

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

5.1 PRODUCTION

Hexachlorobenzene is not currently manufactured as a commercial end product in the United States, and evidence indicates that it has not been commercially produced since the late 1970s (Beyer 1996; EPA 1986b). However, limited amounts of hexachlorobenzene are imported for laboratory and research use. The compound can be produced commercially by reacting benzene with excess chlorine in the presence of ferric chloride at 150–200 °C. In addition, at least one former producer isolated hexachlorobenzene from distillation residues obtained as a by-product in the manufacture of tetrachloroethylene (IARC 1979). Hexachlorobenzene occurs as a byproduct or impurity in the manufacture of several chlorinated solvents (e.g., tetrachloroethylene, trichloroethylene); other chlorinated compounds (e.g., vinyl chloride, chloroanil); and several pesticides, including pentachloronitrobenzene (PCNB), tetrachloro-isophthalonitrile (chlorothalonil), 4-amino-3,5,6-trichloropicolinic acid (picloram), pentachlorophenol (only in Europe) (EPA 1986b; Liu et al. 2012; Tobin 1986), and dimethyltetrachloroterephthalate (DCPA or Dacthal[®]) (Verschuere 1996); and was also produced as a by-product during the production of atrazine, propazine, and simazine (IARC 1979). Hexachlorobenzene was also a contaminant in several chlorinated substances that had previously been used in large quantities but are no longer produced or used, such as the pesticides, mirex and lindane, and the solvent, carbon tetrachloride, which is only available in small quantities for research purposes. Hexachlorobenzene is also released in the environment due to ongoing use in developing countries and improper storage or disposal in developed countries (Dewailly et al. 1999).

In 1972, hexachlorobenzene produced as a by-product during the production of many other chlorinated chemicals was estimated to range from 1,123,500 kg (2,476,868 pounds) to 2,224,900 kg (4,905,015 pounds) (IARC 1979). Limited data indicate that hexachlorobenzene was produced at the Dover Chemical Company, Dover, Ohio and Hummel Chemical Company, South Plainfield, New Jersey, until 1977. It is estimated that 1,450 kg (3,200 pounds) of hexachlorobenzene (as an end-product) were produced in the United States in 1975, and that 3,500–11,500 kg (7,700–25,350 pounds) of hexachlorobenzene were inadvertently produced in the manufacture of chlorinated solvents in 1984 (EPA 1986b). No current estimates of hexachlorobenzene production are available

Table 5-1 lists the facilities in each state that manufacture or process hexachlorobenzene, the intended use, and the range of maximum amounts of hexachlorobenzene that are stored on-site. There are 65 facilities that produce, process, or use hexachlorobenzene in the United States. Current estimates for

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

State ^a	Number of facilities	Minimum amount on site in pounds ^b	Maximum amount on site in pounds ^b	Activities and uses ^c
AL	4	0	9,999	7, 8, 12, 14
AR	1	10,000	99,999	1, 5, 9, 12
CA	2	10,000	99,999	1, 5, 13, 14
CO	1	100	999	2, 13
DE	1	0	99	1, 13
FL	1	100	999	1, 13
ID	1	0	99	14
IL	1	100	999	12
IN	2	0	999	1, 2, 5, 9, 12, 13, 14
KS	1	0	99	1, 13
KY	2	0	99,999	1, 3, 6, 12
LA	9	0	999,999	1, 2, 5, 7, 12, 13, 14
MI	1	0	99	2, 12, 13, 14
MN	1	0	99	14
MS	2	0	999	1, 5, 14
MT	1	0	99	1, 5
NY	3	0	9,999	1, 5, 12, 14
OH	5	0	99,999	12, 14
OR	4	0	999	1, 12, 13, 14
PA	2	0	999	12
SC	1	10,000	99,999	8
TN	1	0	99	1, 5
TX	14	0	99,999	1, 5, 6, 8, 12, 13, 14
UT	3	0	99,999	1, 12, 13, 14
WA	1	0	99	14

^aPost office state abbreviations used.

^bAmounts on site reported by facilities in each state.

^cActivities/Uses:

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

Source: TRI13 2014 (Data are from 2013)

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the amounts of hexachlorobenzene stored on-site as a by-product or impurity range from 0 to 999,999 pounds per year (0–453,951 kg/year) (TRI13 2014). The data from the Toxics Release Inventory (TRI) listed in Table 5-1 should be used with caution, however, since only certain types of facilities were required to report (EPA 1995b). This is not an exhaustive list.

