SULFUR

By Joyce A. Ober

Sulfur, through its major derivative sulfuric acid, ranks as one of the more important elements used as an industrial raw material. It is of prime importance to every sector of the world's industrial and fertilizer complexes. Sulfuric acid production is the major end use for sulfur, and sulfuric acid consumption has been regarded as one of the best indexes of a nation's industrial development. More sulfuric acid is produced in the United States every year than any other chemical; more than 43 million tons—equivalent to about 14 million tons of elemental sulfur—were produced in 1995, 6% more than that of 1994.[1]

Domestic production of sulfur increased in 1995 for the third consecutive year and sulfur consumption increased for the second year in response to expanded production of phosphate fertilizers. The United States maintained its position as the leading producer and consumer of sulfur and sulfuric acid in the world. The quantity of sulfur recovered during the refining of petroleum and the processing of natural gas continued its upward trend established in 1939, the second year the U.S. Bureau of Mines (USBM) published data on the production of this type of sulfur. This data series continued at the U.S. Geological Survery (USGS) when the minerals information activities of USBM were transferred to USGS in 1996. The production of sulfur using the Frasch process was about 6% higher in 1995 than it was in 1994. Frasch production data for 1994 and 1995 were estimated based on reports published by the two companies that produced Frasch during the period, and reports published by the State of Texas. Total production of sulfur from all sources increased, shipments set a record high, and stocks declined.

Byproduct sulfuric acid from the Nation's nonferrous smelters and roasters, essentially mandated by laws concerning sulfur dioxide emissions, supplied a significant quantity of sulfuric acid to the domestic merchant (commercial) acid market. Production has increased slightly.

Worldwide, sulfur production was slightly higher than it was in 1994. Frasch production was 4% higher in 1995, because production increased in the United States. Elemental sulfur production from recovered sources, primarily during the processing of natural gas and petroleum products, increased slightly. Nearly three-quarters of the world's elemental sulfur production came from recovered sources; the quantity of sulfur supplied from these sources was dependent on the world demand for fuels and petroleum products, not on the demand for sulfur.

World sulfur consumption increased modestly. Consumption in fertilizer production increased, although consumption for a myriad of industrial uses continued to be pressured by environmental constraints placed on the products produced or effluents from the chemical processes that use sulfur or its major derivative, sulfuric acid.

World trade of elemental sulfur increased nearly 10% from the levels recorded in 1994. U.S. sulfur inventories decreased nearly 50% during 1995; however, worldwide inventories of elemental sulfur increased about 3%. *(See table 1 and figure 1.)*

Production

Elemental Sulfur.—Elemental sulfur production was slightly higher in 1995 than it was in 1994; shipments were 4% higher in quantity and 60% higher in value due to a substantial increase in the average price of elemental sulfur.

Production statistics are collected on a monthly basis and published in the USGS sulfur monthly Mineral Industry Surveys. Of the 149 operations to which a survey request was sent, all but 1 responded, representing nearly 100% of the total production shown in table 1. Production for the nonrespondent was obtained from the State of Texas Comptroller's Report.

Frasch.—Native sulfur associated with the cap rock of salt domes and in sedimentary deposits is mined by the Frasch hot-water method, in which the native sulfur is melted underground and brought to the surface by compressed air. In 1995, two Frasch mines operated, one in Louisiana and one in Texas. On January 3, 1995, Freeport Sulphur Co. purchased the sulfur assets of Pennzoil Sulphur Co., making Freeport the last Frasch producer in North America. Freeport's acquisition included the Culberson Mine in Texas; sulfur forming and loading facilities in Galveston, TX, and Tampa, FL; the charter of a marine sulfur tanker, two sulfur barges, 503 leased and owned sulfur rail cars; and associated commercial contracts and obligations.[2] The Main Pass Mine, in Louisiana, is 27 kilometers offshore in the Gulf of Mexico. Production at Main Pass averaged approximately 6,000 tons per day throughout the year and production at Culberson averaged about 2,500 tons per day.[3]

Recovered.—Recovered elemental sulfur, a nondiscretionary byproduct from petroleum refining, natural gas processing, and coking plants, was produced primarily to comply with environmental regulations that were applicable directly to emissions from the processing facility or indirectly by restricting the sulfur content of the fuels sold or used by the facility. Recovered elemental sulfur was produced by 58 companies at 137 plants in 26 States, 1 plant in Puerto Rico, and 1 plant in the U.S. Virgin Islands. Most of these plants were of relatively small size, with only 26 reporting annual production exceeding 100,000 tons. By source, 70% was produced at petroleum refineries or satellite plants treating refinery gases and coking

plants. The remainder was produced at natural gas treatment plants. The six largest recovered-sulfur producers in 1995 were Exxon Co. U.S.A., Standard Oil Co. (Indiana), Standard Oil Co. (California), Mobil Oil Corp., Shell Oil Co., and Star Enterprises. The 50 plants owned by these companies accounted for 59% of recovered elemental sulfur output during the year. *(See tables 2 and 3.)*

