

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

4.1 PRODUCTION

Carbon disulfide was first manufactured commercially around 1880 (Timmerman 1978). Until about 1950, the primary industrial-scale production method was by heating charcoal to 750-900°C in the presence of vaporized low-ash sulfur. However, in the United States, extensive research was devoted to finding alternative sources of carbon disulfide, and by 1965 the coal-burning method was largely replaced by a reaction involving natural gas hydrocarbons such as methane, ethane, and ethylene (Timmerman 1978; Windholz 1983). Carbon disulfide is normally available both in technical and reagent grades (up to 99.9% pure with a trace benzene contaminant) (Sax and Lewis 1987; Timmerman 1978) and in alkali (thiocarbonates) as emulsions or solutions for soil treatment (Spencer 1982; Worthing 1987). Trade names for preparations include Weeviltox and Caswell No. 162 (HSDB 1995).

Trends in carbon disulfide production have closely paralleled those of the viscose rayon industry, one of its largest users (HSDB 1995; Mannsville Chemical Products Corp. 1985; Timmerman 1978; WHO 1981). Production increased by nearly 50% between 1941 and 1969, from 242,000 to 362,000 metric tons. This increase was partly due to a sudden rise in demand for carbon tetrachloride, an intermediate in the production of fluorocarbon propellants and refrigerants; carbon disulfide is used in the production of carbon tetrachloride. The 1969 production level remained relatively stable until about 1974 when it declined sharply to the 1975 level of 217,000 metric tons (Timmerman 1978). Carbon disulfide production levels continued to decline, with fluctuations, to 168,000 metric tons in 1984 (Mannsville Chemical Products Corp. 1985; Timmerman 1978). In 1985, production was estimated to be 143,000 metric tons (Mannsville Chemical Products Corp. 1985). No information was found on production levels after 1985.

Because of a long-term decline in the demand for viscose rayon and cellophane and restrictions on the use of fluorocarbon propellants, future production levels of carbon disulfide are uncertain. However, it is expected that demand for this chemical in many other specialty areas will continue at relatively stable levels (Mannsville Chemical Products Corp. 1985; Timmerman 1978).

In the United States, the principal manufacturers of carbon disulfide include Lenzing Fibers Corp., ELF Atochem N.A. Inc., and PPG Industries (TRI93 1995). For additional information on companies that manufacture or process carbon disulfide, refer to Table 4-1. According to the 1993 Toxics Release Inventory (TRI), 80 facilities manufactured or processed carbon disulfide in 1993, 9 fewer than in 1991 (TRI93 1995). Seventy-nine (79) of these facilities reported the maximum amount of carbon disulfide that they would have on site. These data are listed in Table 4-1. The TRI data should be used with caution since only certain types of facilities are required to report. Carbon disulfide is also produced in 14 foreign countries, including 4 producers in Canada, 7 in South and Central America, 9 in Asia, 8 in Europe, and 1 in Australia (CIS 1989). The total annual capacity of the 13 principal foreign manufacturers in 1977 was 911,000 metric tons.

4.2 IMPORT/EXPORT

Imports of carbon disulfide have fallen at a fairly steady rate from 2,700 metric tons in 1980 to 1,400 metric tons in 1985. Exports, on the other hand, fell sharply from 5,900 metric tons in 1980 to 900 metric tons in 1982. Exports continued to decline to 450 metric tons in 1983 and then rose to 1,400 metric tons in 1984 (Mannsville Chemical Products Corp. 1985). No information was found on export levels after 1985.

4.3 USE

Carbon disulfide has been an important industrial chemical since the 1800s because of its many useful properties, including its ability to solubilize fats, rubbers, phosphorus, sulfur, and other elements (Sine 1989; Timmerman 1978; Windholz 1983). Because of its ability to dissolve phosphorus, it was once widely used to produce matches but was later replaced by another chemical. Carbon disulfide's fat solvent properties also made it indispensable in preparing fats, lacquers, and camphor; in refining petroleum jelly and paraffin; and in extracting oil from bones, palmstones, olives, and rags. It was also used in processing India rubber sap from tropical trees. In all of these extraction processes, however, carbon disulfide has been replaced by other solvents (Davidson and Feinleib 1972).