There are some indications that any process that produces dioxins or dibenzofurans (e.g., pulp and paper mills using chlorine for bleaching) will also yield other chlorinated organic compounds such as hexachlorobenzene (EPA 1992). In addition, hexachlorobenzene may be produced as a by-product in waste streams of chlor-alkali plants and wood preserving plants (Leger 1992), and in fly ash (Eicman et al. 1981) and flue gas effluents from municipal incineration (Oberg and Bergstrom 1985; Oehme et al. 1987; Tiernan et al. 1985). No estimates for the amount of hexachlorobenzene produced as a by-product via these sources was available.

5.2 IMPORT/EXPORT

Hexachlorobenzene imports of 2,440 kg (5,400 pounds) in 1977 and 17,300 kg (38,100 pounds) in 1982 were reported (HSDB 2012). No other recent data for import or export in the United States was located. However, the United Nations Environment Program conducted a survey of import/export data for persistent organic pollutants worldwide. Although this report contained no production data, it did contain worldwide import/export data. From 1990–1994, 158.45 tons of hexachlorobenzene were exported worldwide, while 2,258 tons of hexachlorobenzene were imported worldwide (UNEP 1996). It should be noted that U.S. import/export data are not included in this study.

5.3 USE

There are no current commercial uses of hexachlorobenzene as an end-product in the United States. However, hexachlorobenzene was used as a fungicide on the seeds of onions, sorghum, wheat, and other grains (IARC 1979) until 1984, when the last registered use of the compound as a pesticide was voluntarily cancelled. Hexachlorobenzene was also used in the production of pyrotechnic and ordinance materials for the military, the production of synthetic rubber (EPA 1986b), as a porosity controller in the manufacture of electrodes, a chemical intermediate in dye manufacturing, and a wood preservative (IARC 1979).

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5.4 DISPOSAL

Hexachlorobenzene is listed as a toxic substance under Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) under Title III of the Superfund Amendments and Reauthorization Act (SARA) (EPA 1995b). Disposal of wastes containing hexachlorobenzene is controlled by a number of federal regulations. Land disposal restrictions (e.g., treatment standards) apply to wastes containing hexachlorobenzene. Incineration at high temperatures is a proposed disposal method, but incineration can lead to chlorinated products as toxic as hexachlorobenzene. Past disposal methods for industrial wastes containing hexachlorobenzene included incineration, disposal in landfills, discharge to municipal sewage treatment plants, and emission to the atmosphere (Clayton and Clayton 1981; EPA 1988a, 1989a). High temperature incineration (around 1,300 °C) with a retention time of approximately 0.25 seconds is the recommended disposal technique because it is reported to destroy more than 99% of the chemical (HSBC 2012). Lamb et al. (1994) reported that organic waste compounds including hexachlorobenzene are used to co-fire cement kilns. These authors reported that the destruction efficiency of hexachlorobenzene fed to a rotary kiln/afterburner incinerator was greater than 99.9999%. Landfill disposal of hexachlorobenzene can lead to migration of the compound via water and sublimation of the compound into the air. Calaminus et al. (1993) conducted pyrolysis experiments with hexachlorobenzene in an inert atmosphere of argon. These authors reported hexachlorobenzene was substantially pyrolyzed (70%) at temperatures of 1,100 °C for 20 seconds into elemental carbon (soot) and chlorine (Cl₂), but that other polychlorinated compounds (e.g., hexachlorohexane, hexachloro-1,3-cyclopentadiene, octachlorostyrene, octachloronaphthalene, octachloroacenaphthalene, and decachloronaphthoacenaphthalene) were also produced. Process wastes containing hexachlorobenzene from the production of chlorinated aliphatic hydrocarbons has an EPA-prescribed treatment standard before land disposal. These wastes must be treated to specified concentrations prior to land disposal at a hazardous waste facility (EPA 1995b). Deep well injection of hexachlorobenzene is also not recommended (HSBC 2012). A review of remediation and disposal for materials containing hexachlorobenzene is available (Tong and Yuan 2012).

The waste water treatment technology that most closely resembles incineration is wet air oxidation. It is specifically designed to destroy organics in waste waters and efficiently oxidizes organics in aqueous media by operating at relatively high temperatures and pressures. Furthermore, wet air oxidation is typically performed on waste waters that contain relatively high concentrations of organics (i.e., those that are at or near the 1% total organic carbon cutoff for waste water). Carbon adsorption has been specified

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as part of the treatment train because hexachlorobenzene is believed to be adsorbable when present in low concentrations as might be expected in an effluent from either wet air or chemical oxidation (EPA 1985).

No other information was located on the past or present volumes of hexachlorobenzene disposed of by each disposal method.