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

5.1 PRODUCTION

Ethylbenzene is primarily produced by the alkylation of benzene with ethylene in liquid-phase slurry reactors promoted with aluminum chloride catalysts or by vapor-phase reaction of benzene with dilute ethylene-containing feedstock with a boron trifluoride catalyst supported on alumina (Cannella 2007; Clayton and Clayton 1981; HSDB 2009; Welch et al. 2005; Ransley 1984). Newer versions of the method employ synthetic zeolites in fixed-bed reactors as catalysts for alkylation in the liquid phase or narrow pore synthetic zeolites in fixed-bed reactors in the vapor phase (Welch et al. 2005). Other methods of manufacturing ethylbenzene include preparation from acetophenone, dehydrogenation of naphthenes, catalytic cyclization and aromatization, separation from mixed xylenes via fractionation, reaction of ethylmagnesium bromide and chlorobenzene, extraction from coal oil, and recovery from benzene-toluene-xylene (BTX) processing (Clayton and Clayton 1981; HSDB 2009; Ransley 1984; Welch et al. 2005). Commercial grades of ethylbenzene may contain small amounts of *m*-xylene, *p*-xylene, cumene, and toluene (HSDB 2009).

Ethylbenzene is traditionally ranked as one of the top 50 chemicals produced in the United States. Table 5-1 shows the historical production volumes of ethylbenzene from 1983 to 2005 (C&EN 1994a, 1994b, 1995, 2006; Kirschner 1995).

Table 5-2 lists the facilities in each state that manufacture or process ethylbenzene, the intended use, and the range of maximum amounts of ethylbenzene that are stored on site. There are currently 3,755 facilities that produce, process, or use ethylbenzene in the United States. The data listed in Table 5-2 are derived from the Toxics Release Inventory (TRI06 2008). These data should be used with caution however since only certain types of facilities are required to report (EPA 1995d). Therefore, this is not an exhaustive list.

Currently, there are eight major producers of ethylbenzene in the United States, with a combined annual production capacity of approximately 15.8 billion pounds (SRI 2006). These producers and their respective plant locations are provided in Table 5-3.

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Table 5-1. Ethylbenzene Production in the United States from 1983 to 2005

Year	Production in thousands of metric tons	Production in billions of pounds
1983	3,583	7.9
1984	3,447	7.6
1985	3,357	7.4
1986	4,082	9.0
1987	4,218	9.3
1988	4,491	9.9
1989	4,173	9.2
1990	3,810	8.4
1991	5,171	11.4
1992	5,035	11.1
1993	5,352	11.8
1994	5,398	11.9
1995	6,194	13.7
1996	4,699	10.4
1997	5,432	12.0
1998	5,743	12.7
1999	5,945	13.1
2000	5,968	13.2
2001	4,642	10.2
2002	5,412	11.9
2003	5,578	12.3
2004	5,779	12.7
2005	5,251	11.6

Source: C&EN 1994a, 1994b, 1995, 2006; Kirschner 1995

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Table 5-2. Facilities that Produce, Process, or Use Ethylbenzene

State ^a	Number of facilities	Minimum amount on site in pounds ^b	Maximum amount on site in pounds ^b	Activities and uses ^c
AK	21	0	49,999,999	1, 2, 3, 4, 5, 7, 8, 9, 10, 12
AL	109	0	99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
AR	50	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
AS	1	100,000	999,999	9
AZ	34	100	9,999,999	1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 13
CA	238	0	99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
CO	32	0	9,999,999	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13
CT	37	0	999,999,999	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14
DE	18	0	49,999,999	1, 2, 3, 6, 7, 8, 10, 11, 12, 13
GA	86	0	99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
GU	8	100	9,999,999	2, 3, 4, 7, 9, 12
HI	23	0	9,999,999	1, 2, 3, 4, 5, 6, 7, 9, 10, 12, 13, 14
IA	56	0	9,999,999	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13
ID	4	1,000	999,999	1, 5, 7, 9, 11, 12
IL	156	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
IN	134	0	49,999,999	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14
KS	90	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
KY	91	0	49,999,999	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14
LA	235	0	999,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
MA	44	100	499,999,999	1, 2, 4, 5, 7, 8, 9, 10, 11, 12, 14
MD	54	100	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
ME	17	0	49,999,999	2, 3, 4, 7, 9, 10, 11, 12
MI	185	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
MN	79	0	99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
MO	95	0	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
MP	8	0	999,999	2, 3, 4, 7, 9
MS	73	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
MT	19	10,000	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14
NC	68	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
ND	11	1,000	9,999,999	1, 2, 3, 4, 6, 7, 9, 10, 12
NE	22	0	9,999,999	1, 2, 3, 7, 8, 10, 11, 12
NH	16	0	999,999	2, 7, 9, 10, 11, 12, 13
NJ	102	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
NM	30	1,000	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13
NV	15	100	999,999	1, 2, 4, 7, 8, 9, 11, 12
NY	85	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
OH	172	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
OK	59	100	99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

