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SULFUR [ADVANCE RELEASE]

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Sulfur

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In 2013, the global demand for sulfur expanded moderately even with a decreased demand for phosphate fertilizer in many of the leading fertilizer-consuming countries. Demand for sulfur at ore-leaching operations increased as a result of increased copper production at newly commissioned projects. Overall, the global sulfur trade decreased slightly compared with that in 2012 owing to the worldwide decrease in sulfur imports in most leading importing countries (Prud'homme, 2014a, p. 47).

The United States ranked second in world sulfur production following China (table 11). Elemental sulfur and byproduct sulfuric acid, produced as a result of efforts to meet environmental requirements that limit atmospheric emissions of sulfur dioxide, were the dominant sources of sulfur around the world.

Through its major derivative, sulfuric acid, sulfur ranks as one of the most important elements used as an industrial raw material and is of prime importance to every sector of the world's fertilizer and manufacturing industries. Sulfuric acid production is the major end use for sulfur, and consumption of sulfuric acid 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 inorganic chemical; and an estimated 30.0 million metric tons (Mt), which is equivalent to about 9.8 Mt of elemental sulfur, was produced worldwide in 2013, a slight increase from that of 2012 (International Fertilizer Industry Association, 2014b, p. 10).

In 2013, domestic production and shipments of sulfur in all forms were slightly higher than those of 2012 (table 1). Elemental sulfur recovered at petroleum refineries was 3% higher than it was in 2012, and sulfur recovered from natural gas operations decreased slightly (table 3). Producers' stocks increased by 22%, accounting for less than 2% of shipments. Byproduct sulfuric acid production and shipments increased by 5%. Apparent consumption of sulfur in all forms increased by 3%. Imports of elemental sulfur and sulfuric acid combined increased by 3% and exports decreased by 5%. The average unit value of recovered sulfur in 2013 was 44% less than that of 2012, resulting in the value of total elemental sulfur shipments decreasing by 43% compared with the value of shipments in 2012. The total value of byproduct sulfuric acid shipments decreased by about 7% (table 1).

Worldwide, compliance with environmental regulations has contributed to increased sulfur recovery; for 2013, global sulfur production was slightly higher than that of 2012 (table 11). Recovered elemental sulfur is produced primarily during the processing of natural gas and crude petroleum. Estimated worldwide production of native (naturally occurring elemental) sulfur decreased slightly. In the few countries where pyrites remains an important raw material for sulfuric acid production, sulfur production from pyrites increased by 8%.

Since 2005, more than 75% of the world's sulfur production as elemental sulfur and byproduct sulfuric acid has come from recovered sources. Some sources of sulfur were unspecified, which means that the material could have been, and likely was, recovered elemental sulfur or byproduct sulfuric acid, increasing the percentage of byproduct sulfur production to about 90% annually. The quantity of sulfur produced from recovered sources was dependent on the world demand for fuels, nonferrous metals, and petroleum products rather than for sulfur.

World sulfur consumption was estimated to have increased slightly from that of 2012; typically, about 50% was used in fertilizer production, and the remainder, in myriad other industrial uses. World trade of elemental sulfur decreased slightly from the levels reported in 2012. Worldwide inventories of elemental sulfur declined because some of the increased demand was met by drawing down stocks in Kazakhstan (Prud'homme, 2013, p. 44).

Legislation and Government Programs

On July 25, the U.S. Environmental Protection Agency (EPA) designated 29 areas in 16 States as "nonattainment" because they did not meet the 1-hour 2010 National Ambient Air Quality Standard for sulfur dioxide set at 75 parts per million (ppm). Air quality monitors in each of these areas had measured violations of the sulfur dioxide standard. Therefore, State and local governments were required to develop and implement plans to reduce pollution to meet the sulfur dioxide standard. The "nonattainment" areas are required to meet the sulfur dioxide standard as quickly as possible, but no later than 5 years after the designation (U.S. Environmental Protection Agency, 2013). Efforts to meet the sulfur dioxide standard would likely require States to impose stricter pollution controls on powerplants and other emitting industries. Therefore, the amount of sulfur that is recovered would increase.

