

Sulfuric Acid Manufacture and Effluent Control 1971

Marshall Sittig



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Forty-Eight Dollars

**NOYES DATA CORPORATION
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FOREWORD

The detailed, descriptive information in this book was taken from the U.S. patent literature since 1960, whenever possible; but older basic patents were consulted also. Where it was deemed necessary to expand the search, recourse was taken to all the world's literature on sulfuric acid manufacture and the necessary ambient pollution control.

This book serves a double purpose in that it supplies detailed technical information and can be used as a guide to the U.S. patent literature in this field. By indicating all the information that is significant and eliminating legalistic phraseology, this book presents an advanced, industrially oriented review with an encyclopedic approach to the subject.

The U.S. patent literature is the largest and most comprehensive collection of technical information in the world. There is more practical, commercial, timely process information assembled here than is available from any other source. The technical information obtained from a patent is extremely reliable and comprehensive; sufficient information must be included to avoid rejection for "insufficient disclosure".

The patent literature covers a substantial amount of information not available in the journal literature. The patent literature is a prime source of basic commercially utilizable information. This information is overlooked by those who rely primarily on the periodical journal literature. It is realized that there is a lag between a patent application on a new process development and the granting of a patent, but it is felt that this may roughly parallel or even anticipate the lag in putting that development into commercial practice.

Many of these patents are being utilized commercially. Whether used or not, they offer opportunities for technological transfer. Also, a major purpose of this book is to describe the number of technical possibilities available, which may open up profitable areas of research and development.

These publications are bound in paper in order to close the time gap between "manuscript" and "completed book". Industrial technology is progressing so rapidly that hard cover books do not always reflect the latest developments in a particular field, due to the longer time required to produce a hard cover book.

The Table of Contents is organized in such a way as to serve as a subject index. Other indexes by company, inventor, and patent number help in providing easy access to the information contained in this book.

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INTRODUCTION

Sulfuric acid is the number one chemical in terms of both production value and tonnage of production. Among inorganic chemicals it ranks well ahead of ammonia, caustic and chlorine. It also ranks well ahead of ethylene, the number one organic chemical, in terms of both dollar volume and tonnage.

It has frequently been remarked, as pointed out by R. Norris Shreve in "Chemical Process Industries," 3rd Ed., New York, McGraw-Hill (1967), that sulfuric acid is of such paramount significance that the per capita use of sulfuric acid is an index of the technical development of a nation.

Sulfuric acid capacity in the United States totals some 38 million short tons per year produced in about 250 plants, of which about 215 are of the contact type, the remainder being of the older chamber type. Perhaps 30% of these plants have some oleum production capacity. A census of the sulfuric acid plants in the United States appears in Table 1. Also included in this census are sulfuric acid concentrators of the drum type. Actual production was about 28,500,000 ST in 1968.

Sulfuric acid is produced in a great variety of concentrations and in four grades — commercial, electrolyte or high purity, textile (having low organic content), and CP or reagent grade. Many of the industries which use sulfuric acid do not actually consume the acid but change its form. In some cases, regeneration to acid is economical; in others it is not. Industries which are the principal users of sulfuric acid include: the wet process phosphoric acid industry which is on the route to produce many phosphate fertilizers, in petroleum refining, the production of alcohols, the production of titanium dioxide for pigments, in the production of ammonium sulfate, and in the production of normal superphosphate (the usual use of chamber acid which is more dilute than the acid normally produced by contact plants); also, iron and steel pickling, caprolactum, production of surface active agents, production of methylmethacrylate, production of hydrofluoric acid and the production of aluminum sulfate. Industries which do not use up the sulfur values are petroleum refining and alcohol production where the actual consumption of the sulfur values is approximately 10% of the total quantity of acid used, the remainder being supplied from regenerated or reconstituted acid produced from dilute acid from the plant operation. Large amounts of dilute sulfuric acid recovered from smelter operations are also used in leaching operations to produce ore concentrates used in the smelters.

Most acid of all grades is consumed near the point in which it is produced, either by the manufacturer or by nearby industries. Very little acid is shipped more than 200 to 300 miles from the point at which it is made.

A census of sulfuric acid plants as of 1970 has been prepared by Chemical Construction Corp. in "Engineering Analysis of Emissions Control Technology for Sulfuric Acid Manufacturing Processes," Washington, D.C., Clearinghouse for Federal Scientific and Technical Information (March 1970). It was prepared by Chemical Construction Corp. on contract as a tool to help determine the importance of various processes by determining the number of potential possible applications in the United States. The census is not represented as absolutely accurate or complete, since it is not based on a direct survey of acid manufacturers, but upon published data and in-house knowledge.