Byproduct Sulfuric Acid.—Byproduct sulfuric acid at copper, lead, molybdenum, and zinc roasters and smelters amounted to 12% of the total domestic production of sulfur in all forms. Seven acid plants operated in conjunction with copper smelters, and six were accessories to lead, molybdenum, and zinc smelting and roasting operations. The seven largest acid plants (all at copper mines) accounted for 86% of the output. The five largest producers of byproduct sulfuric acid operated seven copper plants. They were Phelps Dodge Corp., Magma Copper Co., ASARCO Incorporated, Cyprus Miami Mining Corp., and Kennecott Corp. *(See table 4.)*

Consumption

Domestic consumption of sulfur in all forms was about 9% higher in 1995 than it was in 1994. In 1995, 78% of the sulfur consumed was obtained from domestic sources compared with 82% in 1994, 77% in 1993, 75% in 1992, and 73% in 1991. The sources of supply were domestic elemental sulfur, 68% and domestic byproduct sulfuric acid, 9%. The remaining 22% was supplied by imports of recovered elemental sulfur and sulfuric acid. The USGS collected end-use data on sulfur and sulfuric acid according to the Standard Industrial Classification (SIC) of industrial activities.

Sulfur differs from most other major mineral commodities in that its primary use is as a chemical reagent rather than a component of a finished product. Its predominant use as a chemical reagent generally required that it first be converted to an intermediate chemical product prior to its initial use by industry. The largest sulfur end use, sulfuric acid, represented 82% of reported consumption with an identified end use. Some identified sulfur end uses were tabulated in the "Unidentified" category because these data were proprietary. Data collected from companies that did not identify shipment by end use also were tabulated as "Unidentified." Although there are no supporting data, it could be reasonably assumed that a significant portion of the sulfur in the "unidentified" category was shipped to sulfuric acid producers or was exported.

Sulfuric acid, because of its desirable properties, retained its position, both domestically and worldwide, as the most universally used mineral acid and the largest volume inorganic chemical in terms of the quantity produced and consumed. Reported U.S. consumption of sulfur in sulfuric acid (100% basis) was lower in 1995, due in part to the need to withhold data that had previously been published, reduced consumption in industrial markets, and poorer response rates from surveyed companies. Apparent consumption figures indicate that actual consumption was probably higher in 1995 than it was in 1994. Sulfuric acid demand for copper ore leaching, the second single largest end use, increased 6% according to reports from sulfuric acid producers. Reported use of sulfuric acid for petroleum refining and other petroleum and coal products appeared to decrease from those of 1994 although withheld data made direct comparison impossible.

According to the 1995 canvass reports, company receipts of spent or contaminated sulfuric acid for reclaiming totaled 1.6 million tons. This figure was believed to be significantly higher than reported; however, most of the acid is recycled by companies that produce acid for consumption in their own operations and also recycle acid used in their plants. Because it does not involve sales or shipments of the spent sulfuric acid, many companies do not handle the acid recycling as a separate process and thus do not report it in the USGS consumption survey. By far, the largest source and consumer of recycled acid is believed to be the petroleum refining industry for use in its alkylation process.

The largest use of sulfur in all forms for agricultural purposes was about 9 million tons in 1994 and 1995. Consumption in phosphatic fertilizers were slightly higher than that in 1994, reflecting the continued strength of the phosphate industry. The estimated quantity of sulfur needed to manufacture exported phosphatic fertilizers increased 5% to 5.7 million tons, indicating that consumption for fertilizers intended for domestic consumption was down slightly. *(See tables 5, 6, and 7.)*

Stocks

Yearend inventories held by Frasch and recovered elemental sulfur producers decreased nearly 50% from those of 1994. Combined yearend stocks amounted to approximately a 15-day supply compared with a 32-day supply in 1994, a 39-day supply in 1993, a 22-day supply in 1992, and a 32-day supply in 1991, based on apparent consumption of all forms of sulfur. *(See table 1.)*

Prices

The reported contract price for elemental sulfur exterminal Tampa, FL, began the year at $64 to $67 per ton, increased to $74 to $77 in late January, where it remained throughout the year. On the basis of total shipments and value reported to the USGS, the average value of shipments for all elemental sulfur was $43.74 per ton in 1995, more than 50% higher than in 1994. *(See table 8.)*

Foreign Trade

Exports of elemental sulfur from the United States, including the U.S. Virgin Islands, were nearly equal in quantity as in 1994 but 37% higher in value because of significant price increases for U.S. material. The average unit value of exported elemental sulfur increased from $54 per ton to $73, an increase of 35%. According to the Bureau of the Census, exports from the west coast were 560,000 tons or 62% of total U.S. exports.

The United States continued to be a net importer of sulfur;

imports exceeded exports by 1.6 million tons in 1995. Recovered sulfur from Canada and Mexico delivered to U.S. terminals and consumers in the liquid phase furnished about 85% of all U.S. sulfur import requirements. Total elemental sulfur imports increased about 34% in quantity; imports by rail from Canada increased 46%, while waterborne shipments from Mexico were 12% higher than those in 1994. Imports from several other countries comprised about 15% of all imported sulfur. The value of elemental sulfur imports increased 131%.