Production

Recovered Elemental Sulfur.—U.S. production statistics were collected on a monthly basis and published in the U.S. Geological Survey (USGS) monthly sulfur Mineral Industry Surveys. All 103 operations to which survey requests were sent responded; this represented 100% of the total production listed in table 1. In 2013, production and shipments were slightly higher than those of 2012. Lower sulfur prices resulted in the value of recovered shipments being 43% lower than that of 2012. For 2013, on average, U.S. petroleum refineries operated at 88.3% of capacity, a slight increase from that of 2012 (U.S. Energy Information Administration, 2015).

Recovered elemental sulfur, which is 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 sulfur was produced by 39 companies at 103 plants in 25 States. The size of the sulfur recovery operations varied greatly from plants producing more than 500,000 metric tons per year (t/yr) to others producing less than 500 t/yr. Of all the sulfur operations canvassed, 34 produced more than 100,000 metric tons (t) of elemental sulfur in 2013; 19 produced between 50,000 and 100,000 t; 29 produced between 10,000 and 50,000 t; and 21 plants produced less than 10,000 t. By source, 88% of recovered elemental sulfur production came from petroleum refineries or satellite plants that treated refinery gases and coking plants; the remainder was produced at natural-gas-treatment plants (table 3).

The leading producers of recovered sulfur, all with more than 500,000 t of sulfur production, were, in descending order of production, Exxon Mobil Corp., Valero Energy Corp., ConocoPhillips Co. (including its joint venture with Encana Corp.), Motiva Enterprises LLC, Marathon Petroleum Corp., and Chevron Corp. The 44 plants owned by these companies accounted for 64% of recovered sulfur output during the year. Recovered sulfur production by State and district is listed in tables 2 and 3.

In 2013, 5 of the 20 largest oil refineries in the world, in terms of crude-processing capacity, were in the United States. In descending order of capacity, they were Exxon Mobil's Baytown, TX, refinery; Marathon's Garyville, LA, refinery; Exxon Mobil's Baton Rouge, LA, refinery; Marathon's Galveston Bay, TX, refinery; and Citgo Petroleum Corp.'s Lake Charles, LA, refinery (Oil & Gas Journal, 2013b). The capacity to process large quantities of crude oil does not necessarily mean that refineries recover large quantities of sulfur, but all these refineries were major producers of recovered sulfur. Sulfur production depends on installed sulfur recovery capacity as well as the types of crude oil that were refined at the specific refineries. Major refineries that process low-sulfur crude oils may have relatively low sulfur production. The United States operated 21% of world refining capacity but had almost 40% of world sulfur recovery capacity at these refineries (Oil & Gas Journal, 2013a, p. 2).

U.S. refining capacity rose slightly from 2009 through 2013, and capacity rose by about 9% from 2000 through 2013, without building any new refineries. In 2013, U.S. refinery capacity was 17.9 million barrels per day. Overall U.S. refinery capacity increased by about 101,000 barrels per day (bbl/d) in 2013. Although this information did not specifically mention sulfur capacity expansion, any such expansions would likely include increased sulfur recovery facilities, probably proportionally higher than the increases in throughput capacity (U.S. Energy Information Administration, 2014b).

During 2013, expansion and improvement projects were underway or in the planning stages at five refineries in the United States. In addition to increasing throughput capacity at the operations, upgrades were intended to increase the existing refineries' capabilities to process low-quality, high-sulfur crude oil, such as those from Canada's oil sands, Saudi Arabia, and Venezuela. Oil sands producers were partners in some of the projects, as part of a strategy to ensure outlets for future oil sands production. One sulfur recovery plant was completed in 2013, but most were expected to be completed between 2014 and 2015 (Sulphur, 2014a).