The census is divided into three parts: Table 1 lists chamber acid plants, Table 2 sulfuric acid drum type concentrators and Table 3 contact acid plants. Vacuum type concentrators have not been included since they present no emission problem and require no consideration in this study. The census is arranged geographically by states, listing each plant. Annual capacity is based upon approximately 330 operating days per year. Although the on-stream factor for most plants is higher than 330 days per year, all plants are not operating at full capacity at all times. Thus, 330 days equivalent is not an unrealistic figure.

The terms "unit," "plant" and "establishment" as used in this census require definition. A unit may be considered as an individual H_2SO_4 production train, capable of independent operation to produce one or more grades of H_2SO_4 from one

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or more raw materials. A plant is one or more units built at the same time and place. For example, Continental Oil at Pierce, Florida, is a 2,000 tpd plant (Table 3) which consists of two 1,000 tpd units in parallel, built simultaneously. An establishment denotes one or more plants built and operated by one company at one location. An example is Valley Nitrogen at Helm, California, which includes 200, 300 and 600 ton plants built at different times but at the same location for the same producer. For plants built after 1954, it has been attempted to list each plant, but prior to 1954 no attempt has been made to differentiate between a plant and an establishment. For example, Cities Service Co. at Isabella, Tennessee, (Table 3) is listed as a plant, but this is very likely more than one plant judging by the capacity and date built. Where a range of years is given before 1954, the reason often is that an establishment consists of two or more plants built at various times within the given span of years.

TABLE 1: CHAMBER PROCESS ACID PLANTS

State	Company	City	Capacity Short Tons		Year Built*	Principal Raw Materials	Highest Concentration Product
			Annual	Daily			
Alabama	Standard Chemical	Troy	17,000	50	Pre-1954	Sulfur	<78% acid
	Home Guano Co.	Dothan	13,500	40	Pre-1954	Sulfur	<78% acid
	Mobil Chem. Co.	Mobile	17,000	50	Pre-1954	Sulfur	<78% acid
Florida	Wilson Toomer Fert. Co.	Cottondale	15,000	45	1950	Sulfur	<78% acid
	Continental Oil/Agrico Chem.	Pensacola	14,000	40	Pre-1954	Sulfur	<78% acid
	Wilson Toomer Fert. Co.	Jacksonville	40,000	120	1946	Sulfur	<78% acid
Georgia	Southern States Phosphate Fert.	Savannah	32,000	100	1917	Sulfur	<78% acid
	Mobil Chem. Co.	Savannah	20,000	60	1900	Sulfur	<78% acid
	Pelham Phos. Co.	Pelham	25,000	70	1912	Sulfur	<78% acid
	F.S. Royster Guano Co.	Athens	25,000	70	Pre-1954	Sulfur	<78% acid
	Armour Agr. Chem. Co.	Albany	20,000	60	Pre-1954	Sulfur	<78% acid
	Armour Agr. Chem. Co.	Columbus	18,000	50	Pre-1954	Sulfur	<78% acid
	Columbia Nitrogen Corp.	Moultrie	20,600	60	Pre-1954	Sulfur	<78% acid
	Continental Oil/Agrico Chem.	Savannah	20,000	60	Pre-1954	Sulfur	<78% acid
	Cotton States Fert. Co.	Macon	16,000	45	Pre-1954	Sulfur	<78% acid
	Georgia Fert. Co.	Valdosta	20,000	60	Pre-1954	Sulfur	<78% acid
Illinois	Mobil Chem. Co.	Rome	18,000	50	Pre-1954	Sulfur	<78% acid
	Armour Agr. Chem. Co.	Chicago Hts.	35,000	100	Pre-1954	Sulfur	<78% acid
Iowa	Continental Oil/Agrico Chem.	Fulton	16,000	45	Pre-1954	Sulfur	<78% acid
	Continental Oil/Agrico Chem.	Humboldt	25,000	70	Pre-1954	Sulfur	<78% acid
Maryland	Continental Oil/Agrico Chem.	Humboldt	25,000	70	Pre-1954	Sulfur	<78% acid
	Kerr McGee Chem. Corp.	Baltimore	105,000	300	1917	Sulfur	<78% acid
	F.S. Royster Guano Co.	Baltimore	40,000	120	Pre-1954	Sulfur	<78% acid
Mississippi	Continental Oil/Agrico Chem.	Baltimore	34,000	100	Pre-1954	Sulfur	<78% acid
	Inter. Min. & Chem. Corp.	Tupelo	18,000	50	Pre-1954	Sulfur	<78% acid
N. Carolina	Continental Oil/Agrico Chem.	Greensboro	21,000	60	Pre-1954	Sulfur	<78% acid
S. Carolina	Mobil Chem. Co.	Charleston	18,000	50	1900	Sulfur	<78% acid
	Planters Fert. Phos. Co.	Charleston	25,000	70	Pre-1954	Sulfur	<78% acid
	F.S. Royster Guano Co.	Charleston	12,000	35	Pre-1954	Sulfur	<78% acid
	Anderson Fertilizer Co.	Anderson	17,000	50	Pre-1954	Sulfur	<78% acid
	Continental Oil/Agrico Chem.	Charleston	20,000	60	Pre-1954	Sulfur	<78% acid
	Continental Oil/Agrico Chem.	Columbia	11,000	35	Pre-1954	Sulfur	<78% acid
	Inter. Min. & Chem. Corp.	Spartanburg	20,000	60	Pre-1954	Sulfur	<78% acid
Tennessee	Mobil Chem. Co.	Memphis	18,000	50	1903	Sulfur	<78% acid
Virginia	Mobil Chem. Co.	Richmond	35,000	100	1912	Sulfur	<78% acid
	F.S. Royster Guano Co.	Norfolk	22,000	65	Pre-1954	Sulfur	<78% acid
	American Agr.	Alexandria	20,000	60	Pre-1954	Sulfur	<78% acid
	W.R. Grace & Co.	Norfolk	22,000	65	Pre-1954	Sulfur	<78% acid