The United States also had significant trade in sulfuric acid. Sulfuric acid exports increased 21% from those of 1994. Imports were significantly greater than exports, 86% of which were by rail from Canada, and the remainder from several other countries, primarily by ship. The tonnage decreased 10% from the quantity reported in 1994; the value of imported sulfuric acid increased 9%. *(See tables 9, 10, 11, and 12.)*

World Review

World production was slightly higher than that of 1994, as was consumption. Prices recovered somewhat from the lows experienced in the past few years. Frasch production increased for the second consecutive year, recovered sulfur production increased slightly, and byproduct sulfuric acid production was about the same. Production advances continue to outpace consumption; worldwide sulfur inventories stood at 15.4 million tons, of which 60% of the total was stockpiled in Canada.

Industry Structure.—In 1995, the global sulfur industry remained divided into two sectors, discretionary and nondiscretionary. In one, the mining of sulfur or pyrites was the sole objective; this voluntary production of native sulfur or pyrites was based on the orderly mining of discrete deposits, with the objective of obtaining as nearly a complete recovery of the resource as economic conditions permit. In the other, sulfur or sulfuric acid was recovered as an involuntary byproduct, the quantity of output subject to demand for the primary product irrespective of sulfur demand. In 1995, involuntary sources represented about 73% of the sulfur in all forms produced worldwide.

Poland and the United States were the only countries that produced 1 million tons or more of native sulfur using either the Frasch method or conventional mining methods. Small quantities of native sulfur were produced in Asia, Europe, North America, and South America. Pyrites have significantly decreased in importance to the world sulfur supply; China and Spain were the only countries in the top 15 sulfur producers whose prime sulfur source was pyrites. About 72% of all pyrites production was in these countries.

Recovered elemental sulfur was the predominant sulfur source in Canada, France, Germany, Iran, Russia, Saudi Arabia, and the United States. Additionally, recovered elemental sulfur was an important source in Japan and Mexico.

International sulfur trade was dominated by a limited number of exporting countries. Four countries, Canada; Poland; the former Soviet Union, primarily Russia; and Saudi Arabia, in descending order of the quantity shipped, exported more than 1.5 million tons of elemental sulfur each and accounted for 67% of sulfur trade in 1995. Major sulfur importers were Morocco, the United States, India, Tunisia, and Brazil, in descending order of importance, all with imports of more than 1 million tons.

Canada.—In 1995, Canada was the world's leading producer of recovered sulfur, primarily from sour gas deposits, and the largest sulfur exporter. Canadian sulfur exports increased 34% above 1994 totals in response to higher prices; stocks grew 1.3 million tons to 9.3 million tons.

Iraq.—Although sulfur production in Iraq did not have an impact on the world market in 1995, the potential existed for Iraq to return to its role as a leading exporter when the United Nations sanctions against the country are lifted. Sulfur production capacity at the Mishraq Mine was believed to be more than 1 million tons per year. When sanctions are lifted, production would be expected to approach full capacity as quickly as possible, much of which could be expected to be exported.

Poland.—One of the few remaining producers of native sulfur, Poland's Frasch production has remained relatively steady over the past 4 years, although less than half of 1988 when nearly 5 million tons were produced. As Poland has become increasingly market-economy based, environmental concerns in Poland have necessitated increased compliance to environmental protection legislation and energy prices have increased, both factors which drive up the cost of producing sulfur. Poland has restructured its sulfur industry to remain a viable supplier in the world market. Actions have been taken to significantly reduce the cost of production by reducing the amount of hot water required, reducing the work force, and eliminating nonproductive assets, i.e., holiday homes and unused facilities.[4] Sulfur was produced at the Jerziorko and Osiek Mines. *(See table 13.)*

Outlook

Although the fortune of the U.S. sulfur industry improved in 1995, the longer term outlook changed little: increased output with slower growth in consumption resulting in variable prices and growing inventories. Specific details are much more difficult. Which producers will suffer most from the oversupply situation is a question that can only be answered over time.

World sulfur demand is forecast to increase at an annual rate of less than 2% per year for the next 10 years. World demand is projected to attain 58.4 million tons in the year 2000 and increase to nearly 63 million tons in 2005. Growth of sulfur consumption in the United States is expected to be modest. The phosphate fertilizer industry was operating near capacity and prospects for significant expansion in this area are low, with expectations for growth reflecting only slight increases to efficiency at operating plants and little chance for new facilities. Industrial consumption should remain fairly steady with the only serious possibility of increases in nonferrous ore leaching.

Almost two-thirds of sulfur consumption in the United States is for agricultural uses. More than 80% of U.S. agricultural sulfur demand and almost 60% of world agricultural sulfur

consumption was for the manufacture of phosphoric acid in 1995. World demand for phosphate fertilizers is forecast to increase at an annual rate of about 2.4% for the next 10 years. It is assumed that more than 80% of the growth will be for the production of phosphoric acid to produce high-analysis fertilizers, which will directly affect world sulfur demand. Consumption of sulfur for phosphate fertilizer manufacture in the United States is divided into two main components: (1) demand for phosphate fertilizers consumed by domestic farmers and (2) demand for exported phosphate fertilizers.

In 1995, an estimated 5.7 million tons of sulfur was required to manufacture the phosphatic fertilizers exported from the United States compared with about 4.9 million tons of sulfur for domestic phosphoric fertilizer use, based on data reported in the USGS "Phosphate Rock Annual Report." Consumption in the U.S. fertilizer industry is expected to remain relatively steady.

