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

4.1 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). 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, 1993a; USDA 1995). All registered uses were banned in 1990 (EPA 1990b), and existing stocks 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). More recently, 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 1995). The most recent production volumes found in the available literature are from 1982, when it was estimated that 3.7 million pounds (less than 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).

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.” In recent years, Hercules Incorporated has essentially let the name of toxaphene lapse into the public 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).

Toxaphene-like pesticide agents are still produced and are widely used in many countries. While it is impossible to quantify production figures or usage rates, India and many countries in Latin America, Eastern Europe, the former Soviet Union, and Africa still use various toxaphene products as pesticides (Bidleman et al. 1989; Stem et al. 1993). It has been recently estimated that total global toxaphene use from 1950 to 1993 was greater than 1.3 million tons (1.2 billion kg) (Voldner and Li 1993); however, this is likely to be a significant underestimation (Swackhamer et al. 1993). Since toxaphene is a complex mixture, continued reliance on the use of “technical toxaphene” as a reference may actually complicate the task of identifying toxaphene signatures for contaminants transported via global atmospheric pathways.

While most attention has been focused on the intentional production of polychlorinated camphenes (PCCs) as pesticide agents, there is growing 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). Studies from places as far-flung as New Zealand, Japan, the Great Lakes region of the United States, and Scandinavia suggest that PCCs can be found in many parts of the world where toxaphene mixtures were never used as pesticide agents (EPA 1993a; Jamuzi et al. 1992; Paasivirta and Rantio 1991).

Because toxaphene is a Priority Pollutant under the Clean Water Act, it is required to be included in the Toxics Release Inventory (TRI) (EPA 1995a). Since all registered uses of toxaphene on food commodities were canceled by 1990 (EPA 1982a, 1990b, 1993b), and the sale and use of existing stocks in the United States were prohibited after March 1, 1990 (USDA 1995), production of toxaphene for all domestic uses in the United States has ceased. However, U.S. chemical manufacturers can legally produce pesticides for export that are currently banned or not registered for use in the United States (FASE 1996). Toxaphene currently has no entries associated with its production in 1993, the most recent production year for which data are available (TR193 1995). However, the TRI is not an exhaustive list. If toxaphene is being produced in the United States for export, production information would not necessarily appear on the TRI database.

4.2 IMPORT/EXPORT

No current information was found regarding the import of toxaphene into or the export of toxaphene from the United States (HSDB 1995). In 1972, a total of 8,000 tons (7.25 million kg) of toxaphene, or 35% of the annual production, was exported (SRI International 1993; USITC 1991; von Rumker et al. 1974).

4.3 USE

Toxaphene was formerly used as a nonsystemic stomach and contact insecticide with some acaricidal activity. Being nonphytotoxic (except to cucurbitus), it was used to control many insects thriving on cotton, corn, fruit, vegetables, and small grains and to control the *Cussia obtusifola* 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). Its 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 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 less than 1% on sorghum (IARC 1979). Based on estimates of von Rumker et al. (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 apparently been discontinued in the United States and Canada.

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; controlling grasshopper and army worm infestations on cotton, corn, and small grains; controlling 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). On September 1, 1993, all tolerances, interim tolerances, and food additive regulations for toxaphene on all agricultural commodities were revoked (EPA 1993b).

4.4 DISPOSAL

Four types of toxaphene hazardous wastes have been defined under the Resource Conservation and Recovery Act (RCRA) (EPA 1980b). Only one type (waste exhibiting a “toxicity characteristic” for toxaphene) has a technology-based standard under the RCRA land disposal restrictions. A solid waste is said to exhibit a toxicity characteristic for toxaphene, and is classified as a RCRA toxic, if an aqueous extract performed by the legally defined procedure from a representative sample of the waste contains toxaphene in a concentration equal to or greater than 0.5 mg/L (ppm) (EPA 1980b). It must be treated by biodegradation or incineration (waste waters only) to comply with the restrictions. The three remaining wastes are: waste water treatment sludge from the production of toxaphene; untreated process waste water from the production of toxaphene; and off-specification toxaphene (does not meet the desired chemical purity). These three wastes have concentration-based standards that must be achieved before the waste can be land-disposed in a RCRA permitted facility (EPA 1988c).

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 1974, 1980b, 1988c). 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 1974). Landfill has also been identified as a recommendable method of disposal of toxaphene (IRPTC 1985). Recent research has shown that thermal desorption is 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 7.

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