* Where Pre-1954 is given, exact date was not available.

Total — 37 plants producing 885,100 short tons per year.

TABLE 2: DRUM TYPE SULFURIC ACID CONCENTRATORS

State	Company	City	No. of Units	Year Built
Alabama	Alabama Ord. Works	Sylacauga	9	1942
Arkansas	Maumelle Ord. Works	Marche	8	1941
	Monsanto	El Dorado	1	1960
Illinois	Kankakee Ord. Works	Elwood	7	1942
	Standard Oil Co. of Ind.	Wood River	1	1943
Indiana	Wabash River Ord. Works	Dana	9	1942
Kansas	Sunflower Ord. Works	Eudora	8	1942
Kentucky	Kentucky Ord. Works	Paducah	6	1942
Louisiana	Rubicon Chemicals	Geismar	1	1964
Minnesota	Gopher Ord. Works	Rosemount	5	1942
Missouri	Weldon Spring Ord. Works	Weldon Spring	16	1941
New Jersey	American Cyanamid	Bound Brook	1	1941
	Du Pont	Gibbstown	1	1963
	Du Pont	Gibbstown	1	1966
Ohio	Plum Brook Ord. Works	Sandusky	12	1941
Oklahoma	Oklahoma Ord. Works	Pryor	9	1941
Pennsylvania	Pennsylvania Ord. Works	Williamsport	12	1942
	Keystone Ord. Works	Geneva	10	1942
	Allied Chemical	Newell	1	1962
Tennessee	Chickasaw Ord. Works	Memphis	2	1942
	Holston Ord. Works	Kingsport	7	1942
	Volunteer Ord. Works	Tyner	9	1942
Texas	Texaco	Port Arthur	2	1942
	Longhorn Ord. Works	Karnack	6	1942
Utah	Utah Oil Refining Co.	Salt Lake City	1	1943
W. Virginia	W. Virginia Ord. Works	Pt. Pleasant	12	1942
	American Cyanamid	Willow Island	1	1957
	Allied Chemical	Moundsville	1	1964
	Carbide & Carbon Chem. Co.	Institute	1	1966

Total — 29 establishments with 29 plants and 160 units.

For Table 3, the column headed "Principal Raw Materials" differentiates between sulfur burning plants and wet gas plants. Sulfur burning plants list only sulfur as a raw material. Other plants, even though they may burn some sulfur, are wet gas plants since their emission characteristics and selection of control methods will be determined by the nonsulfur raw material(s).

The column labeled "Highest Concentration Product" on Table 3 lists only two categories, since these determine the emission characteristics. An oleum plant may produce one or more oleum grades, and may also produce 98 or 93% acid, but as long as oleum is produced, this fact governs the emission characteristics of the plant. Plants producing acid only below 99% H_2SO_4 have essentially the same emission problems, regardless of the grades produced.