Byproduct Sulfuric Acid.—Sulfuric acid production at copper, lead, molybdenum, and zinc roasters and smelters accounted for about 7% of total domestic production of sulfur in all forms and totaled the equivalent of 616,000 t of elemental sulfur. Byproduct sulfuric acid production increased by 5% compared with that of 2012 (tables 1, 4). Three acid plants operated in conjunction with copper smelters, and two were byproduct operations of lead, molybdenum, and zinc smelting and roasting operations. The three largest byproduct sulfuric acid plants, in terms of size and capacity, were associated with copper smelters and accounted for 86% of the byproduct sulfuric acid output. The copper producers—Asarco LLC, Kennecott Utah Copper Corp., and Freeport-McMoRan Copper & Gold Inc.—each operated a sulfuric acid plant at its primary copper smelter.

Consumption

Apparent domestic consumption of sulfur in all forms was 3% higher than that of 2012 (table 5). Of the sulfur consumed, 65% was obtained from domestic sources as elemental sulfur (60%) and byproduct acid (5%) compared with 65% in 2012, 64% in 2011, 67% in 2010, and 79% in 2009. The remaining 35% was supplied by imports of recovered elemental sulfur (26%) and sulfuric acid (9%). The USGS collected end-use data on sulfur and sulfuric acid according to the Standard Industrial Classification (SIC) of industrial activities (table 6).

Sulfur differs from most other major mineral commodities in that its primary use is as a chemical reagent rather than as a component of a finished product. This use generally requires that it be converted to an intermediate chemical product prior to its initial use by industry. The leading sulfur end use, sulfuric acid, represented 66% of reported consumption with an identified end use. Although reported as elemental sulfur consumption in table 6, it is reasonable to assume that nearly all the sulfur consumption reportedly used in petroleum refining was first converted to sulfuric acid, bringing sulfur used to produce sulfuric acid to 85% of the total sulfur consumption. Some identified sulfur end uses were included in the "Unidentified" category (table 6) because these data were proprietary. A significant portion of the sulfur in the "Unidentified" category may have been shipped to sulfuric acid producers or exported, although data to support such assumptions were not available.

Because of its desirable properties, sulfuric acid retained its position as the most universally used mineral acid and the most produced and consumed inorganic chemical, by volume. Data based on USGS surveys of sulfur and sulfuric acid producers showed that reported U.S. consumption of sulfur in sulfuric acid (100% basis) increased by 8%, and total reported sulfur consumption increased by 7%. The reported increase in sulfuric acid consumption can be attributed to a threefold increase in sulfuric acid use in petroleum refining and other petroleum and coal products. Reported consumption figures do not correlate with calculated apparent consumption owing to reporting errors and possible double counting in some data categories. These data are considered independently from apparent consumption as an indication of market shares rather than actual consumption totals.

Agriculture was the leading sulfur-consuming industry; consumption in this end use increased by 4% to 7.52 Mt compared with 7.26 Mt in 2012 resulting from increased consumption in other agricultural chemicals. Based on export data reported by the U.S. Census Bureau, the estimated quantity of sulfur needed to manufacture exported phosphatic fertilizers decreased by about 12% to 3.7 Mt. In 2013, about 45% of the domestic phosphate fertilizer production was exported.

The second-ranked end use for sulfur was in petroleum refining and other petroleum and coal products. Producers of sulfur and sulfuric acid reported that the consumption of sulfur in that end use increased by 30% from that of 2012. Demand for sulfuric acid in copper ore leaching, which was the third-ranked end use, decreased by 32%.

Production data for sulfuric acid produced as a result of recycling spent and contaminated acid from petroleum alkylation and other processes in 2013 were no longer available from the U.S. Census Bureau. Two types of companies recycle this material—companies that produce acid for consumption in their own operations and also recycle their own spent acid, and companies that provide acid regeneration services to sulfuric acid users. The petroleum-refining industry was thought to be the leading source and consumer of recycled acid for use in its alkylation process.

Stocks

Yearend inventories held by recovered elemental sulfur domestic producers increased to 161,000 t, 22% greater than those of 2012 (table 1). Based on apparent consumption of all forms of sulfur, combined yearend stocks amounted to about a 5-day supply, which compares with a 4-day supply in 2012. Final stocks in 2013 represented 3% of the quantity held in inventories at the end of 1976, when sulfur stocks peaked at 5.65 Mt, a 7.4-month supply at that time (Shelton, 1980, p. 877). When the United States mined large quantities of sulfur, as in 1976, mining companies had the capacity to store large quantities. When mining ceased in 2000, storage capacity declined significantly. Since that time, stocks have been relatively low because recovered sulfur producers have minimal storage capacity.

