

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

5.1 PRODUCTION

Vinyl chloride was first produced commercially in the 1930s by reacting hydrogen chloride with acetylene. Currently, vinyl chloride is produced commercially by the chlorination of ethylene through one of two processes, direct chlorination or oxychlorination. Direct chlorination reacts ethylene with chlorine to produce 1,2-dichloroethane. Similarly, oxychlorination produces 1,2-dichloroethane, but this is accomplished by reacting ethylene with dry hydrogen chloride and oxygen. After both processes, the 1,2-dichloroethane is subjected to high pressures (2.5–3.0 megapascals) and temperatures (550–550 °C). This causes the 1,2-dichloroethane to undergo pyrolysis, or thermal cracking, which forms the vinyl chloride monomer and hydrogen chloride. The vinyl chloride monomer is then isolated (Cowfer and Magistro 1985). The technical-grade product is available in 99.9% purity (HSDB 2005). Efforts are being made to minimize by-product formation (hydrocarbons, chlorinated hydrocarbons, and unreacted material) in 1,2-dichloroethane pyrolysis (Cowfer and Magistro 1985).

Table 5-1 summarizes the facilities in the United States that either manufacture or process vinyl chloride. This information was obtained from the Toxic Release Inventory (TRI03 2005), and also lists the maximum amounts of vinyl chloride that are present at these sites and the end uses of vinyl chloride. Table 5-2 lists the facilities that solely manufacture vinyl chloride for commercial purposes and their production capacities. In 2001, the global demand for vinyl chloride was 14.89 billion pounds; in 2002, demand was 15.94 billion pounds; and in 2006, it is estimated that demand for vinyl chloride will be 17.8 billion pounds (CMR 2003). Demand for vinyl chloride monomer is almost entirely dependent upon the consumption of polyvinyl chloride (PVC) materials. Demand is expected to increase globally at a rate of approximately 3.5% annually due to increasing demand in Asia, while demand in the United States is expected to increase by about 2.8% annually (CMR 2003).

5.2 IMPORT/EXPORT

Imports of vinyl chloride totaled 29 million pounds (13.17 million kilograms) in 1994 and 164 million pounds in 1991 (CPS 1993; NTD 1995). Imports have been steadily declining from a high of 302 million pounds in 1989, prior to which they had been increasing (CPS 1993). Currently, the amounts of vinyl

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

State ^a	Number of facilities	Minimum amount on site in pounds ^b	Maximum amount on site in pounds ^b	Activities and uses ^c
AL	2	1,000	999,999	2, 3, 6, 7
AR	3	1,000	999,999	6, 12
CA	8	100	9,999,999	2, 3, 6, 7, 8, 9, 10, 12
DE	6	10,000	99,999,999	2, 3, 6, 11, 12
FL	2	100,000	9,999,999	6
GA	3	1,000	999,999	6, 7, 8
IL	5	1,000	49,999,999	6, 8, 11
IN	4	0	99,999	1, 7, 8, 13
KS	8	100	99,999	1, 2, 3, 5, 6, 10, 12, 13
KY	10	1,000	49,999,999	1, 2, 3, 4, 6, 12, 14
LA	37	100	10,000,000,000	1, 2, 3, 4, 5, 6, 11, 12, 13
MI	8	1,000	9,999,999	2, 3, 6, 12
MO	5	1,000	9,999,999	1, 2, 3, 5, 6, 8, 11
MS	4	1,000,000	999,999,999	6
NC	7	0	999,999	1, 5, 6, 8, 11
NE	1	10,000	99,999	12
NJ	11	1,000	49,999,999	6, 7, 8, 12
NY	2	10,000	999,999	6, 8
OH	10	0	9,999,999	2, 3, 6, 7, 8, 11, 12
OK	1	1,000,000	9,999,999	6
PA	2	1,000,000	9,999,999	3, 6, 8
SC	2	10,000	9,999,999	8, 12
TX	43	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14
UT	1	1,000	9,999	12
VA	4	1,000	999,999	1, 7, 12, 13
WI	1	10,000	99,999	7