Its fat, rubber, and metal solvent properties have made carbon disulfide highly suitable for a variety of other continuing industrial applications including the following: vulcanization and manufacture of

TABLE 4-1. Facilities That Manufacture or Process Carbon Disulfide

Facility	Location ^a	Range of maximum amounts on site in pounds	Activities and uses
GULF STATES STEEL INC. GE CO.	GADSDEN, AL BURKVILLE, AL	1,000-9,999 0-99	Produce; As an impurity Produce; As an impurity
AKZO NOBEL CHEMICALS INC.	AXIS, AL	No data	Produce; For on-site use/processing; For sale/distribution; As a reactant; As a chemical processing aid
COURTAULDS FIBERS INC.	AXIS, AL	100,000-999,999	As a reactant
WITCO CORP.	PHENIX CITY, AL	100-999	Produce; As a by-product
VISKASE CORP.	OSCEOLA, AR	100,000-999,999	As a chemical processing aid
COLUMBIAN CHEMICALS CO.	EL DORADO, AR	0-99	Produce; As a by product
HICKSON KERLEY INC.	SAHUARITA, AZ	100,000-999,999	As a reactant
MINEREC INC.	TUCSON, AZ	100,000-999,999	As a reactant
ZENECA INC.	RICHMOND, CA	100,000-999,999	As a reactant
AMVAC CHEMICAL CORP.	LOS ANGELES, CA	100,000-999,999	As a reactant
VANDERBILT CHEMICAL CORP.	BETHEL, CT	100,000-999,999	As a reactant
UNIROYAL CHEMICAL CO. INC.	CT	100,000-999,999	As a reactant
STAR ENT.	DELAWARE CITY, DE	10,000-99,999	As a chemical processing aid
VININGS IND. INC.	MARIETTA, GA	100,000-999,999	As a reactant
HERCULES INC.	BRUNSWICK, GA	10,000-99,999	As a reactant
TEXTILE RUBBER & CHEMICAL CO.	GA	100,000-999,999	As a reactant
VISKASE CORP.	BEDFORD PARK, IL	100,000-999,999	As a chemical processing aid
AMOCO	WOOD RIVER, IL	100,000-999,999	As a reactant
BF GOODRICH	HENRY, IL	100,000-999,999	As a reactant
TEPAK INC.	DANVILLE, IL	100,000-999,999	As a reactant; As a chemical processing aid
UNO-VEN CO.	IL	0-99	Produce; As a by-product
BETHLEHEM STEEL CORP. GE CO.	BURNS HARBOR, IN MOUNT VERNON, IN	1,000-9,999 0-99	Produce; As a by-product Produce; As a by-product
FLEXEL INDIANA INC.	COVINGTON, IN	100,000-999,999	As a chemical processing aid
COLUMBIAN CHEMICALS CO.	ULYSSES, KS	0-99	Produce; As a by-product
FLEXEL INC.	TECUMSEH, KS	100,000-999,999	As a reactant
VANDERBILT CHEMICAL CORP.	MURRAY, KY	100,000-999,999	As a reactant
UNIROYAL CHEMICAL CO. INC.	GEISMAR, IA	100,000-999,999	As a reactant
CITGO PETROLEUM CORP.	LAKE CHARLES, LA	1,000-9,999	Produce; As a by-product
RHONE-POULENC BASIC CHEMICALS	BATON ROUGE, LA	100,000-999,999	Ancillary uses
CABOT CORP.	VILLE PLATTE, LA	100-999	Produce; As a by-product
DEGUSSA CORP.	LOUISA, LA	0-99	Produce; As a by-product

TABLE 4-1. Facilities That Manufacture or Process Carbon Disulfide (continued)

