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

5.1 PRODUCTION

No information is available in the TRI database on facilities that manufacture or process acrylamide because this chemical is not required to be reported under Section 313 of the Emergency Planning and Community Right-to-Know Act (Title III of the Superfund Amendments and Reauthorization Act of 1986) (EPA 1998).

Acrylamide can be produced from acrylonitrile treated with sulfuric acid or hydrochloric acid, followed by base neutralization or use of an ion exclusion column to separate the chemical from its sulfate salt (Haberman 2002; HSDB 2009; Lewis 2007; O'Neil et al. 2006). Although historically the primary method of acrylamide production, this method results in sulfate byproducts and significant waste streams, and thus, commercial acrylamide producers no longer use this process (Haberman 2002). A newer process was developed in which a solution of acrylonitrile is passed over a fixed bed copper catalyst at 85 °C, resulting in an acrylamide solution. This method has been modified by various companies since its development. A Raney copper catalyst can also be used in both slurry and fixed-bed reactors (Haberman 2002). American Cyanamid uses a proprietary catalytic direct hydration process to produce acrylamide from acrylonitrile, using a reaction of water of solid surfaces of metal, metallic salts, or metallic oxides, which avoids the formation of unwanted byproducts (HSDB 2009).

Numerous other methods of acrylamide production have been developed. Acryloyl chloride or acrylic anhydride can be reacted with ammonia to yield acrylamide. Microorganisms can also be used to convert acrylonitrile to acrylamide via an enzymatic hydration process (Haberman 2002).

Table 5-1 lists the facilities in each state that manufacture, process, or use acrylamide as well as the intended use and the range of amounts of acrylamide that are stored on site. There are currently 233 facilities that produce, process, or use acrylamide in the United States. The data listed in Table 5-1 are derived from the Toxics Release Inventory (TRI 09 2011). These data should be used with caution, however, since only certain types of facilities are required to report. Therefore, this is not an exhaustive list. Commercial production of acrylamide in 1983 was reported as 86,233 pounds (HSDB 2009). Currently, there are four major producers of acrylamide in the United States, with a combined production capacity of approximately 141,000 metric tons (311 million pounds) (SRI 2008). These producers and their respective plant locations are provided in Table 5-2.

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

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	10,000	9,999,999	6, 14
AR	6	0	99,999	1, 2, 3, 5, 6, 7, 12
CA	15	0	9,999,999	1, 2, 3, 4, 6, 7, 8, 9, 10
CO	3	0	99,999	6
CT	6	10,000	9,999,999	2, 3, 4, 6
DE	1	0	0	0
FL	3	100,000	999,999	2, 3, 6
GA	8	0	9,999,999	1, 4, 6, 7
IL	13	0	9,999,999	2, 3, 6, 7, 12
IN	1	10,000	99,999	12
KY	4	10,000	999,999	6, 12
LA	16	0	9,999,999	1, 2, 3, 4, 5, 6, 9, 10, 12, 13
MA	4	1,000	99,999	6, 7
MD	5	0	999,999	6, 7
MI	22	0	49,999,999	1, 2, 3, 4, 6, 7, 8, 10, 11, 12
MO	5	100	99,999	1, 2, 3, 6, 7, 8
NC	8	100	999,999	6, 7
NE	4	0	99,999	3, 7, 8, 11, 12
NJ	9	0	999,999	1, 6, 10, 12, 13
NY	11	100	99,999	6, 7, 9, 10, 12
OH	11	0	999,999	1, 6, 7, 12, 13
OR	1	1,000	9,999	6
PA	8	0	499,999,999	6
SC	13	0	999,999	6, 7, 12, 14
TN	8	0	9,999,999	6, 12
TX	21	0	9,999,999	1, 2, 3, 5, 6, 7, 12, 13
UT	1	1,000	9,999	12
VA	8	100,000	49,999,999	1, 2, 3, 4, 6
WA	2	100,000	999,999	6, 12
WI	6	0	99,999	2, 3, 6, 7

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

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
WV	5	0	499,999,999	1, 5, 6, 12
WY	1	1,000,000	9,999,999	9

[a]Post office state abbreviations used
[b]Amounts on site reported by facilities in each state
[c]Activities/Uses:

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

Source: TRI09 2011 (Data are from 2009)

Table 5-2. 2008 Acrylamide Production in the United States

Company	Location	Annual capacity (metric tons[a])	Remarks
Chemtall, Inc.	Riceboro, Georgia	65,000	From purchased acrylonitrile; captive consumption for polyacrylamide
Ciba Specialty Chemicals Corporation Water & Paper Treatment Business Segment	Suffolk, Virginia	15,000	From purchased acrylonitrile; primarily captive consumption for polyacrylamide
Kemira Water Solutions, Inc.	Waggaman, Louisiana	41,000	From captive acrylonitrile; captive consumption for polyacrylamide
Nalco Company	Garyville, Louisiana	20,000	From purchased acrylonitrile; primarily captive consumption for polyacrylamide
Total		141,000	

[a]All production is as solution.

Source: SRI 2008; SRI Consulting estimates as of February 1, 2008

Acrylamide is produced as a byproduct when foods are cooked at high temperatures, such as by frying, roasting, and baking (Muttucumaru et al. 2008). This occurs by the Maillard reaction, where thermal degradation of amino acids occurs in the presence of reducing sugars at temperatures above 120 °C. The major precursors for acrylamide formation by the Maillard reaction are free asparagines and reducing sugars (Arisseto et al. 2007; Mottram 2002; Muttucumaru et al. 2008; Stadler et al. 2002). Acrylamide concentrations in the foods rise with temperature and length of heating, and appear to be affected by water content, food composition, and processing conditions (WHO 2002).

5.2 IMPORT/EXPORT

The demand for acrylamide in the United States was reported as 245 and 253 million pounds in 2006 and 2007, respectively. U.S. imports were 61 and 55 million pounds in 2006 and 2007, respectively, while U.S. exports were 57 and 53 million pounds in 2006 and 2007, respectively (CMR 2008).

5.3 USE

Commercially-produced acrylamide is used mainly as an intermediate in the production of polyacrylamides (EU 2002; Haberman 2002; O'Neil et al. 2006; WHO 2003). This accounts for 94% of manufactured acrylamide (Haberman 2002). Polyacrylamides are then primarily used as flocculants for clarifying drinking and treating municipal and industrial effluents (Abdelmagid 1982; EPA 2006c; EU 2002; Haberman 2002; WHO 2003). They aid in dewatering sludge from sewage treatment plant effluent as well as industrial waste water from pulp and paper plants (Abdelmagid 1982; Haberman 2002). Polyacrylamides are also found in cosmetics and toiletries and are used to prepare polyacrylamide gels for use in biotechnology laboratories (EU 2002; Lewis 2007). In the oil industry, acrylamide is used as a flow control agent to enhance oil production from wells. Acrylamide and polyacrylamides are also used in the production of dyes and organic chemicals such as N-methylacrylamide, in copolymers for contact lenses, in permanent-press fabrics, for sizing paper and textiles, as a binder and retention aid for pulp and paper production, in the processing of ore, in sugar refining, and as a chemical grouting agent and soil stabilizer for the construction of tunnels, sewers, wells, and reservoirs (Abdelmagid 1982; EPA 2006c; EU 2002; Haberman 2002; Lewis 2007; O'Neil et al. 2006; WHO 2003).

5.4 DISPOSAL

Acrylamide is typically produced as an intermediate for the production of polyacrylamides (Haberman 2002; O'Neil et al. 2006), and is therefore consumed in the process. No information was found regarding the disposal of acrylamide.