TABLE 3: CONTACT PROCESS ACID PLANTS

State	Company	City	Annual Capacity Short Tons	Daily Capacity Short Tons	Year Built*	Principal Raw Materials	Highest Concentration Product
Alabama	Mobil Chem. Co.	Birmingham	26,000	70	1938	Sulfur	<99% acid
	American Cyanamid Co.	Mobile	28,000	75	1947	Sulfur	<99% acid
	Mobil Chem. Co.	Dothan	26,000	70	1966	Sulfur	<99% acid
	Du Pont	Mineral Springs	21,000	60	Pre-1954	Sulfur	Oleum
	Reichhold Chem. Inc.	Tuscaloosa	52,000	150	1956	Sulfur	Oleum
	Stauffer Chem. Co.	LeMayne	140,000	400	1956	Sulfur	Oleum
Arizona	Arizona Agrochemical Corp.	Chandler	28,000	85	1959	Sulfur	<99% acid
	Bagdad Copper Corp.	Bagdad	60,000	175	1961	Sulfur	<99% acid
	Phelps Dodge Corp.	Morenci	210,000	600	1965	Cu smelter gas	Oleum
	Phelps Dodge Corp.	Morenci	59,500	175	1968	Cu smelter gas	Oleum
	Kennecott Copper Corp.	Ray	262,000	750	1968	Cu smelter gas	<99% acid
	Monsanto Co.	El Dorado	132,000	375	Pre-1954	Sulfur	<99% acid
Arkansas	Arkla Chemical Corp.	Helena	210,000	600	1967	Sulfur	<99% acid
	Olin	N. Little Rock	87,000	250	1947	Sulfur and H ₂ S	Oleum
	Allied Chemical Corp.	Nichols	120,000	350	Pre-1954	Sulfur	<99% acid
California	Occidental Petroleum Corp.	Lathrop	245,000	700	1957	Sulfur	<99% acid
	Valley Nitrogen Prod. Inc.	Helm	70,000	200	1959	Sulfur	<99% acid
	Valley Nitrogen Prod. Inc.	Helm	105,000	300	1963	Sulfur	<99% acid
	Valley Nitrogen Prod. Inc.	Helm	210,000	600	1965	Sulfur	<99% acid
	AFC Inc.	Edison	67,500	200	1967	Sulfur	<99% acid
	Monsanto Co.	Avon	105,000	300	1953	Sludge and H ₂ S	Oleum
	American Smelting & Refining	Selby	15,000	50	Pre-1954	Smelter gas	<99% acid
	Allied Chemical Corp.	El Segundo	140,000	400	Pre-1954	Sludge and H ₂ S	<99% acid
	Stauffer Chem. Co.	Dominguez	230,000	650	Pre-1954	Sludge and H ₂ S	<99% acid
	Allied Chemical Corp.	Richmond	65,000	200	1943	Sludge and H ₂ S	<99% acid
	Allied Chemical Corp.	Richmond	105,000	300	1955	Sludge and H ₂ S	<99% acid
	Union Oil Co. of California	Los Angeles	113,000	325	1960	Sludge and H ₂ S	<99% acid
	Stauffer Chem. Co.	Richmond	175,000	500	Pre-1954	Sulfur	Oleum
	Stauffer Chem. Co.	Vernon	105,000	300	Pre-1954	Sulfur	Oleum
	Stauffer Chem. Co.	Martinez	297,500	850	1969	Sulfur	Oleum
	Union Carbide Corp.	Urvan	60,000	175	1960-1965	Sulfur	<99% acid
	Allied Chemical Corp.	Denver	50,000	150	Pre-1954	Pyrites	Oleum
	Allied Chemical Corp.	N. Claymont	350,000	1,000	Pre-1954	Sludge + pyrites	Oleum
	Mobil Chem. Co.	Nichols	110,000	300	Pre-1954	Sulfur	<99% acid
	American Cyanamid Co.	Brewster	320,000	900	Pre-1954	Sulfur	<99% acid
Colorado	Union Carbide Corp.	Urvan	60,000	175	1960-1965	Sulfur	<99% acid
Delaware	Allied Chemical Corp.	N. Claymont	350,000	1,000	Pre-1954	Sludge + pyrites	Oleum
Florida	Mobil Chem. Co.	Nichols	110,000	300	Pre-1954	Sulfur	<99% acid
	American Cyanamid Co.	Brewster	320,000	900	Pre-1954	Sulfur	<99% acid

(continued)

TABLE 3: (continued)