Prices

Despite a slight increase in global consumption of sulfur during 2013, prices were lower than those of 2012. On the basis of value data reported to the USGS, the average unit value of shipments for all elemental sulfur was estimated to be $68.83 per metric ton, which was 44% less than that of 2012. The decreased unit value reported by producers correlated with the trends in prices recorded in trade publications.

Contract prices for elemental sulfur at terminals in Tampa, FL, which are reported weekly in Green Markets, began the year at $160 per ton. By July, prices decreased to $95 per ton. In mid-October, prices decreased again to $75 per ton and remained at this price through yearend.

Prices vary greatly on a regional basis. Tampa prices were usually the highest reported in the United States because of the large demand for sulfur in the central Florida area. At yearend, U.S. West Coast prices ranged from $93 per ton to $98 per ton. Nearly all the sulfur produced in some regions, such as the West Coast, was processed at forming plants, incurring substantial costs to make solid sulfur in acceptable forms to be shipped overseas. The majority of West Coast sulfur was shipped overseas. World sulfur prices generally were higher than domestic prices in 2013.

Even though prices vary by location, provider, and type, the Abu Dhabi National Oil Co.'s (ADNOC) price is recognized as an indicator of world sulfur price trends. In 2013, the ADNOC contract price averaged about $120 per ton, with the lowest price of $70 per ton in August and the highest price of $160 per ton in April (Fertilizer Week, 2014).

Foreign Trade

The average unit value of exported elemental sulfur was $134 per ton, a 32% decrease from $198 in 2012 (table 7). The leading destination for this material was Brazil, followed by, in descending quantity, China and Mexico. Export facilities on the Gulf Coast that began shipping in 2006 have become a significant source for exported sulfur. Exports from the West Coast were 887,000 t, or 51% of total U.S. exports. Exports from the Gulf Coast were 835,000 t, or 48% of the U.S. total.

The United States continued to be a net importer of sulfur. Imports of elemental sulfur exceeded exports by about 1.2 Mt. Recovered elemental sulfur from Canada, Mexico, and Venezuela, delivered to U.S. terminals and consumers in the liquid phase, furnished almost 100% of U.S. sulfur import requirements. Total elemental sulfur imports in 2013 were slightly greater than those of 2012, and lower prices for imported material resulted in the value being about 15% less than that of 2012. Imports from Canada, mostly by rail, were estimated to be slightly less than those of 2012, waterborne shipments from Mexico were 22% higher, and waterborne imports from Venezuela were estimated to have remained the same. Canada was the source of an estimated 81% of elemental sulfur imports, and Mexico supplied 15% (table 9).

In addition to elemental sulfur, the United States trades in sulfuric acid. Sulfuric acid exports were 3% higher than those of 2012 (table 8). Acid imports were about 18 times greater than exports (tables 1, 10). Canada and Mexico were the sources of 88% of sulfuric acid imported into the United States, most of which was probably byproduct acid from smelters. Shipments from Canada and some from Mexico came by rail, and the remainder of imports came primarily by ship from Asia and Europe. The tonnage of sulfuric acid imports was about 4% greater than that of 2012, and the value of imported sulfuric acid decreased by about 12%.

World Review

The world sulfur industry remained divided into two sectors—discretionary and nondiscretionary. In the discretionary sector, the mining of sulfur or pyrites is the sole objective; this voluntary production of either sulfur or pyrites (mostly naturally occurring iron sulfide) is 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 nondiscretionary sector, sulfur or sulfuric acid is recovered as an involuntary byproduct; the quantity of output is subject to demand for the primary product and environmental regulations that limit atmospheric emissions of sulfur compounds irrespective of sulfur demand. Discretionary sources, once the primary sources of sulfur in all forms, represented 12% of the sulfur produced in all forms worldwide in 2013 (table 11).

