum amount on site in pounds ^b	Maximum amount on site in pounds ^b	Activities and uses ^c
AL	7	0	99	12
AR	22	0	99,999	1, 2, 3, 5, 7, 9, 12
CA	9	0	9,999	12
ID	1	0	99	1, 3, 12
IL	12	0	999	12
IN	3	0	9,999	2, 3, 12, 13, 14
KY	4	1,000	9,999	12
LA	7	0	9,999	12
MI	7	0	999	12, 14
MS	1	1,000	9,999	2, 3, 8
NE	8	100	999,999	12
NJ	2	100	999	12
NV	5	0	99,999	2, 3, 12
OH	33	0	99,999	12
OK	5	0	99,999	12
OR	13	100	9,999	12
PA	4	0	99	12
SC	4	0	99,999	1, 5, 12
TX	34	0	9,999,999	1, 3, 12
UT	14	0	99,999	12
WI	5	0	99	8, 14

^aPost office state abbreviations used.

^bAmounts on site reported by facilities in each state.

^cActivities/Uses:

- | | | |
|--------------------------|--------------------------|-----------------------------|
| 1. Produce | 6. Impurity | 11. Chemical Processing Aid |
| 2. Import | 7. Reactant | 12. Manufacturing Aid |
| 3. Onsite use/processing | 8. Formulation Component | 13. Ancillary/Other Uses |
| 4. Sale/Distribution | 9. Article Component | 14. Process Impurity |
| 5. Byproduct | 10. Repackaging | |

Source: TRI12 2013 (Data are from 2012)

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involved with the import of toxaphene into the United States during 2012 (TRI12 2013) for industrial applications. No other information was found regarding the import of toxaphene into or the export of toxaphene from the United States.

5.3 USE

Toxaphene was formerly used as a nonsystemic stomach and contact insecticide with some acaricidal activity. Being nonphytotoxic (except to cucurbits), it was used to control many insects thriving on cotton, corn, fruit, vegetables, and small grains and to control the *Cassia obtusifolia* soybean pest. Toxaphene was also used to control livestock ectoparasites such as lice, flies, ticks, mange, and scab mites (Knipling and Westlake 1966; Meister 1988; Worthing 1979). Toxaphene's relatively low toxicity to bees and its long persisting insecticidal effect made it particularly useful in the treatment of flowering plants. Toxaphene was not used to control cockroaches because its action on them is weaker than chlordane (IARC 1979). Toxaphene was used at one time in the United States to eradicate unwanted fish (Muirhead Thomson 1971). The principal use was for pest control on cotton crops (IUPAC 1979; Verschueren 1983). In 1974, an estimated 20 million kg used in the United States was distributed as follows: 85% on cotton; 7% on livestock and poultry; 5% on other field crops; 3% on soybeans; and <1% on sorghum (IARC 1979). Based on estimates of EPA (1974) for 1972, 75% of the toxaphene production for that year was for agricultural use; 24% was exported; and 1% was used for industrial and commercial applications.

Toxaphene solutions were often mixed with other pesticides partly because toxaphene solutions appear to help solubilize other insecticides with low water solubility. Toxaphene was frequently applied with methyl or ethyl parathion, DDT, and lindane (IARC 1979; WHO 1974).

Through the early 1970s, toxaphene or mixtures of toxaphene with rotenone were used widely in lakes and streams by fish and game agencies to eliminate biologic communities that were considered undesirable for sport fishing (Lockhart et al. 1992; Stern et al. 1993). This practice was especially prominent in parts of Canada and the northern United States for fish restocking experiments on smaller glacial lakes. Because the toxic effects of toxaphene may persist for many years in an aquatic system, difficulties in establishing the desired sports fisheries were among the first strong indications that toxaphene was a persistent and bioaccumulative material. Such uses of toxaphene by fish and game agencies have been discontinued in the United States and Canada.

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Toxaphene use in this country has declined drastically since 1975, when it was reported to be the most heavily used pesticide (Sanders 1975). The total used was estimated at only 9,360 tons (8.5 million kg) in 1980 and 5,400 tons (4.9 million kg) in 1982 (WHO 1984). In November 1982, EPA canceled the registrations of toxaphene for most uses as a pesticide or pesticide ingredient (EPA 1982a). In the period following November 1982, its use was restricted to controlling scabies on sheep and cattle; grasshopper and army worm infestations on cotton, corn, and small grains; and specific insects on banana and pineapple crops in Puerto Rico and the U.S. Virgin Islands; and for emergency use only (to be determined on a case-by-case basis by EPA) (EPA 1982a; WHO 1984). Formulations suitable for other purposes could be sold or distributed until December 31, 1983, for use only on registered sites (EPA 1982a). The distribution or sale of remaining stocks of toxaphene formulations were permitted until December 31, 1986, for use on no-till corn, soybeans, and peanuts (to control sicklepod), and dry and southern peas, and to control emergency infestations. All registered uses of toxaphene mixtures in the United States and any of its territories were canceled in 1990 (EPA 1990b).

5.4 DISPOSAL

Toxaphene may not be disposed of by water or ocean dumping or by burning in the open air. The recommended disposal method is incineration in a pesticide incinerator at a temperature and residence time combination that will result in complete destruction of the chemical (EPA 1989). Any emissions generated by incineration must meet the requirements of the Clean Air Act Amendments, Title III, and any liquids, sludges, or solid residues produced should be disposed of in accordance with federal, state, and local pollution control requirements. Municipal solid waste incinerators may be used, providing that they meet the criterion of a new pesticide incinerator and are operated under supervision (EPA 1989). Landfill has also been identified as a recommendable method of disposal of toxaphene (IRPTC 1985). Thermal desorption is reported to be an effective technology for treating soils contaminated with toxaphene (Troxler et al. 1993). Federal, state, and local regulations governing the treatment and disposal of wastes containing toxaphene are presented in Chapter 8.

No information was found in the available literature on the amounts of toxaphene disposed of in the United States by any disposal method.