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

4.1 PRODUCTION

Table 4-l lists the facilities in each state that manufacture or process sulfuric acid, the intended use, and the range of maximum amounts of sulfuric acid that are stored on site. The data listed in Table 4-l are derived from the Toxics Release Inventory (TRI) (TR196 1998). Only certain types of facilities were required to report. Therefore, this is not an exhaustive list. According to the 1996 TRI, 707 facilities in the United States and 7 facilities in the Commonwealth of Puerto Rico manufactured or processed sulfuric acid in 1996 (TR196 1998). Similar data were not available for sulfur trioxide. Because sulfur trioxide is produced as a precursor to sulfuric acid in the principal method of producing sulfuric acid, sulfur trioxide is likely to be present at the facilities listed in Table 4-l.

From 1972 until 1993, the quantity of sulfuric acid produced in the United States increased; $2.83x10^7$ metric tons were produced in 1972,2.94×10^7 metric tons were produced in 1975, and 3.60×10^7 metric tons were produced in 1985. Production from 1990 to 1993 varied from 2.99×10^7 metric tons to 3.35×10^7metric tons. In 1995, sulfuric acid was the most produced chemical in the United States at 3.56×10^7 metric tons which was a significant increase over 1994 production (3.34×10^7 metric tons) (C&EN 1996).

There are two major processes that have been used to produce sulfuric acid, the chamber process and the contact process. The chamber process was once the predominant method for sulfuric acid production in North America and western Europe; however, its use in these regions has dropped from 80% in 1910 to 15% in 1960 to virtually zero (IARC 1992). In the chamber process, sulfur dioxide is oxidized to sulfur trioxide, which combines with water vapor to form sulfuric acid in the following way: $2N0 + 0_2 \rightarrow 2 NO_2$, $2 NO_2 + 2 SO_2 + 2H_2O \rightarrow 2H_2SO_4 + 2N0$. Nitrogen dioxide acts as the oxidant. The end products of this process are sulfuric acid and nitrogen oxides. With this process, sulfuric acid of a concentration of about 78% can be produced.

Sulfuric acid can also be produced by the contact process. This process is based on technology that was developed around 1900 and has become the primary method of sulfuric acid production (IARC 1992). The principal steps in the contact process are (1) oxidation of sulfur to sulfur dioxide with dry air, (2) cooling of the gases, (3) conversion or oxidation of the sulfur dioxide to sulfur trioxide, (4) cooling of the sulfur trioxide

Table 4-1. Facilities that Manufacture or Process Sulfuric Acid

State[a]	Number of Facilities	Range of Maximum Amounts on Site in Pounds[b]	Activities and Uses[c]
AL	22	0–999,999	1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13
AR	12	100–9,999,999	1, 3, 4, 5, 6, 7, 11, 12, 13
AZ	12	0–99,999,999	1, 3, 5, 7, 8, 10, 11, 12, 13
CA	94	0–49,999,999	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13
CO	6	0–99,999	1, 2, 3, 4, 8, 10, 12, 13
CT	13	1,000–99,999	1, 5, 7, 11, 12, 13
DE	2	10,000–99,999,999	1, 3, 4, 7
FL	41	0–499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13
GA	40	0–49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
HI	2	10,000–9,999,999	1, 3, 4, 11, 12, 13
IA	9	0–9,999,999	1, 3, 4, 7, 8, 11, 12, 13
ID	62	0–49,999,999	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13
IN	38	0–9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13
KS	8	1,000–49,999,999	1, 7, 8, 9, 11, 12, 13
KY	22	0–999,999	1, 3, 4, 5, 7, 10, 11, 12, 13
LA	35	0–999,999,999	1, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13
MA	26	0–999,999	1, 5, 7, 11, 12, 13
MD	11	1,000–99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 13
ME	15	0–99,999	1, 5, 6, 11, 12, 13
MI	54	0–9,999,999	1, 2, 3, 5, 6, 7, 8, 9, 11, 12, 13
MN	8	0–49,999,999	1, 4, 5, 7, 13
MO	20	0–49,999,999	1, 4, 5, 6, 7, 8, 11, 12, 13
MS	16	1,000–99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13
MT	2	0–49,999,999	1, 4, 5, 6
NC	35	0–99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13
ND	2	100–99,999	8, 13
NE	4	1,000–999,999	7, 8, 11, 13
NH	8	0–9,999	1, 3, 5, 6, 7, 11, 12, 13
NJ	16	100–49,999,999	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13
NM	4	10,000–499,999,999	1, 2, 3, 4, 5, 7, 12, 13
NV	1	0–99	1, 5
NY	30	0–999,999	1, 2, 3, 4, 5, 6, 7, 11, 12, 13
OH	34	0–999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13
OK	10	0–9,999,999	1, 4, 5, 6, 11, 12, 13
OR	9	0–99,999	1, 3, 6, 8, 11, 12, 13
PA	57	0–9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
PR	12	1,000–49,999,999	1, 3, 4, 7, 11, 12, 13
RI	2	10,000–99,999	13
SC	25	0–9,999,999	1, 2, 3, 5, 6, 7, 8, 11, 12, 13
TN	37	0–99,999,999	1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13
TX	77	0–49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
UT	4	1,000–499,999,999	1, 3, 4, 7, 9, 11, 12, 13
VA	16	0–49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13
VI	1	1,000–9,999	1, 3, 7, 11
VT	1	0–99	1, 5
WA	20	0–9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13
WI	52	0–9,999,999	1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13
WV	7	0–9,999,999	1, 3, 7, 11, 12, 13
WY	3	1,000–9,999,999	1, 3, 4, 5, 7, 11