Poland was the only country that produced more than 500,000 t of native sulfur by using either the Frasch process or conventional mining methods (table 11). The Frasch process is the term for hot-water mining of native sulfur associated with the caprock of salt domes and in sedimentary deposits; in this mining method, the native sulfur is melted underground with superheated water and brought to the surface by compressed air. The United States, where the Frasch process was developed early in the 20th century, was the leading producer of Frasch sulfur until 2000. Small quantities of native sulfur were produced in Asia, Europe, and South America. The importance of pyrites to the world sulfur supply has significantly decreased; China was the only country among the top producers whose primary sulfur source was pyrites. China accounted for 91% of world pyrites production.

Of the 15 countries listed in table 11 that produced more than 1 Mt of sulfur, 13 obtained the majority of their production as recovered elemental sulfur. These 15 countries produced 84% of the total sulfur produced worldwide. In 2013, about 31.3 Mt of elemental sulfur was traded globally. The leading exporters were, in decreasing order of tonnage, Canada, Kazakhstan, Russia, Saudi Arabia, the United Arab Emirates, Qatar, the United States, Japan, Iran, and the Republic of Korea, all with more than 1 Mt of exports. The leading importer was China, by far, followed by, in decreasing order of tonnage, Morocco, the United States, Brazil, India, Tunisia, and Australia (International Fertilizer Industry Association, 2014a).

In 2013, the slight increase in sulfur consumption exceeded global production, even with lower demand in the phosphate fertilizer sector. As a result, stocks in Kazakhstan and, to a much lesser extent, Canada were used to meet global needs (Prud'homme, 2013, p. 44). Prices were highest at the beginning of 2013 and decreased toward the yearend. International prices for 2013 averaged higher than those in the United States. Sulfur imports increased in most of the main sulfur-consuming countries, except China, which was the world's leading importer in 2013, with about 34% of the total.

Native sulfur production, including production of Frasch sulfur at Poland's last operating mine, was about 7% lower than that of 2012. Recovered elemental sulfur production and byproduct sulfuric acid production were slightly higher compared with those of 2012. Globally, production of sulfur from pyrites increased by about 8%. Pyrites are a less attractive alternative to elemental sulfur for sulfuric acid production. The environmental remediation costs of mining pyrites are onerous, and additional costs are incurred when using this less environmentally friendly raw material to produce sulfuric acid.

Canada.—Ranked fourth in the world in sulfur production, Canada was the leading sulfur and sulfuric acid exporter. In 2013, sulfur production in Canada was 3% higher than it was in 2012. About two-thirds of Canada's sulfur was recovered at natural gas and oil sands operations in Alberta, with some recovered from natural gas in British Columbia and from oil refineries in other parts of the country.

Canada's sulfur production was expected to remain stable over the medium term and may increase during the long term as a result of expanded oil sands production. Sulfur production from natural gas was expected to decline as natural gas reserves decrease. Exploration for conventional natural gas came to a halt in 2012. Production from oil sands operations was expected to overtake natural gas processing, and sulfur recovered from petroleum refineries was expected to remain relatively stable. Canada was likely to remain a leader in world sulfur production. Byproduct acid production was expected to remain relatively stable.

The most current report from Alberta's Energy Resources Conservation Board showed that sulfur emissions in 2011 from Alberta's natural-gas-processing plants declined by 62% from levels in 2000 and by 7% from those of 2010. Sulfur emissions declined as the result of improved sulfur recovery technology at several plants and the closing of one plant in 2011. Although sulfur recovery increased as a percentage of gas processing, total sulfur recovery declined during the same period because of lower gas-processing volumes (Energy Resources Conservation Board, 2012, p. 6).

At yearend 2013, sulfur inventory in western Canada was estimated to be 11 Mt. About 9.7 Mt of the sulfur stocks was stored at Syncrude Canada Ltd.'s Fort McMurray, Alberta, oil sands operation. Fort McMurray is so remote that transporting the sulfur to market is extremely difficult and expensive. The lack of railway access is a major obstacle in the shipment of sulfur from oil sands production sites. Only about 1.3 Mt of the sulfur from central Alberta was easily marketable (Prud'homme, 2014a, p. 49).