The broad spectrum industrial or nonagricultural sulfur use category accounted for less than one-third of U.S. sulfur consumption and about 40% of world sulfur demand. Although significant variations in demand for the diverse elements within this broad category are expected in the United States and other geographic areas, world industrial demand is expected to grow at an average rate of less than 1% annually over the next 10 years, reaching about 28 million tons in 2005.

The necessity for the removal of sulfur from solid, liquid, and gaseous effluents for environmental protection has caused the production of sulfur and sulfur compounds from these sources to exceed production from primary sources of supply. The long-term prospect is that 85% or more of the world sulfur supply will come from environmentally regulated sources and that output from these sources will be produced regardless of world sulfur demand. As a result, it is probable that after the turn of the century, no new operation that produces sulfur as its primary product will be developed, except where it may be deemed necessary for political or social reasons and more voluntary operations will be curtailed. In 1980, voluntary sources of production—Frasch, native sulfur, and pyrites—accounted for 50% of world output, about 55 million tons. In 1995, these same sources supplied only 27% of the world production of 54.3 million tons of sulfur.

By the end of 1995, there were some indications that the sulfur market was beginning to weaken. Freeport Sulphur announced plans early in 1996 to cut production at both mines to better balance supply and demand to maintain prices. Other voluntary producers seem to be maintaining a relatively stable level of production with a slight downward trend. However, recovered sulfur production will continue to expand at a faster pace than demand, and as more countries enact and enforce environmental legislation on a par with North American and European laws, tremendous new quantities of sulfur could be recovered. More stringent regulation and compliance will be long-term developments and cannot be quantified at the current time, but changes are inevitable. World sulfur production is predicted to reach nearly 62 million tons in the year 2000 and 64 million tons in 2005.

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[1]Production Growth Sputtered in Most Sectors. Chem. & Eng. News, v. 74, No. 26, 1996, p. 41.

[2]Fertilizer Markets. Freeport to Buy Most of Pennzoil Sulphur. V. 5, No. 14, p. 1.

[3]Freeport McMoRan Resource Partners Limited Partnership. 1995 10-K Report. 1996, p. 4.

[4]Manser, R. Struggling to Stand Tall, Poland's Deep Restructuring. Sulphur (London), No. 232, 1994, pp. 21-29.

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TABLE 1
SALIENT SULFUR STATISTICS 1/ 2/

(Thousand metric tons, sulfur content, and thousand dollars unless otherwise specified)

	1991	1992	1993	1994	1995
United States:					
Production:					
Frasch	2,870	2,320	1,900 3/	2,960	3,150 e/
Recovered	6,650	7,050	7,720 4/	7,160	7,250
Other forms	1,310	1,300	1,430	1,380	1,400
Total	10,800	10,700	11,100	11,500	11,800
Shipments:					
Frasch	3,120	2,600	1,480 3/	W	W
Recovered	6,680	7,090	7,580 4/	10,300 5/	10,700 5/
Other forms	1,310	1,300	1,430	1,390 r/	1,400
Total	11,100	11,000	10,500	11,700	12,100
Exports:					
Elemental	1,200	966	656	899	906
Sulfuric Acid	49	46	46	46	56
Imports:					
Elemental	3,020	2,730	2,040	1,650	2,510
Sulfuric Acid	603	649	797	696	628
Consumption, all forms	13,500 r/	13,400 r/	12,600 r/	13,100 r/	14,300
Stocks, Dec. 31: Producer, Frasch and recovered	1,190	809	1,380	1,160	583
Value:					
Shipments, f.o.b. mine or plant:					
Frasch	$272,000	$151,000	$101,000	W	W
Recovered	$429,000	$315,000	$189,000	$293,000 5/	$469,000 5/
Other forms	$112,000	$76,100	$63,100	$86,100	$85,500
Total	$813,000	$543,000	$335,000	$379,000	$555,000
Exports, elemental	$120,000	$69,700	$39,700	$48,400	$66,200
Imports, elemental	$242,000	$130,000	$49,800	$62,000	$143,000
Price, elemental, dollars per metric ton, f.o.b. mine or plant	$71.45	$48.14	$31.86	$28.60	$43.74
World: Production, all forms (including pyrites)	54,600 r/	50,700 r/	51,300 r/	54,100 r/	54,300

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Recovered."

1/ Data are rounded to three significant digits, except prices; may not add to totals shown.

2/ May include data from Puerto Rico and the U.S. Virgin Islands.

3/ Includes 10 months of Frasch sulfur data. Two remaining months of Frasch data included with "Recovered" to avoid disclosing company proprietary data.

4/ Includes corresponding Frasch sulfur data for November and December.

5/ Includes corresponding Frasch sulfur data.