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Table 5-2. Facilities that Produce, Process, or Use Ethylbenzene

State ^a	Number of facilities	Minimum amount on site in pounds ^b	Maximum amount on site in pounds ^b	Activities and uses ^c
OR	36	0	9,999,999	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13
PA	145	0	99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
PR	58	100	10,000,000,000	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
RI	19	0	999,999,999	1, 2, 4, 7, 8, 9, 10, 11, 12
SC	55	0	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
SD	8	100	99,999	7, 10, 11
TN	81	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
TX	412	0	10,000,000,000	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
UT	45	100	9,999,999	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13
VA	69	0	49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
VI	9	10,000	49,999,999	1, 2, 3, 4, 6, 7, 8, 9, 12
VT	5	0	999,999	7, 11
WA	69	0	499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
WI	73	0	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
WV	60	0	9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
WY	34	1,000	9,999,999	1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14

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

- | | | |
|--------------------------|--------------------------|-----------------------------|
| 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: TRI06 2008 (Data are from 2006)

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Table 5-3. Manufacturers and Annual Production Capacity of Ethylbenzene

Manufacturer	Plant location	Annual capacity (millions of pounds)
Chevron Phillips Chemical Company	St. James, Louisiana	2,083
	Pascagoula, Mississippi	289
Cos-Mar Company	Carville, Louisiana	2,822
The Dow Chemical Company	Freeport, Texas	1,896
INEOS America	Texas City, Texas	1,124
Lyondell Chemical Company	Channelview, Texas	3,245
NOVA Chemical Corporation	Bayport, Texas	1,940
Sterling Chemicals Incorporated	Texas City, Texas	1,920
Westlake Styrene Corporation	Sulphur, Louisiana	450
Total capacity		15,769

Source: SRI 2006

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5.2 IMPORT/EXPORT

According to the Chemical Marketing Reporter, import volumes were negligible in 2002 and were 4.95×10^7 kg (109 million pounds) in 2003 (CMR 2004). Import volumes for ethylbenzene have been relatively small as compared to annual production, typically representing $\leq 1\%$ of the annual domestic production volume.

U.S. exports for 2002 and 2003 were reported as 1.86×10^7 kg (41 million pounds) and 1.50×10^7 kg (33 million pounds), respectively (CMR 2004). Export volumes for ethylbenzene have been relatively small, typically representing $\leq 1\%$ of the annual domestic production volume.

5.3 USE

Ethylbenzene is used primarily as a precursor in the production of styrene (ACGIH 2002; Cannella 2007; Ransley 1984; Verschueren 1983). It is estimated that $>99\%$ of the ethylbenzene manufactured in the United States is ultimately used in styrene production, while the remainder is exported or sold in solvent applications (CMR 2004; HSDB 2009; Welch et al. 2005). Ethylbenzene is also used as a solvent, a constituent of asphalt and of naphtha, and in fuels (ACGIH 2002; Verschueren 1983) as well as in the manufacture of acetophenone, cellulose acetate, diethylbenzene, ethyl anthraquinone, ethylbenzene sulfonic acids, propylene oxide, and α -methylbenzyl alcohol (HSDB 2000; Verschueren 1983; Welch et al. 2005).

5.4 DISPOSAL

Regulations governing the treatment and disposal of wastes containing ethylbenzene are detailed in Chapter 8. Recommended methods for the disposal of ethylbenzene include burial in a landfill and rotary kiln incineration, liquid injection incineration, and fluidized bed incineration (EPA 1981d; HSDB 2009). Ethylbenzene may be disposed of by adsorbing it in vermiculite, dry sand, earth, or a similar material and then by burial in a secured sanitary landfill or by atomizing in a suitable combustion chamber (IRPTC 1985). Ethylbenzene is a good candidate for liquid injection incineration at a temperature range of 650–1,600 °C and a residence time of 0.1–2 seconds; a candidate for rotary kiln incineration at a temperature range of 820–1,600 °C and a residence time of seconds for gases and liquids and hours for solids; and a good candidate for fluidized bed incineration at a temperature range of 450–980 °C and a residence time of seconds for gases and liquids, and longer for solids (HSDB 2009).

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The following waste water treatment technologies have been investigated for disposal of ethylbenzene; biological treatment, air and steam stripping, or activated carbon treatment (HSDB 2009). Spent ethylbenzene solvents and still bottoms from the recovery of these solvents are designated hazardous wastes and, as such, are subject to the Resource Conservation and Recovery Act (RCRA) of 1976 handling and record-keeping requirements (EPA 1992c).

According to the TRI, in 2006, an estimated 141,972 pounds (64,455 kg) were transferred off-site, which includes releases to publicly owned treatment works (POTWs) (TRI06 2008). No additional information was located on the trends in disposal methods related to ethylbenzene.