Facility	Location ^a	Range of maximum amounts on site in pounds	Activities and uses
WITCO CORP.	TAFT, LA	100,000-999,999	As a reactant
MARINE SHALE PROCESSORS, INC.	AMELIA, LA	1,000-9,999	As a reactant
CABOT CORP.	FRANKLIN, LA	100-999	Produce; As a by-product
COLUMBIAN CHEMICALS	CENTERVILLE, LA	0-99	Produce; As a by-product
KOCH IND. INC.	MN	1,000-9,999	Produce; As a by-product
BAYER CORP.	KANSAS CITY, MO	100,000-999,999	As a reactant
PETROLITE CORP.	SAINT LOUIS, MO	10,000-99,999	As a reactant
BUCKMAN LABS. INC.	CADET, MO	100,000-999,000	As a reactant
AMERADA HESS CORP.	PURVIS, MS	1,000-9,999	As a chemical processing aid
MONTANA SULPHUR & CHEMICAL CO.	BILLINGS, MT	0-99	Produce; As a by-product; As a reactant
DU PONT	DEEPWATER, NJ	100,000-999,999	As a reactant
MERCK & CO. INC.	RAHWAY, NJ	100,000-999,999	As a reactant
3M	TONAWANDA, NY	100,000-999,999	As a reactant
GOODYEAR TIRE & RUBBER CO.	NIAGARA FALLS, NY	100,000-999,999	As a reactant
FERRO CORP.	WALTON HILLS, OH	10,000-99,999	As a reactant
ZENECA INC.	PERRY, OH	100,000-999,999	As a reactant
LUBRIZOL CORP.	PAINESVILLE, OH	10,000-99,999	As a reactant
NYLONGE CORP.	ELYRIA, OH	100,000-999,999	As a reactant
WITCO CORP.	PONCA CITY, OK	100-999	Produce; As a by-product
FLEXSYS AMERICA LP	MONOGAHELA, PA	100,000-999,999	As a chemical processing aid
SOUTHERN WATER TREATMENT CO.	GRENVILLE, SC	100,000-999,999	As a reactant
HODGSON CHEMICALS INC.	ROCK HILL, SC	100,000-999,999	As a reactant
NORTH AMERICAN RAYON CORP.	ELIZABETHTON, TN	100,000-999,999	As a reactant; As a chemical processing aid
LENZING FIBERS CORP.	LOWLAND, TN	1,000,000-9,999,999	As a reactant
ALCO CHEMICAL	CHATTANOOGA, TN	100,000-999,999	As a reactant
VISKASE CORP.	LOUDON, TN	100,000-999,999	As a chemical processing aid
SPONTEX INC.	COLUMBIA, TN	100,000-999,999	As a reactant
DEGUSSA CORP.	ARANSAS PASS, TX	0-99	Produce; As a by-product
DOW CHEMICAL CO.	FREEPORT, TX	0-99	Produce; As an impurity
CABOT CORP.	PAMPA, TX	0-99	Produce; As a by-product
J. M. HUBER CORP.	BAYTOWN, TX	0-99	Produce; As a by-product
GOODYEAR TIRE & RUBBER CO.	HOUSTON, TX	0-99	Produce; As a by-product
RHONE-POULENC BASIC CHEMICALS	HOUSTON, TX	10,000-99,999	Ancillary uses

TABLE 4-1. Facilities That Manufacture or Process Carbon Disulfide (continued)

Facility	Location ^a	Range of maximum amounts on site in pounds	Activities and uses
LUBRIZOL CORP.	DEER PARK, TX	10,000-99,999	As a reactant
J. M. HUBER CORP.	BORGER, TX	0-99	Produce; As a by-product
ELF ATOCHEM N.A. INC.	BEAUMONT, TX	1,000,000-9,999,999	Produce; As a by-product
BAKER PERFORMANCE CHEMICALS	DAYTON, TX	10,000-99,999	As a formulation component
WITCO CORP.	SUNRAY, TX	0-99	Produce; As a by-product
J. M. HUBER CORP.	ORANGE, TX	0-99	Produce; As a by-product
DU PONT	RICHMOND, VA	100,000-999,999	As a reactant; As a chemical processing aid
HICKSON KERLEY INC.	KENNEWICK, WA	100,000-999,999	As a reactant
3M	WI	100,000-999,999	As a reactant
PPG IND. INC.	NEW MARTINSVILLE, WV	1,000,000-9,999,999	Produce; For sale/distribution
COLUMBIAN CHEMICALS CO.	PROCTOR, WV	0-99	Produce; As a by-product
CABOT CORP.	WAVERLY, WV	0-99	Produce; As a by-product
AC & S INC.	NITRO, WV	10,000-99,999	As a reactant
MONSANTO CO.	NITRO, WV	100,000-999,999	As a reactant

Source: TRI93 1995

^aPost office state abbreviations used

NA = not available

rubber and rubber accessories; production of resins, xanthates, thiocyanates, plywood adhesives, and flotation agents; solvent and spinning-solution applications primarily in the manufacture of rayon; polymerization inhibition of vinyl chloride; conversion and processing of hydrocarbons; petroleum-well cleaning; brightening of precious metals in electroplating; thin film deposition of nickel; as an agent to increase corrosion and wear-resistance in metals; rust removal from metals; and removal and recovery of metals and other elements from waste water and other media (Davidson and Feinleib 1972; EPA 1978a; Sine 1989; WHO 1981; Windholz 1983; Worthing 1987). It has also been used in industry as a means to promote sulfation in the synthesis of rare earth sulfides used in semiconductors, as a regenerator for transition metal sulfide catalysts, as a development restrainer in photography and lithography, and as a solvent to remove printing on recycled plastics (Timmerman 1978).

