

4. PRODUCTION, IMPORT, USE, AND DISPOSAL

4.1 PRODUCTION

Tetrachloroethylene is produced by several temperate and subtropical marine macroalgae at the rate of 0.0026-8.2 ng/g fresh weight/hour. These species of algae have also been shown to produce trichloroethylene, usually at greater rates. It has been concluded that emission of trichloroethylene and tetrachloroethylene from algae to the atmosphere “may be of such a magnitude that it cannot be neglected in the global atmospheric chlorine budget” (Abrahamsson et al. 1995).

Tetrachloroethylene is a commercially important chlorinated hydrocarbon solvent and chemical intermediate. It is used as a dry cleaning and textile-processing solvent and for vapor degreasing in metal-cleaning operations. Tetrachloroethylene was first commercially produced in the United States in 1925 via a four-step process using acetylene and chlorine as raw materials (IARC 1979). By 1975, only one U.S. plant was using this process because of the high cost of acetylene. Currently, the majority of tetrachloroethylene produced in the United States is made by one of two processes: direct chlorination of certain hydrocarbons or oxychlorination. The first process involves the reaction of chlorine with a hydrocarbon such as methane, ethane, propane, or propylene. A chlorinated derivative of a hydrocarbon may also be used. The reaction forms a crude product, which can be purified to yield a marketable grade of tetrachloroethylene. This is easier and more economical than the acetylene process. The second process, oxychlorination of ethylene via ethylene dichloride, is widely used to coproduce trichloroethylene and tetrachloroethylene without any net production of hydrogen chloride (Chemical Products Synopsis 1985; Keil 1985).

Tetrachloroethylene is produced in the following grades: purified, technical, U.S. Pharmacopoeial (USP), spectrophotometric, and dry cleaning (ACGIH 1991). The dry cleaning and technical grades meet specifications for technical grade, differing only in the amount of stabilizer added to prevent decomposition. Stabilizers, which include amines or mixtures of epoxides and esters, are added to prevent decomposition. Tetrachloroethylene, which is thus stabilized and not easily hydrolyzed, is transported in tanks and drums (ACGIH 1991).

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U.S. production volumes of tetrachloroethylene in recent years have been reported as follows (C&EN 1994):

<u>Year</u>	<u>Production</u> <u>(millions of pounds)</u>
1993	271
1992	245
1991	239
1990	372
1989	481
1988	498
1987	473
1986	414
1985	678
1984	573
1983	547

These data show there has been an overall decline of about 50% between 1983 and 1993. The future production market for tetrachloroethylene has been projected at either zero growth or a long-term gradual decline (Chemical Products Synopsis 1985). The facilities that manufactured or processed tetrachloroethylene in 1993 are listed in Table 4-1 (TRI93 1995). Toxics Release Inventory (TRI) data should be used with caution since only certain types of facilities are required to report. This is not an exhaustive list.

The 1995 Directory of Chemical Producers in the United States lists three major manufacturers of tetrachloroethylene with a total annual capacity of 490 million pounds (SRI 1995).

4.2 IMPORT/EXPORT

The volume of tetrachloroethylene imported to the United States has increased sharply since 1980 because of the strength of the dollar abroad (Chemical Products Synopsis 1985). In 1990, about 75.3 million pounds of tetrachloroethylene were imported into the United States, while in 1994, about 83.8 million pounds were imported into the United States (NTD 1995). Tetrachloroethylene exported

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Table 4-1. Facilities That Manufacture or Process Tetrachloroethylene

State ^a	Number of facilities	Range of maximum amounts on site in thousands of pounds ^b	Activities and uses ^c
AL	5	1-100	2, 3, 4, 10, 13
AR	4	1-100	2, 3, 8, 12, 13
AZ	2	1-10	13
CA	63	0-10000	2, 3, 4, 7, 8, 9, 10, 11, 12, 13
CO	2	1-100	12, 13
CT	16	1-1000	11, 12, 13
FL	11	1-1000	8, 11, 12, 13
GA	12	0-1000	2, 3, 5, 8, 10, 11, 13
IA	7	0-1000	11, 12, 13
IL	35	0-10000	2, 3, 4, 8, 10, 11, 12, 13
IN	26	0-100	2, 3, 8, 10, 11, 12, 13
KS	8	1-10000	1, 3, 4, 7, 8, 11, 12, 13
KY	10	1-1000	1, 3, 7, 8, 11, 12, 13
LA	16	0-50000	1, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13
MA	7	1-1000	8, 10, 12, 13
MD	2	1-10	12, 13
ME	1	1-10	12
MI	10	1-1000	7, 8, 10, 11, 12, 13
MN	11	1-100	2, 3, 11, 12, 13
MO	12	1-1000	8, 11, 12, 13
MS	5	10-1000	8, 11, 12, 13
MT	2	1-100	11, 13
NC	20	0-1000	2, 3, 5, 7, 8, 11, 12, 13
NE	4	1-100	12, 13
NH	4	1-100	13
NJ	6	0-100	8, 11, 12, 13
NY	20	0-1000	8, 10, 11, 12, 13
OH	48	0-1000	2, 3, 8, 10, 11, 12, 13
OK	8	1-1000	11, 12, 13
OR	1	10-100	11
PA	18	0-10000	8, 10, 11, 12, 13
PR	2	0-10	2, 5, 8, 13
SC	12	1-100	8, 12, 13
TN	8	1-1000	8, 11, 12, 13
TX	25	1-50000	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13
UT	3	1-100	11, 13
VA	7	0-1000	2, 3, 9, 11, 13
VT	1	100-1000	12