State	Company	City	Annual Capacity Short Tons	Daily Capacity Short Tons	Year Built*	Principal Raw Materials	Highest Concentration Product
Florida	W.R. Grace & Co.	Bartow	230,000	700	Pre-1954	Sulfur	<99% acid
	Inter. Min. & Chem. Corp.	Bartow	210,000	600	Pre-1954	Sulfur	<99% acid
	Swift & Co.	Agricola	315,000	900	1948	Sulfur	<99% acid
	Mobil Chem. Co.	Nichols	200,000	600	1955-1959	Sulfur	<99% acid
	American Cyanamid Co.	Brewster	260,000	750	1955	Sulfur	<99% acid
	Cities Service Co. Inc.	Tampa	300,000	900	1955-1959	Sulfur	<99% acid
	Cities Service Co. Inc.	Tampa	300,000	900	1955-1959	Sulfur	<99% acid
	Cities Service Co. Inc.	Tampa	300,000	900	1955-1959	Sulfur	<99% acid
	Cities Service Co. Inc.	Tampa	300,000	900	1955-1959	Sulfur	<99% acid
	W.R. Grace & Co.	Bartow	230,000	700	1955-1959	Sulfur	<99% acid
	F.S. Royster Guano Co.	Mulberry	385,000	1,100	1960-1965	Sulfur	<99% acid
	Mobil Chem. Co.	Nichols	225,000	650	1960-1965	Sulfur	<99% acid
	American Cyanamid Co.	Brewster	50,000	150	1960	Sulfur	<99% acid
	Chemical Inc.	Bartow	315,000	900	1960-1965	Sulfur	<99% acid
	Chemical Inc.	Bartow	210,000	600	1960-1965	Sulfur	<99% acid
	Inter. Min. & Chem. Corp.	Bartow	140,000	400	1960-1965	Sulfur	<99% acid
	Chemical Inc.	Bartow	315,000	900	1962	Sulfur	<99% acid
	Armour Agr. Chemical Co.	Ft. Meade	520,000	1,500	1963	Sulfur	<99% acid
	Armour Agr. Chemical Co.	Bartow	280,000	800	1964	Sulfur	<99% acid
	Chemical Inc.	Bartow	315,000	900	1964	Sulfur	<99% acid
	Continental Oil Co./Agrico Chem.	Pierce	700,000	2,000	1964	Sulfur	<99% acid
	Borden Chem./Smith Douglas	Plant City	490,000	1,400	1966	Sulfur	<99% acid
	Central Phosphates Inc.	Plant City	600,000	1,700	1966	Sulfur	<99% acid
	Fairland Ind. Inc.	Green Bay	550,000	1,570	1966	Sulfur	<99% acid
Georgia	W.R. Grace & Co.	Bartow	365,000	1,100	1966	Sulfur	<99% acid
	Occidental Petroleum Corp.	White Springs	700,000	2,000	1966	Sulfur	<99% acid
	Kaiser Agr. Chem. Co.	Savannah N.	35,000	100	1952	Sulfur	<99% acid
	American Cyanamid Co.	Savannah	160,000	450	1953	Sulfur	<99% acid
	American Cyanamid Co.	Savannah	85,000	250	1956	Sulfur	<99% acid
Hawaii	Minerals & Chem./Phillipp Corp.	Attapulgas	36,000	100	1956	Sulfur	<99% acid
	Cities Service Co. Inc.	Augusta	131,200	375	1967	Sulfur	<99% acid
	Standard Oil Co. of California	Honolulu	40,000	115	1960-1965	Sludge	<99% acid
	J.R. Simplot Co.	Pocatello	225,000	650	1959	Sulfur	<99% acid
	J.R. Simplot Co.	Pocatello	420,000	1,200	1966	Sulfur	<99% acid
Idaho	Bunker Hill Co.	Kellogg	90,000	250	1954	Zn smelter gas	<99% acid
	Bunker Hill Co.	Kellogg	120,000	350	1966	Zn smelter gas	<99% acid

(continued)

TABLE 3: (continued)