Carbon disulfide's most important industrial use, however, has been in the manufacture of regenerated cellulose rayon by the viscose process (viscose rayon) and of cellophane (Davidson and Feinleib 1972; EPA 1978a; NIOSH 1977; Timmerman 1978; WHO 1981). In 1974, over 80% of the carbon disulfide manufactured was used to make viscose rayon and cellophane (Austin 1974). This proportion fell to 50% in 1984, but the rayon and cellophane uses still accounted for the greatest fraction of carbon disulfide production (Mannsville Chemical Products Corp. 1985). Since 1989, the consumption of carbon disulfide in the production of carbon tetrachloride has increased to 38%, while the rayon industry's consumption has dropped to 34% (HSDB 1995).

Another principal industrial use for carbon disulfide has been as a feedstock for carbon tetrachloride production (Mannsville Chemical Products Corp. 1985; NIOSH 1977; Timmerman 1978). While only 10% of U.S. carbon disulfide production was used to produce carbon tetrachloride in 1960, this increased to 32% in 1974, largely because of a rapid increase in the demand for carbon tetrachloride for the production of fluorocarbon propellants and refrigerants (Timmerman 1978). Although most chemical manufacturers have switched to methanol as a raw material for carbon tetrachloride, beginning in 1985, Akzo America, Inc., continued to use carbon disulfide for this purpose (Mannsville Chemical Products Corp. 1985). Beginning in 1989, 38% of the carbon disulfide produced was used to manufacture carbon tetrachloride (HSDB 1995).

In the food industry, carbon disulfide has been used to protect fresh fruit from insects and fungus during shipping, in adhesives for food packaging, and in the solvent extraction of growth inhibitors (Timmerman 1978).

In agriculture, carbon disulfide has been widely used as a fumigant to control insects in stored grain, normally when mixed with carbon tetrachloride to reduce the fire hazard (Sine 1989; Worthing 1987). It has also been used to remove botfly larva infestations from the stomachs of horses and ectoparasites from swine (Rossoff 1974). Use of carbon disulfide as a grain fumigant was voluntarily cancelled after 1985 (EPA 1985a). An intensive specialty use is to desorb charcoal sampling tubes in NIOSH methods for airborne organics (NIOSH 1984b). Carbon disulfide is used extensively in research laboratory chemical synthetic methods (Dunn and Rudolf 1989).

In 1989, the estimated distribution of carbon disulfide utilization was as follows: 34% of production went to manufacture viscose rayon, 6% to produce cellophane, 38% to produce carbon tetrachloride, 7% to produce rubber chemicals, and 15% to produce pesticides and to solubilize waxes and oils (HSDB 1995). Future use patterns remain uncertain, although it is expected that less may be used to produce viscose rayon, cellulose, and carbon tetrachloride, products for which the demand has declined and for which alternate production processes may be found (HSDB 1995; Mannsville Chemical Products Corp. 1985; Timmerman 1978). Unless substitutes for carbon disulfide are found, its use levels may depend largely on relative import and export levels of textiles and apparel (Mannsville Chemical Products Corp. 1985). Carbon disulfide use for many other specialty industrial purposes is expected to continue (HSDB 1995; Timmerman 1978).

4.4 DISPOSAL

Carbon disulfide is a very flammable liquid that burns to produce carbon dioxide and sulfur dioxide. Therefore, it is a good candidate for controlled incineration, provided that a sulfur dioxide scrubber is used. Some methods proposed by the EPA (HSDB 1995) include liquid injection incineration at a temperature ranging from 650°C to 1,600°C, rotary kiln incineration at a temperature range of 820-1,600°C, and fluidized bed incineration at a temperature range of 450-980°C. Carbon disulfide can be removed from waste water by air stripping (HSDB 1995). Adsorption to activated coal with hydrogen sulfide in the absence of free oxygen yields a process that can regenerate large percentages of sulfur for reuse (HSDB 1995). It is not recommended that landfills be used as a disposal method because of the high flammability of this compound (HSDB 1995). No information was found on quantities and locations of disposal. The EPA CERCLA guideline for reportable quantities is 100 pounds (EPA 1995m).