^aPost office state abbreviations used^bAmounts on site reported by facilities in each state^cActivities/Uses:

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|--------------------------|--------------------------|-----------------------------|
| 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: TRI03 2005 (Data are from 2003)

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Table 5-2. U.S. Production Capacity of Vinyl Chloride

U.S. Producer	Location	Capacity (millions pounds per year)
Dow Chemicals	Oyster Creek, Texas; Freeport, Texas	2,700
Dow Chemicals	Plaquemine, Louisiana	1,500
Formosa Plastics	Baton Rouge, Louisiana	980
Formosa Plastics	Point Comfort, Texas	1,235
Geismar Vinyls	Geismar, Louisiana	650
Georgia Gulf	Lake Charles, Louisiana	1,000
Georgia Gulf	Plaquemine, Louisiana	1,600
Oxy Mar	Ingleside, Texas	2,300
Oxy Vinyls	Deer Park, Texas	1,300
Oxy Vinyls	La Porte, Texas	2,400
PHH Monomers	Lake Charles, Louisiana	1,300
Westlake Monomers	Calvert City, Kentucky	1,200
U.S. total capacity:		18,165 million pounds

Source: CMR 2003

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chloride imported into the United States are negligible (CMR 2003). Exports of vinyl chloride were 1.65 billion pounds (0.75 billion kilograms) in 1992 and 2.10 billion pounds (0.95 billion kilograms) in 1994 (NTD 1995). Recent estimates have shown a slight decrease in U.S. export volumes. In 2001, exports of vinyl chloride totaled 1.89 billion pounds and in 2002, exports were 1.43 billion pounds (CMR 2003).

5.3 USE

Vinyl chloride is an important industrial chemical because of its wide variety of end-use products and the low cost of producing polymers from it. Approximately 98% of all vinyl chloride produced is used to manufacture PVC materials (CMR 2003). These PVC materials are widely used in automotive parts, packaging products, pipes, construction materials, furniture, and a variety of other products (Cowfer and Magistro 1985). Other miscellaneous uses, which account for about 2% of the vinyl chloride that is produced annually, include the production of 1,1,1-trichloroethane and copolymers with vinyl acetate, vinyl stearate, and vinylidene chloride (CMR 2003).

Vinyl chloride has been used in the past as a refrigerant, as an extraction solvent for heat-sensitive materials, and in the production of chloroacetaldehyde and methyl chloroform (IARC 1979). In the United States, limited quantities of vinyl chloride were used as an aerosol propellant and as an ingredient of drug and cosmetic products; however, these practices were banned by the EPA in 1974 (HSDB 2005; IARC 1979).

5.4 DISPOSAL

Since vinyl chloride has been identified by EPA as a hazardous material, its disposal is regulated under the Federal Resource Conservation and Recovery Act (RCRA) (EPA 1993d). The transportation of hazardous materials for disposal is regulated by the Department of Transportation in compliance with this act (DOT 1993). The recommended method of disposal is total destruction by incineration. The temperature of the incinerator must be sufficient to ensure the complete combustion of the vinyl chloride in order to prevent the formation of phosgene. The recommended temperature range for incineration is 450–1,600 °C, with residence times of seconds for gases and liquids, and hours for solids (HSDB 2005). If in solution, the vinyl chloride product may need to be adsorbed onto a combustible material prior to incineration. Recommended materials include vermiculite, sawdust, or a sand-soda ash mixture (90/10)

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covered with wood and paper (OHM/TADS 1985). The vinyl chloride can also be dissolved in a flammable solvent prior to incineration. An acid scrubber should be used in conjunction with the incinerator in order to remove any hydrogen chloride that is produced by the combustion process (HSDB 2005; OHM/TADS 1985). Alternatively, chemical destruction may be used, especially with small quantities. From 1 to 2 days is generally sufficient for complete destruction (HSDB 2005).

Aqueous byproduct solutions from the production of vinyl chloride are usually steam-stripped to remove volatile organic compounds, neutralized, and then treated in an activated sludge system to remove nonvolatile organic compounds remaining in the waste water (Cowfer and Magistro 1983).