State	Company	City	Annual Capacity Short Tons	Daily Capacity Short Tons	Year Built*	Principal Raw Materials	Highest Concentration Product
Illinois	Allied Chemical Corp.	Chicago	130,000	400	Pre-1954	Sulfur	<99% acid
	Swift & Co.	Calumet City	35,000	100	1947	Sulfur	<99% acid
	Borden Chem./Smith Douglas	Streator	43,000	125	1951	Sulfur	<99% acid
	National Distillers Chem. Corp.	Tuscola	175,000	500	1953	Sulfur	<99% acid
	American Zinc Co.	Sauget	140,000	400	1960-1965	Sulfur	<99% acid
	Hooker Chem. Corp.	Marseilles	240,000	700	1962	Sulfur	<99% acid
	Wilson Co. Inc.	Elwood	210,000	600	Pre-1954	Sulfur + sludge	Oleum
	Charles Pfizer Co. Inc.	E. St. Louis	6,000	18	Pre-1954	Ferrous sulfate	<99% acid
	American Zinc Co.	E. St. Louis	154,000	450	1967	Zn smelter gas	<99% acid
	Monsanto Co.	Monsanto	234,000	675	Pre-1954	Sulfur	Oleum
	New Jersey Zinc Co.	DePue	420,000	1,200	1967	Zn smelter gas + S	<99% acid
	Allied Chemical Corp.	E. St. Louis	180,000	500	1928	Sulfur	Oleum
	Olin	Joliet	350,000	1,000	1942	Sulfur	Oleum
	American Cyanamid Co.	Joliet	50,000	150	1954	Sulfur	Oleum
	Monsanto Co.	Monsanto	140,000	400	1955	Sulfur	Oleum
	Stauffer Chem. Co.	Hammond	140,000	400	1929	Sludge + sulfur	Oleum
	Du Pont	E. Chicago	325,000	950	Pre-1954	Zn smelter gas + sludge	Oleum
Indiana	Stauffer Chem. Co.	Hammond	165,000	500	1957	Sludge + sulfur	Oleum
	Marion Mfg. Co.	Indianapolis	42,000	125	1947	Sludge + sulfur	Oleum
	Inter. Min. & Chem. Corp.	Mason City	25,000	70	Pre-1954	Sulfur	<99% acid
Iowa	Sinclair Petrochemicals Inc.	Ft. Madison	525,000	1,500	1968	Sulfur	<99% acid
	National Distillers Chem. Corp.	Dubuque	52,000	150	1943	Sulfur	Oleum
	Eagle Picher Co.	Galena	155,000	450	1954	S + Zn smelter gas	<99% acid
Kansas	National Distillers Chem. Corp.	DeSoto	88,000	250	1943	Sulfur	Oleum
Kentucky	Du Pont	Wurtland	210,000	600	Pre-1954	Sulfur	Oleum
	Pennsalt Chem. Corp.	Calvert City	44,000	125	1948	Sulfur	Oleum
Louisiana	Olin	Bossier City	70,000	200	1929	Sulfur	<99% acid
	Allied Chemical Corp.	Baton Rouge	87,000	250	1954	Sulfur	<99% acid
	American Cyanamid Co.	Fortier	35,000	100	1960-1965	Sulfur	<99% acid
	Hooker Chem. Corp.	Taft	510,000	1,500	1965	Sulfur	<99% acid
	Allied Chemical Corp.	Geismar	525,000	1,500	1967	Sulfur	<99% acid
	Freeport Sulphur Co.	Convent	1,680,000	4,800	1968	Sulfur	<99% acid
	Stauffer Chem. Co.	Baton Rouge	560,000	1,600	1969	Sulfur + sludge	Oleum
	Cities Service Co. Inc.	Lake Charles	149,000	450	1943	Sludge + H ₂ S	<99% acid
	Du Pont	Burnside	525,000	1,500	1967	Sulfur + sludge	Oleum

(continued)

TABLE 3: (continued)

State	Company	City	Annual Capacity Short Tons	Daily Capacity Short Tons	Year Built*	Principal Raw Materials	Highest Concentration Product
Maryland	Bethlehem Steel Corp.	Sparrows Pt.	87,000	250	1953	Pyrites + H ₂ S	<99% acid
	Olin	Baltimore	105,000	300	1943	Sulfur	Oleum
	Olin	Baltimore	70,000	200	1941	Sulfur	Oleum
	Olin	Baltimore	175,000	500	1949	Sulfur	Oleum
	W.R. Grace & Co.	Baltimore	140,000	400	1960-1965	Sulfur	Oleum
Massachusetts	Monsanto Co.	Everett	105,000	300	1969	Sulfur	Oleum
Michigan	W.R. Grace & Co.	Detroit	35,000	100	Pre-1954	Sulfur	<99% acid
	American Cyanamid Co.	Kalamazoo	25,000	70	1947	Sulfur	<99% acid
	Continental Oil/Agrico Chem.	Bay City	35,000	100	1957	Sulfur	<99% acid
	Allied Chemical Corp.	Detroit	210,000	600	1941	Sulfur + sludge	Oleum
Minnesota	North Star Chem. Inc.	Pine Bend	115,000	330	1959	Sulfur	<99% acid
Mississippi	Coastal Chem. Corp.	Pascagoula	260,000	750	1958	Sulfur	<99% acid
Missouri	Missouri Lead Smelting Co.	Salem	70,000	200	1967	Zn or Pb smelter gas	<99% acid
	St. Joseph Lead	Herculaneum	119,000	350	1969	Pb smelter gas	<99% acid
	W.R. Grace & Co.	Joplin	70,000	200	1960-1965	Sulfur	Oleum
	National Lead Co.	St. Louis	70,000	200	1945	Sulfur	<99% acid
	National Lead Co.	St. Louis	160,000	450	1950	Sulfur	<99% acid
	National Lead Co.	St. Louis	160,000	450	1957	Sulfur	<99% acid
	Anaconda Cq.	Anaconda	155,000	450	Pre-1954	Zn smelter gas	<99% acid
Montana	Anaconda	Yerington	130,000	400	1953	Sulfur + ore	<99% acid
Nevada	La Place Chem. Co.	Edison	70,000	200	1967	Sulfur	<99% acid
	National Lead Co.	Sayreville	105,000	300	1947	Sulfur	Oleum
	National Lead Co.	Sayreville	105,000	300	1948	Sulfur	Oleum
	National Lead Co.	Sayreville	160,000	450	1950	Sulfur	Oleum
	National Lead Co.	Sayreville	160,000	450	1955	Sulfur	Oleum
	Olin	Paulsboro	300,000	850	1959	Sulfur + sludge	Oleum
	Allied Chemical Corp.	Elizabeth	200,000	600	1957	Sulfur + sludge	<99% acid
	Allied Chemical Corp.	Elizabeth	220,000	600	1957	Sulfur + sludge	<99% acid
	Du Pont	Gibbstown	100,000	300	Pre-1954	Sulfur	Oleum
	Du Pont	Linden	300,000	850	Pre-1954	Sulfur	Oleum
	Du Pont	Deepwater	120,000	350	Pre-1954	Sulfur	Oleum
	American Cyanamid Co.	Warners	197,000	550	1928	Sulfur	Oleum
	American Cyanamid Co.	Bound Brook	64,000	200	1940	Sulfur	Oleum
	Essex Chem./Chems. Div.	Newark	180,000	500	1956	Sulfur	Oleum