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Table 4-1. Facilities That Manufacture or Process Tetrachloroethylene (continued)

State ^a	Number of facilities	Range of maximum amounts on site in thousands of pounds ^b	Activities and uses ^c
WA	1	1-10	12
WI	12	1-100	7, 8, 10, 12, 13
WY	1	0-1	11, 13

Source: TRI93 1995

^a Post office state abbreviations used^b Data in TRI are maximum amounts on site at each facility^c Activities/Uses:

- | | |
|-------------------------------|----------------------------------|
| 1. Produce | 8. As a formulation component |
| 2. Import | 9. As a product component |
| 3. For on-site use/processing | 10. For repackaging only |
| 4. For sale/distribution | 11. As a chemical processing aid |
| 5. As a by-product | 12. As a manufacturing aid |
| 6. As an impurity | 13. Ancillary or other uses |
| 7. As a reactant | |

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from the United States was about 55.2 million pounds in 1990, and 44 million pounds in 1994 (NTD 1995).

4.3 USE

Tetrachloroethylene is commercially important as a chlorinated hydrocarbon solvent and as a chemical intermediate. An estimate of the current end-use pattern for tetrachloroethylene is as follows: 55% for chemical intermediates, 25% for metal cleaning and vapor degreasing, 15% for dry cleaning and textile processing, and 5% for other unspecified uses (Chemical Profile 1995).

In textile processing, tetrachloroethylene is used as a scouring solvent that removes oils from fabrics after knitting and weaving operations, and as a carrier solvent for sizing and desizing, and for fabric finishes and water repellents. Tetrachloroethylene is able to dissolve fats, greases, waxes, and oils without harming natural or man-made fibers. However, because of the growing popularity of washand-wear fabrics, improved efficiency of dry cleaning equipment, and increased chemical recycling, the demand for tetrachloroethylene as a dry cleaning solvent has steadily declined. There are three major types of dry cleaning facilities, industrial, commercial and coin-operated. Industrial facilities have the largest average output, while smaller commercial facilities are the most common. Coinoperated dry cleaners are being phased out, and new coin-operated machines are no longer available (EPA 1995). A survey conducted by the International Fabricare Institute in 1989 indicated that 88.4% of the dry cleaners in the United States use tetrachloroethylene (Andrasik and Cloutet 1990).

Another major use of tetrachloroethylene is as a vapor and liquid degreasing agent. Since tetrachloroethylene dissolves many organic compounds, select inorganic compounds, and high-melting pitches and waxes, it can be used to clean and dry contaminated metal parts and other fabricated materials. It is also used to remove soot from industrial boilers (Verschueren 1983). Tetrachloroethylene has been used as an anthelmintic in the treatment of hookworm and some nematode infestations, but it has been replaced by drugs that are less toxic and easier to administer (Budavari 1989; HSDB 1996).

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4.4 DISPOSAL

Recently, the chemical industry has responded to increased environmental and ecological concerns with efforts to improve recovery and recycling of tetrachloroethylene. One method of disposal involves absorption in vermiculite, dry sand, earth, or a similar material and then burial in a secured sanitary landfill (HSDB 1996). A second method involves incineration at $>450^{\circ}\text{C}$ after mixing with another combustible fuel. With the latter method, combustion must be complete to prevent the formation of phosgene, and an acid scrubber must be used to remove the haloacids produced (HSDB 1996).

Recent federal regulations prohibit land disposal of various chlorinated solvent materials that may contain tetrachloroethylene. Any solid waste containing tetrachloroethylene must be listed as a hazardous waste unless the waste is shown not to endanger the health of humans or the environment (EPA 1985b, 1988). Destruction and removal efficiency of tetrachloroethylene that is designated as a principal organic hazardous constituent must be 99.99%. Discharge of tetrachloroethylene into U.S. waters requires a permit (WHO 1987). Before implementing land disposal of waste residue, environmental regulatory agencies should be consulted for recent guidance on acceptable disposal practices (HSDB 1996).