TABLE 2
RECOVERED SULFUR PRODUCED AND SHIPPED IN THE UNITED STATES, BY STATE 1/

(Thousand metric tons and thousand dollars)

State	1994			1995		
		Shipments			Shipments	
	Production	Quantity	Value	Production	Quantity	Value
Alabama	406	405	10,600	396	396	17,500
California	764	764	7,170	800	804	13,200
Illinois	303	305	5,200	331	331	14,700
Louisiana	798	2,940 2/	133,000 2/	789	W	W
Michigan and Minnesota	192	193	2,260	258	258	7,060
Mississippi	612	596	7,320	550	557	12,100
New Mexico	43	43	54	41	41	576
North Dakota	79	79	448	57	57	538
Ohio	51	51	859	60	60	2,090
Pennsylvania	98	96	1,800 r/	51	51	1,360
Texas	2,060	3,110 2/	96,700 2/	2,090	2,970 2/	144,000 2/
Washington	105	105	527	114	113	1,330
Wyoming	963	971	13,300	1,030	1,020	13,700
Other 3/	692	692	14,300	682	4,060 2/	241,000 2/
Total	7,160	10,300	293,000	7,250	10,700	469,000

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Other."
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes corresponding Frasch sulfur data.
3/ Includes Arkansas, Colorado, Delaware, Florida, Indiana, Kansas, Kentucky, Montana, New Jersey, Utah, Virginia, Wisconsin, Puerto Rico, U.S. Virgin Islands, and items indicated by symbol "W."

TABLE 3
RECOVERED SULFUR PRODUCED AND SHIPPED IN THE UNITED STATES,
BY PETROLEUM ADMINISTRATION FOR DEFENSE (PAD) DISTRICT 1/

(Thousand metric tons)

District and source	1994		1995	
	Production	Shipments	Production	Shipments
PAD 1:				
Petroleum and coke	303	303	245	238
Natural gas	52	52	50	50
Total	355	355 r/	295	288
PAD 2:				
Petroleum and coke	801	803	904	899
Natural gas	79	80	58	58
Total	880	883	962	957
PAD 3: 2/				
Petroleum	2,800	2,790	2,860	W
Natural gas	1,210	4,390 3/	1,100	W
Total	4,010 r/	7,180	3,970	7,400 3/
PAD 4 and 5:				
Petroleum	1,020	1,020	1,030	1,030
Natural gas	901	911	999	994
Total	1,920	1,930	2,030	2,030
Total petroleum	4,930	4,910	5,040	W
Total natural gas	2,240	5,440 3/	2,210	W
Grand total	7,160	10,300	7,250	10,700 3/

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Includes Puerto Rico and the U.S. Virgin Islands.
3/ Includes corresponding Frasch sulfur data.

TABLE 4
BYPRODUCT SULFURIC ACID 1/ PRODUCED
IN THE UNITED STATES 2/

(Thousand metric tons, sulfur content, and thousand dollars)

Type of plant	1994	1995
Copper 3/	1,200	1,210
Zinc 4/	118	118
Lead and molybdenum 4/	66	70
Total	1,390 r/	1,400
Value	86,100	85,500

r/ Revised.
1/ Includes acid from foreign materials.
2/ Data are rounded to three significant digits; may not add to totals shown.
3/ Excludes acid made from pyrites concentrates.
4/ Excludes acid made from native sulfur.

TABLE 5
CONSUMPTION OF SULFUR 1/ IN THE UNITED STATES 2/

(Thousand metric tons)

	1994	1995
Total elemental:		
Shipments 3/	10,300	10,700
Exports	899	906
Imports	1,650	2,510
Total	11,100	12,300
Byproduct sulfuric acid:		
Shipments	1,390 r/	1,400
Exports 4/	46	56
Imports 4/	696	628
Total, all forms	13,100 r/	14,300

r/ Revised.
1/ Crude sulfur or sulfur content.
2/ Data are rounded to three significant digits; may not add to totals shown.
4/ Includes all sulfuric acid imports, regardless of source.

TABLE 6
SULFUR AND SULFURIC ACID SOLD OR USED IN THE UNITED STATES, BY END USE 1/

(Thousand metric tons, sulfur content)

SIC	End use	Elemental sulfur 2/		Sulfuric acid (sulfur equivalent)		Total	
		1994	1995	1994	1995	1994	1995
102	Copper ores	--	--	787	836	787	836
1094	Uranium and vanadium ores	--	--	1	1	1	1
10	Other ores	--	--	34	93	34	93
26, 261	Pulpmills and paper products	W	W	295	306	295	306
28, 285, 286, 2816	Inorganic pigments, paints and allied products, industrial organic chemicals, other chemical products 3/	26	34	240	161	266	195
281	Other inorganic chemicals	127	132	208	122	335	254
282, 2822	Synthetic rubber and other plastic materials and synthetics	W	W	256	244	256	244
2823	Cellulosic fibers, including rayon	--	--	51	50	51	50
283	Drugs	--	--	13	4	13	4
284	Soaps and detergents	8	9	46	12	54	21
286	Industrial organic chemicals	--	--	113	48	113	48
2873	Nitrogenous fertilizers	--	--	145	88	145	88
2874	Phosphatic fertilizers	--	--	8,040 r/	8,200	8,040 r/	8,200
2879	Pesticides	--	--	7	10	7	10
287	Other agricultural chemicals	786 r/	673	36	29	822 r/	702
2892	Explosives	--	--	9	3	9	3
2899	Water-treating compounds	--	--	110	73	110	73
28	Other chemical products	--	--	38	41	38	41
29, 291	Petroleum refining and other petroleum and coal products	529	395	236	236	765	631
30	Rubber and miscellaneous plastic products	542	W	--	--	542	W
331	Steel pickling	--	--	10	7	10	7
333	Nonferrous metals	--	--	31	8	31	8
33	Other primary metals	--	--	4	1	4	1
3691	Storage batteries (acid)	--	--	59	25	59	25
	Exported sulfuric acid	--	--	77	10	77	10
	Total identified	2,020 r/	1,240	10,800 r/	9,760	12,900 r/	11,900
	Unidentified	542 r/	533	500	497	1,040	1,030
	Grand total	2,560 r/	1,780	11,300 r/	10,300	13,900 r/	12,900

r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Unidentified."