(continued)

TABLE 3: (continued)

State	Company	City	Annual Capacity Short Tons	Daily Capacity Short Tons	Year Built*	Principal Raw Materials	Highest Concentration Product
New Mexico	Kerr McGee Chem. Corp.	Grants	140,000	400	1958	Sulfur	<99% acid
	Climax Chemical Co.	Hobbs	53,000	150	1962	Sulfur + H ₂ S	<99% acid
New York	Allied Chemical Corp.	Buffalo	195,000	550	Pre-1954	Sulfur	Oleum
	Eastman Kodak Co.	Rochester	7,000	20	1930	Sulfur	Oleum
N. Carolina	Mobil Chem. Co.	Wilmington	25,000	70	1944	Sulfur	<99% acid
	Swift Co.	Wilmington	50,000	150	1955	Sulfur	<99% acid
	Acme Chemical	Acme	55,000	170	1964	Sulfur	<99% acid
	Texas Gulf Sulphur Co.	Lee Creek	1,067,500	3,050	1966	Sulfur	<99% acid
	Armour Agr. Chem. Co.	Wilmington	70,000	200	1968	Sulfur	<99% acid
	Allied Chemical Corp.	Cleveland	125,000	350	Pre-1954	Sulfur	<99% acid
	Diamond Fertilizer Co.	Sandusky	11,000	35	Pre-1954	Sulfur	<99% acid
	Du Pont	Cleveland	200,000	600	Pre-1954	Sulfur	<99% acid
Ohio	Inter. Min. & Chem. Corp.	Lockland	35,000	100	Pre-1954	Sulfur	<99% acid
	Mobil Chem. Co.	Cincinnati	14,000	40	1938	Sulfur	<99% acid
	Minn. Mining & Mfg. Co.	Copley	60,000	175	1942	Sulfur	<99% acid
	American Cyanamid Co.	Hamilton	90,000	250	1955	Sulfur	<99% acid
	Continental Oil/Agrico Chem.	Cairo	43,500	125	1960	Sulfur	<99% acid
	American Zinc Co.	Columbus	70,000	200	1967	Zn smelter gas	<99% acid
	Du Pont	North Bend	105,000	300	1955-1959	Sulfur	Oleum
	Ozark Mahoning Co.	Tulsa	120,000	360	1941	H ₂ S	<99% acid
	National Zinc	Bartlesville	65,000	200	Pre-1954	Zn smelter gas + S	<99% acid
	New Jersey Zinc Co.	Palmerton	180,000	500	Pre-1954	Zn smelter gas	Oleum
	Witco Chem. Co. Inc.	Petrolia	35,000	100	1933	Sludge + sulfur	Oleum
	Atlantic Richfield Co.	Philadelphia	140,000	400	1955-1959	Sludge + H ₂ S	Oleum
Pennsylvania	Du Pont	Cornwells Hts.	70,000	200	Pre-1954	Unknown	<99% acid
	Allied Chemical Corp.	Newell	250,000	700	Pre-1954	S + FeS ₂ + sludge	<99% acid
	U.S. Steel Corp.	Neville Island	45,000	125	Pre-1954	Sulfur + H ₂ S	<99% acid
	Charles Pfizer Co. Inc.	Easton	12,200	35	1967	Ferrous sulfate	<99% acid
	St. Joseph Lead	Josephstown	100,000	300	1968	Zn smelter gas	<99% acid
	Rohm & Haas Co.	Philadelphia	88,000	250	1929-1954	Sulfur	<99% acid
	Essex Chemical	E. Providence	17,000	50	1929-1949	Sulfur	<99% acid
	W.R. Grace & Co.	Charleston	35,000	100	1955-1959	Sulfur	<99% acid
	Cities Service Co. Inc.	Copperhill	280,000	800	Pre-1954	Pyrites	Oleum
	Cities Service Co. Inc.	Isabella	700,000	2,000	Pre-1954	Pyrites	<99% acid
Tennessee	Volunteer Ordnance	Tyner	145,000	400	Pre-1954	Sulfur	Oleum