In September, North West Redwater Partnership, a 50–50 joint venture between North West Upgrading Inc. and Canadian Natural Resources Ltd., began construction on the first phase of a 150,000-bbl/d refinery at a cost of Can$5.7 billion. The plant was located north of Edmonton, Alberta, in Sturgeon County. The project would process bitumen (a heavy black viscous oil) primarily to produce ultra-low-sulfur diesel fuel for local use and export. The first phase, which would produce 50,000 bbl/d, was scheduled to be completed by yearend 2016 (Oil & Gas Journal, 2013b, p. 42).

China.—China was the leading producer of sulfur in all forms. China also was the world's leading producer of pyrites, with about 56% of its sulfur in all forms coming from that source. The country was the leading sulfur importer, with 10.6 Mt representing 34% of the global imports (International Fertilizer Industry Association, 2014a). Imports represented about 70% of elemental sulfur consumption in China, with the Middle East as the leading source of the imports, followed by Kazakhstan and Japan. Fertilizer production consumed about two-thirds of the sulfuric acid used in China.

By June 2013, China planned to launch national fuel standards for automotive diesel fuel, which would allow a maximum sulfur content of 50 ppm in diesel fuel. This was to be followed by similar specifications for gasoline by yearend in order to begin reducing smog in many of the cities in China. By 2017, the fuel standards would limit the sulfur content to no more than 10 ppm for diesel fuel and gasoline (Sulphur, 2013).

In December 2013, the Government of China released its 2014 export tariff rates for phosphate fertilizers to discourage exports during periods of high domestic demand. The base rate of the low-tariff window (May 16 to October 15) for diammonium phosphate and monoammonium phosphate would be 50 Renminbi (RMB) per ton. The tax rate for phosphate fertilizers during high season would be 50 RMB per ton plus 15% during January 1 to May 15 and October 16 to December 31 (CRU Group, 2014).

Vietnam.—Construction of a 200,000-bbl/d Vietnamese oil refinery in Nghi Son Economic Zone in Thanh Hoa Province was scheduled to begin in July. The plant was expected to produce 40,000 t/yr of sulfur by 2017, increasing to 80,000 t/yr at full production. The refinery was expected to cost $9 billion and was to be supplied by heavy crude oil from Kuwait (Fertilizer Week, 2013).

Outlook

Since 2000, recovered sulfur production in the United States has been relatively stable, averaging about 8.5 Mt/yr, but increases are expected in upcoming years as expansions, upgrades, and new facilities at existing refineries are completed. The expansions would enable refiners to increase throughput of crude oil and to process higher sulfur crude oils; additional sulfur production would be a result of refinery upgrades. Projects that had been announced before or during 2013 have the potential to add sulfur recovery capacity of about 450,000 t/yr by 2015, if all are completed on proposed schedules (Sulphur, 2014a). Production from natural gas operations is expected to increase from that of 2014 as more natural gas is recovered from shale formations, horizontal drilling, and hydraulic fracturing. More efficient, cost-effective drilling techniques, primarily in shale formations, and low natural gas prices likely would continue to spur development in U.S. natural gas production (U.S. Energy Information Administration, 2013, p. 13).

Worldwide recovered sulfur output is also expected to increase as a result of higher sulfur recovery in the oil and gas sector. Through 2014, worldwide production of sulfur is not expected to meet demand. However, sulfur surpluses are expected in 2015, increasing thereafter as a result of increased production, especially from oil sands in Canada; from heavy-oil processors in Venezuela; and from Eastern Europe, central Asia, and west Asia (primarily the countries of the United Arab Emirates, Saudi Arabia, and Turkmenistan) (Prud'homme, 2014b).

Production increases are expected to come from increased sulfur recovery from natural gas in Russia, improved sulfur recovery at oil refineries, and new development of sour gas deposits in Asia. Refineries in developing countries are expected to improve environmental protection measures and, in the future, eventually approach the environmental standards of plants in Japan, North America, and Western Europe. Higher sulfur recovery likely will result from a number of factors, including higher refining rates, higher sulfur content in crude oil, lower allowable sulfur content in finished fuels, and reduced sulfur emissions mandated by regulations.