1/ Data are rounded to three significant digits; may not add to totals shown.

2/ Does not include elemental sulfur used for production of sulfuric acid.

3/ No elemental sulfur was used in inorganic pigments and paints and allied products.

TABLE 7
SULFURIC ACID FROM SMELTERS SOLD OR USED IN THE UNITED STATES,
BY END USE 1/

(Thousand metric tons of 100% H_2SO_4)

SIC	Use	1994	1995
102	Copper ores	1,920	2,250
1094	Uranium and vanadium ores	5	W
10	Other ores	105	285
26, 261	Pulp mills and other paper products	51	51
2816	Inorganic pigments	W	W
281	Other inorganic chemicals	95	76
2823	Cellulosic fibers	W	W
283	Drugs	W	W
2873	Nitrogenous fertilizers	W	48
2874	Phosphatic fertilizers	410	489
287	Other agricultural chemicals	82	56
2899	Water-treating compounds	170	76
28	Other chemical products	12	15
291	Petroleum refining	11	W
331	Steel pickling	W	W
333	Nonferrous metals	12	13
3691	Storage batteries (acid)	32	15
	Unidentified	590	597
	Total domestic	3,500	3,970
	Exports	W	W
	Grand total	3,500	3,970

W Withheld to avoid disclosing company proprietary data; included with "Unidentified."
1/ Data are rounded to three significant digits; may not add to totals shown.

TABLE 8
REPORTED SALES VALUES OF SHIPMENTS
OF SULFUR F.O.B. MINE OR PLANT

(Dollars per metric ton)

	1994	1995
Frasch	W	W
Recovered	W	W
Average	28.60	43.74

W Withheld to avoid disclosing company proprietary data.

TABLE 9
U.S. EXPORTS 1/ OF ELEMENTAL SULFUR, BY COUNTRY 2/

(Thousand metric tons and thousand dollars)

	1994		1995	
Country	Quantity	Value	Quantity	Value
Argentina	17	568	36	2,130
Australia	17	1,660	23	3,250
Bangladesh	46	1,590	26	1,280
Brazil	157	6,970	116	6,690
Canada	9	2,340	29	4,070
Colombia	10	658	9	721
India	48	1,820	178	9,020
Indonesia	52	2,680	85	4,530
Korea, Republic of	28	5,270	27	9,750
Mexico	63	3,740	64	4,540
Morocco	39	1,040	33	1,460
Senegal	130	5,460	187	9,980
South Africa	56	2,280	1	185
Tunisia	62	2,340	33	1,320
Other	165 r/	10,000 r/	59	7,240
Total	899	48,400	906	66,200

r/ Revised.
1/ Includes exports from the U.S. Virgin Islands.
2/ Data are rounded to three significant digits; may not add to totals shown.

Source: Bureau of the Census.

TABLE 10
U.S. EXPORTS OF SULFURIC ACID (100% H_2SO_4), BY COUNTRY 1/

Country	1994 Quantity (metric tons)	1994 Value (thousands)	1995 Quantity (metric tons)	1995 Value (thousands)
Argentina	(2/)	$4	1,000	$116
Canada	66,800	4,690	64,300	4,890
China	6,220	279	1,250	225
Costa Rica	2,190	144	697	141
Dominican Republic	2,880	241	4,570	280
Israel	6,230	488	13,300	858
Japan	855	50	630	182
Korea, Republic of	(2/)	460	914	44
Mexico	11,400	911	45,000	2,310
Netherlands	1,580	35	2,270	78
Netherlands Antilles	4,880	245	5,650	237
Panama	6,810	239	3,900	156
Saudi Arabia	811	64	1,200	64
Singapore	937	201	1,910	380
Taiwan	2,510	769	3,530	814
Trinidad and Tobago	3,640	247	5,110	365
United Kingdom	1,650	54	(2/)	3
Uruguay	--	--	3,500	158
Venezuela	7,470	206	7,550	325
Other	13,300 r/	1,720 r/	3,880	1,210
Total	140,000	11,000 r/	170,000	12,800

r/ Revised.
1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 11
U.S. IMPORTS OF ELEMENTAL SULFUR, BY COUNTRY 1/

(Thousand metric tons and thousand dollars)

Country	1994 Quantity	1994 Value2/	1995 Quantity	1995 Value
Canada	1,120	36,500	1,630	63,200
Mexico	450	20,900	506	29,300
Other	81	4,640	377	50,000
Total	1,650	62,000	2,510	143,000

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Declared customs valuation.

Source: Bureau of the Census.