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TABLE 3: (continued)

State	Company	City	Annual Capacity Short Tons	Daily Capacity Short Tons	Year Built*	Principal Raw Materials	Highest Concentration Product
Texas	Olin	Pasadena	210,000	600	1947	Sulfur	<99% acid
	Borden Chem./Smith Douglas	Texas City	155,000	450	1953	Sulfur	<99% acid
	Phosphate Chem. Inc.	Pasadena	420,000	1,200	1960-1965	Sulfur	<99% acid
	Potash Co. of America	Machovec	15,000	45	1960-1965	Sulfur	<99% acid
	Occidental Petroleum Corp.	Plainview	105,000	300	1963	Sulfur	<99% acid
	American Plant Food Corp.	Galena Park	140,000	400	1965	Sulfur	<99% acid
	American Smelting & Refining Co.	Corpus Christi	70,000	200	Pre-1954	Zn smelter gas	Oleum
	Du Pont	La Porte	85,000	250	1955-1959	Sludge + sulfur	Oleum
	Du Pont	La Porte	265,000	750	1961	Sludge + sulfur	Oleum
	Gulf Oil Corp.	Port Arthur	105,000	300	Pre-1954	Sludge + H ₂ S	<99% acid
	Stauffer Chem. Co.	Baytown	275,000	800	1955	Sludge	<99% acid
	Olin	Beaumont	180,000	500	1957	Sludge + H ₂ S	<99% acid
	Shamrock Oil & Gas Corp.	Dumas	32,000	100	1958	Sludge + H ₂ S	<99% acid
	Texaco Inc.	Port Arthur	92,400	250	1965	Sludge + H ₂ S	<99% acid
	American Oil	Texas City	173,200	500	1969	Sludge	<99% acid
	Olin	Port Arthur	70,000	200	Pre-1954	Sludge	Oleum
	Stauffer Chem. Co.	Houston	620,000	1,750	Pre-1954	Sludge	Oleum
	Stauffer Chem. Co.	Ft. Worth	120,000	350	Pre-1954	Sludge	Oleum
	Stauffer Chem. Co.	Houston	700,000	2,000	1967	Sludge	Oleum
Utah	AZ Minerals Corp.	Mexican Hat	28,000	100	1957	Sulfur	<99% acid
	Kennecott Copper Corp.	Magna	260,000	750	Pre-1954	Cu smelter gas	<99% acid
	Kennecott Copper Corp.	Magna	140,000	400	1955-1959	Cu smelter gas	<99% acid
	Kennecott Copper Corp.	Magna	175,000	500	1967	Cu smelter gas	<99% acid
Virginia	American Cyanamid Co.	Piney River	30,000	85	1930	Sulfur	<99% acid
	Borden Chem./Smith Douglas	Norfolk	70,000	200	1937	Sulfur	<99% acid
	Allied Chemical Corp.	Front Royal	140,000	400	1945	Sulfur	<99% acid
	Swift & Co.	Buell	47,000	135	1947	Sulfur	<99% acid
	Weaver Fertilizer Co. Inc.	Norfolk	30,000	100	1955-1959	Sulfur	<99% acid
	Allied Chemical Corp.	Hopewell	140,000	400	1966	Sulfur	<99% acid
	Du Pont	Richmond	90,000	250	Pre-1954	Sulfur	<99% acid
	Hercules Powder	Radford	25,000	70	Pre-1954	Sulfur	Oleum
	Georgia-Pacific Corp.	Bellingham	10,000	30	1965	Sulfur	<99% acid
	American Smelting & Refining Co.	Tacoma	70,000	200	Pre-1954	Smelter gas	<99% acid
Washington	Allied Chemical Corp.	Anacortes	40,000	125	1958	Sludge + H ₂ S + S	<99% acid
	Allied Chemical Corp.	Nitro	135,000	400	1948	Sulfur	<99% acid
W. Virginia	Allied Chemical Corp.						

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