World consumption of natural gas is expected to maintain strong growth, and sulfur recovery from that sector likely will continue to increase. Natural gas continued to be the fuel of choice in many regions of the world in the electric power and industrial sectors, in part because of its lower carbon intensity compared with coal and oil, which makes it an attractive fuel source in countries where governments are implementing policies to reduce greenhouse gas emissions or carbon dioxide. Some future gas production is expected to come from unconventional natural gas resources such as tight gas, shale gas, and coalbed methane (U.S. Energy Administration, 2014a). Use of unconventional natural gas sources in some areas of the world may affect the sulfur supply outlook for the future because these sources tend to have lower sulfur content. However, increased sulfur from sour gas processing in China, central Asia, and the Middle East is projected to more than compensate for the decrease in sulfur resulting from unconventional natural gas sources.

Domestic byproduct sulfuric acid production may fluctuate somewhat as the copper industry reacts to market conditions and varying prices by adjusting output at operating smelters. Worldwide, the outlook for byproduct acid is more predictable. Because copper production costs in some countries are lower than in the United States, acid production from those countries has increased, and continued increases are likely. Many copper producers have installed more efficient sulfuric acid plants to limit sulfur dioxide emissions at new and existing smelters. Worldwide, sulfur emissions at nonferrous smelters declined as a result of improved sulfur recovery; increased byproduct acid production is likely to become more a function of metal demand than a function of improved recovery technology. Smelter acid production in the United States has decreased by 40% since 2000. China's smelter acid production has more than doubled in the past 5 years. China is forecasted to account for the majority of the increased smelter acid production followed by new environmentally mandated smelter capacity in Africa, Kazakhstan, Russia, and Uzbekistan (Sulphur, 2014b).

Frasch sulfur and pyrites production, however, have little chance of significant long-term increases. In 2013, Frasch sulfur production decreased by 22% from that of 2012. Because of the continued increases in elemental sulfur recovery and byproduct sulfuric acid production for environmental reasons, discretionary sulfur has become increasingly less important as demonstrated by the lack of expansion in the Frasch sulfur industry. The Frasch process has become the high-cost process for sulfur production and any new projects would require sulfur prices to increase enough to justify the initial investment. Pyrites, with significant direct production costs, are an even higher cost raw material for sulfuric acid production when the environmental aspects are considered. Discretionary sulfur output is likely to continue a steady decline. The decrease likely will be pronounced when large operations are closed for economic reasons, as was the case in 2000 and 2001.

For the long term, sulfur and sulfuric acid likely will continue to be important in agricultural and industrial applications. Because sulfuric acid consumption for phosphate fertilizer production is expected to increase at a lower rate than for some other uses, phosphate fertilizer may become less dominant, but it is expected to remain the leading end use. Ore leaching likely will be the largest area of sulfur consumption growth. Copper and nickel leaching are the major consumers of sulfuric acid, but uranium leaching is increasing as the demand increases for nuclear power (Sulphur, 2011).

From year to year, however, the use of sulfur directly or in compounds such as fertilizer likely will continue to be dependent on agricultural economies and vary according to economic conditions. If widespread use of plant nutrient sulfur is adopted, then sulfur consumption in that application could increase significantly; thus far, however, growth has been slow. Major expansions of phosphate fertilizer production are expected at facilities in China, Morocco, and Saudi Arabia (Heffer and Prud'homme, 2014). Overall, one-half of all sulfur consumption (in all forms) is used for phosphate fertilizer production.

Less traditional uses for elemental sulfur have not increased. In the 1970s and 1980s, research showed the effectiveness of sulfur in several construction uses that would most likely consume huge quantities of sulfur in sulfur-extended asphalt and sulfur concretes. In many instances, these materials were found to be superior to the more conventional products, but their use so far has been very limited. Concrete made with sulfur is more resistant to acid and saltwater; the manufacturing process lowers carbon dioxide emissions and does not require water to manufacture. However, when sulfur prices are high, sulfur is less attractive for unconventional applications where low-cost raw materials are important.