Source: TRI96 1998

a Post office state abbreviations used

b Range represents maximum 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

gas, and (5) absorption of the sulfur trioxide in water to produce sulfuric acid. The heart of the contact process is the converter in which sulfur dioxide is converted catalytically to sulfur trioxide. A variety of catalysts can be used including platinum, oxides of iron, chromium, copper, manganese, titanium, vanadium, and other metals. Presently, vanadium catalysts in various forms are most widely used. Current methods allow for conversion rates as high as 99.5-99.7% (IARC 1992). Sulfuric acid is most commonly marketed in four grades: commercial, electrolyte (high purity for batteries), textile (low organic content), and chemically pure or reagent grades (IARC 1992).

Fuming sulfuric acid (oleum) is produced at contact process plants in special towers by adding sulfur trioxide to sulfuric acid (IARC 1992).

4.2 IMPORT/EXPORT

Import/export data for the 1990s indicate that the United States imports more sulfuric acid and fuming sulfuric acid (oleum) than it exports. During 1990-1994, U.S. imports of sulfuric acid and fuming sulfuric acid in million metric tons were 1.7, 1.8,2,2.4, and 2.1 in 1990, 1991, 1992, 1993, and 1994, respectively (NTDB 1996). Import data for 1995 were not available. During 1991-1995, U.S. exports of sulfuric acid and fuming sulfuric acid in metric tons were 147,470, 139,790, 144,865, 136,874, and 170,201 in 1991, 1992,1993,1994, and 1995, respectively (NTDB 1996).

4.3 USE

Sulfur trioxide is primarily used as an intermediate in the production of sulfuric acid. It is also used for sulfonation in the formation of additional compounds with amines and in the manufacture of explosives (Budavari 1989). Sulfur trioxide can also be used in the sulfonation of organic compounds (especially nonionic detergents), as a component of solar energy collectors, and as a powerful but indiscriminate oxidizing agent (HSDB 1998).

In the United States, the main use of sulfuric acid is in phosphate fertilizer production where it used to convert phosphate rock to phosphoric acid (IARC 1992). Sulfuric acid is consumed in the production of fertilizer, while in many other uses the sulfuric acid can be recovered and reused. Sulfuric acid is also used in the manufacture of explosives, dyestuffs, other acids, parchment paper, glue, purification of petroleum, and the pickling of metals (Budavari 1989; IARC 1992). It is also used in electroplating baths, nonferrous metallurgy, in the production of rayon and film, as a laboratory reagent and etchant, and in storage batteries (HSDB 1998). Sulfuric acid is also a general purpose food additive (HSDB 1998). In the United States in 1988, the percentages of sulfuric acid used in various processes were estimated as 68% for phosphate fertilizers; 7% for petroleum refining; 4% for ore processing; 3.5% for industrial organic chemicals; 2.5% for synthetic rubber and plastics; 2.5% for pulp and paper; and 9% for other unidentified uses (IARC 1992).

4.4 DISPOSAL

Sulfuric acid is listed as a toxic substance under Section 3 13 of the Emergency Planning and Community Right to Know Act (EPCRA) under Title III of the Superfund Amendments and Reauthorization Act (SARA) (EPA 1998f). Disposal of wastes containing sulfuric acid is controlled by a number of federal regulations (see Chapter 7).

Spent sulfuric acid can often be reprocessed to obtain a product of virgin quality. Enormous amounts of spent sulfuric acid are reprocessed since most of the sulfuric acid used for industrial processes acts only as a reagent and does not form part of the final product; one exception is the fertilizer industry (IARC 1992). It has been suggested that waste sulfuric acid can also be recycled using sulfate-reducing bacteria to produce hydrogen sulfide (Stucki et al. 1993).

It is not recommended that sulfuric acid or sulfur trioxide be placed in a landfill. Environmental regulatory agencies should be consulted for acceptable disposal practices (HSDB 1998). Sulfuric acid has been disposed of by being placed in sealed containers and by being absorbed in vermiculite, dry sand, or earth. Sulfuric acid may also be diluted and then neutralized. One method of neutralization is to add the acid slowly to a solution of soda ash and slaked lime, and to then flush with a large volume of water. Once sulfuric acid is diluted, and neutralized it can be discharged to a sewer. When diluting, the acid should always be added to a large volume of water because the heat released when a small bolus of water is added can cause the water to turn to steam, and the resulting effervescence can splatter the acid.