TABLE 12
U.S. IMPORTS OF SULFURIC ACID (100% H_2SO_4), BY COUNTRY 1/

Country	1994 Quantity (metric tons)	1994 Value 2/ (thousands)	1995 Quantity (metric tons)	1995 Value 2/ (thousands)
Argentina	--	--	3,600	$1,660
Canada	1,680,000	$72,900	1,660,000	75,600
Chile	--	--	20,900	462
Germany	264,000	5,680	94,400	4,720
Japan	103,000	2,880	23,600	1,930
Mexico	18,600	1,350	95,300	8,540
Netherlands	27,600	671	(3/)	10
Spain	984	91	--	--
Sweden	29,700	1,130	--	--
United Kingdom	11,000	374	670	--
Other	73	23	22,700	40
Total	2,130,000	85,100	1,920,000	93,000

1/ Data are rounded to three significant digits; may not add to totals shown.
2/ Declared c.i.f. valuation.
3/ Less than 1/2 unit.

Source: Bureau of the Census.

TABLE 13
SULFUR: WORLD PRODUCTION IN ALL FORMS, BY COUNTRY AND SOURCE 1/ 2/

(Thousand metric tons)

Country and source 3/	1991	1992	1993	1994	1995 e/
Canada: Byproduct:					
Metallurgy	872	931	900 r/	870 r/	860 4/
Natural gas	5,488	5,769	6,600 r/	7,000 r/	7,100 4/
Petroleum	230	235	340 r/	350 r/	380 4/
Tar sands	540	552	590 r/	630 r/	670 4/
Total	7,130	7,487	8,430 r/	8,850 r/	9,010 4/
China: e/					
Native	320	320	330	330	330
Pyrites	4,940	4,930 r/	5,330 r/	5,870 r/	5,500
Byproduct, all sources	650	650	700	700	700
Total	5,910	5,900 r/	6,360 r/	6,900 r/	6,530
France: Byproduct:					
Natural gas	794	770	829	865 r/	797 4/
Petroleum	225	230	278	219 r/	200
Unspecified e/	180	150	150	100 r/	100
Total e/	1,200	1,150	1,260	1,180 r/	1,100
Germany:					
Pyrites e/	95	25	--	--	--
Byproduct:					
Metallurgy	23	23	33	35 e/	30
Natural gas and petroleum	1,080	1,016	1,137	1,200 e/	1,200
Unspecified 5/	84	100	XX	XX	XX
Total e/	1,280	1,160	1,171 4/	1,240	1,230
Iran: Byproduct: e/					
Metallurgy	50	50	50	50	50
Natural gas and petroleum	650	700	750	830	840
Total	700	750	800	880 4/	890
Iraq: e/					
Frasch	250	250 r/	250 r/	250 r/	250
Byproduct, natural gas and petroleum	50	100	200	225 r/	225
Total	300	350 r/	450 r/	475 r/	475
Japan:					
Pyrites	30	31	29	4	2
Byproduct:					
Metallurgy	1,352	1,374	1,383	1,269 r/	1,360
Petroleum	1,244	1,340	1,510	1,550 e/	1,500
Total	2,626	2,745	2,922	2,820 r/ e/	2,860
Mexico:					
Frasch	1,040	710	102	--	--
Byproduct:					
Metallurgy e/	280	817	730	2,014 4/	2,000
Natural gas and petroleum	754	775	804	877	882 4/
Unspecified e/	20 4/	--	-- r/	-- r/	--
Total e/	2,094	2,300	1,640 r/	2,890 r/	2,880
Poland: 6/					
Frasch	3,280 r/	2,282	1,860 r/	2,200 r/	2,200
Native	601 r/	562 r/	-- r/	-- r/	--
Byproduct:					
Metallurgy	185 r/	207 r/	220 r/	200 e/	200
Petroleum	28	26 r/	29 r/	25 e/	25
Gypsum e/	10	10	10	10	10
Total	4,104 r/	3,087 r/	2,119 r/	2,435 r/	2,440
Russia: e/ 7/ 8/					
Native	XX	100	100	80	80
Pyrites	XX	390	640	700	750
Byproduct, natural gas	XX	2,830 r/	2,680 r/	2,550 r/	2,970
Other	XX	175	180	175	200
Total	XX	3,500 r/	3,600 r/	3,510 r/	4,000
Saudi Arabia: Byproduct, all sources	2,000	2,370 r/	2,400 r/	2,300 r/	2,200 4/

See footnotes at end of table.

TABLE 13--Continued
SULFUR: WORLD PRODUCTION IN ALL FORMS, BY COUNTRY AND SOURCE 1/ 2/

(Thousand metric tons)

Country and source 3/	1991	1992	1993	1994	1995 e/
South Africa:					
Pyrites	293	296	323	252	159 4/
Byproduct:					
Metallurgy e/	68	56	81	118 r/ 4/	117 4/
Petroleum 9/	160 e/	166	171	209 r/	233 4/
Total	521	518	575	579 r/	509 4/
Spain:					
Pyrites	546	406 r/	327 e/	350 e/	350
Byproduct: e/					
Coal (lignite) gasification	2	2	2	2	2
Metallurgy	252	258	258	250	250
Petroleum	105	90	100	100	100
Total e/	905	860	687	702	702
U.S.S.R.: e/ 10/					
Frasch	900	XX	XX	XX	XX
Native	1,800	XX	XX	XX	XX
Pyrites	1,700	XX	XX	XX	XX
Byproduct:					
Metallurgy	1,100	XX	XX	XX	XX
Natural gas	2,200	XX	XX	XX	XX
Petroleum	400	XX	XX	XX	XX
Total	8,100	XX	XX	XX	XX
United States:					
Frasch	2,870	2,320	1,900 11/	2,930 e/	3,150
Pyrites	W	W	W	(12/)	(12/)
Byproduct:					
Metallurgy	1,300	1,290	1,430 r/	1,380 r/	1,400 4/
Natural gas	2,400	2,530	2,850 13/	2,240	2,210 4/
Petroleum	4,240	4,520	4,820	4,920	5,040 4/
Unspecified	4	3	3	(12/)	(12/)
Total	10,800	10,700	11,000	11,500 e/	11,800
Other countries:	6,923 r/	7,944 r/	7,888 r/	7,849 r/	7,665
Of which:					
Frasch	5	18	20	20	20
Native	94	1,000 r/	789 r/	619 r/	540
Pyrites	2,000 r/	1,742	1,499 r/	1,533 r/	1,387
Byproduct:					
Metallurgy	2,009 r/	2,167 r/	2,258 r/	2,000 r/	1,996
Natural gas	234 r/	385 r/	410 r/	348 r/	347
Natural gas and petroleum, undifferentiated	340 r/	355 r/	455 r/	794 r/	888
Petroleum	1,320 r/	1,419 r/	1,578 r/	1,655 r/	1,601
Unspecified sources	920 r/	857 r/	879 r/	880 r/	887
Grand total:	54,600 r/	50,700 r/	51,300 r/	54,100 r/	54,300
Of which:					
Frasch	8,340 r/	5,580 r/	4,140 r/	5,400 r/	5,620
Native	2,820 r/	1,980 r/	1,220 r/	1,030 r/	950
Pyrites	9,600 r/	7,820 r/	8,150 r/	8,710 r/	8,100
Byproduct:					
Coal (lignite) gasification	2	2	2	2	2
Metallurgy	7,490 r/	7,170 r/	7,340 r/	8,190 r/	8,260
Natural gas	11,100	12,300 r/	13,400 r/	13,000 r/	13,400
Natural gas and petroleum, undifferentiated	2,870 r/	2,950 r/	3,350 r/	3,930 r/	4,040
Petroleum	7,950 r/	8,030 r/	8,820 r/	9,030 r/	9,080
Tar sands	540	552	590 r/	630 r/	670
Unspecified sources	3,860 r/	4,300 r/	4,310 r/	4,150 r/	4,090
Gypsum	10	10	10	10	10

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data; included with "Byproduct: Unspecified sources." XX Not applicable.
1/ World totals, U.S. data, and estimated data are rounded to three significant digits; may not add to totals shown.
2/ Table includes data available through Aug. 15, 1996.

TABLE 13--Continued
SULFUR: WORLD PRODUCTION IN ALL FORMS, BY COUNTRY AND SOURCE 1/ 2/

3/ The term "Source" reflects both the means of collecting sulfur and the type of raw material. Sources listed include the following: (1) Frasch recovery; (2) native, comprising all production of elemental sulfur by traditional mining methods (thereby excluding Frasch); (3) pyrites (whether or not the sulfur is recovered in the elemental form or as acid); (4) byproduct recovery, either as elemental sulfur or as sulfur compounds from coal gasification, metallurgical operations including associated coal processing, crude oil and natural gas extraction, petroleum refining, tar sand cleaning, and processing of spent oxide from stack-gas scrubbers; and (5) recovery from the processing of mined gypsum. Recovery of sulfur in the form of sulfuric acid from artificial gypsum produced as a byproduct of phosphatic fertilizer production is excluded because to include it would result in double counting. It should be noted that production of Frasch sulfur, other native sulfur, pyrites-derived sulfur, mined gypsum-derived sulfur, byproduct sulfur from extraction of crude oil and natural gas, and recovery from tar sands are all credited to the country of origin of the extracted raw materials, in contrast, byproduct recovery from metallurgical operations, petroleum refineries, and spent oxides are credited to the nation where the recovery takes place, which in some instances is not the original source country of the crude product from which the sulfur is extracted.

4/ Reported figure.

5/ Data for 1991-92 represent byproduct production from the eastern states. Production data for 1993-95 represent those of the unified country.

6/ Official Polish sources report total Frasch and native mined elemental sulfur output annually, undifferentiated; this figure has been divided between Frasch and other native sulfur on the basis of information obtained from supplementary sources.

7/ Sulfur is believed to be produced from Frasch and pyrite, and as a petroleum byproduct, however information is inadequate to formulate reliable estimates.

8/ Formerly part of the U.S.S.R.; data were not reported separately until 1992.

9/ Includes byproduct production from synthetic fuels.

10/ Dissolved in Dec. 1991.

11/ Includes 10 months of Frasch sulfur production data. Two remaining months of Frasch data included with byproduct: natural gas data to conform with proprietary data requirements.

12/ Survey discontinued in 1994; data not available.

13/ Includes Frasch sulfur production data for November and December.