In the near term, increased global production and continued demand will keep the sulfur market balanced, which is expected to be followed in the long term by a surplus worldwide. International sulfur trade is expected to increase significantly, driven by demand for sulfuric acid in industrial sectors (particularly new ore-leaching operations) and a modest increase in demand for fertilizers.

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TABLE 1
SALIENT SULFUR STATISTICS[1]

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

	2009	2010	2011	2012	2013
United States:					
Quantity:					
Production:					
Recovered	8,190 [2]	8,320 [2]	8,230 [2]	8,410 [2]	8,600
Other	749	791	720	586	616
Total	8,940	9,110	8,950	9,000	9,210
Shipments:					
Recovered	8,110 [2]	8,380 [2]	8,210 [2]	8,450 [2]	8,590
Other	749	791	720	586	616
Total	8,860	9,170	8,930	9,030	9,200
Exports:					
Elemental	1,430 [3]	1,450 [3]	1,310 [3]	1,850 [3]	1,750
Sulfuric acid	83	71	109	53	54
Imports:					
Elemental[e]	1,700	2,950	3,270	2,930	2,990
Sulfuric acid	413	690	872	933	972
Consumption, all forms[4]	9,460	11,300	11,700	11,000	11,400
Stocks, December 31, producer, recovered	231	166	175	132	161
Value:					
Shipments, free on board (f.o.b.) mine or plant:					
Recovered [e]	14,000 [2]	587,000 [2]	1,310,000 [2]	1,040,000 [2]	591,000
Other	87,500	92,400	113,000	109,000	101,000
Total	101,000	679,000	1,430,000	1,150,000	692,000
Exports, elemental	82,200 [5]	171,000 [5]	266,000 [5]	366,000 [5]	234,000
Imports, elemental	54,100	214,000	301,000	238,000	202,000
Price, elemental, f.o.b. mine or plant[e] dollars per metric ton	1.73	70.16	159.88	123.54	68.83
World, production, all forms (including pyrites)	68,300 [r]	68,800 [r]	69,900 [r]	69,200 [r]	70,400

[e]Estimated. [r]Revised.
[1]Data are rounded to no more than three significant digits except prices; may not add to totals shown.
[2]Includes the U.S. Virgin Islands.
[3]Includes exports from the U.S. Virgin Islands to foreign countries.
[4]Calculated as shipments minus exports plus imports.
[5]Includes value of exports from the U.S. Virgin Islands to foreign countries.

TABLE 2

RECOVERED SULFUR PRODUCED AND SHIPPED IN THE UNITED STATES, BY STATE[1]

(Thousand metric tons and thousand dollars)

	2012			2013		
		Shipments			Shipments	
State	Production	Quantity	Value[e]	Production	Quantity	Value[e]
Alabama	272	274	37,600	289	290	21,600
California	1,040	1,040	154,000	1,060	1,060	48,500
Illinois	593	592	77,700	606	607	37,600
Louisiana	1,490 r	1,490 r	185,000 r	1,450	1,450	97,100
New Mexico	19	18	2,220	16	17	748
Ohio	130	131	20,400	141	141	8,390
Texas	3,060 r	3,050 r	372,000 r	3,160	3,160	259,000
Washington	165	165	17,900	194	195	11,200
Wyoming	591	589	32,100	596	594	23,000
Other[2]	1,050	1,110	144,000	1,080	1,070	84,200
Total	8,410	8,450	1,040,000	8,600	8,590	591,000

[e]Estimated. [r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes Colorado, Delaware, Florida, Indiana, Kansas, Kentucky, Michigan, Minnesota, Mississippi, Montana, New Jersey, North Dakota, Oklahoma, Pennsylvania, Tennessee, Utah, Virginia, Wisconsin, and the U.S. Virgin Islands (2012).

TABLE 3

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

(Thousand metric tons)

	2012		2013	
District and source	Production	Shipments	Production	Shipments
PAD 1:				
Petroleum and coke	132	136	183	184
Natural gas	13	13	13	13
Total	145	150	196	197
PAD 2:				
Petroleum and coke	1,080	1,080	1,070	1,070
Natural gas	18	18	13	13
Total	1,100	1,100	1,080	1,080
PAD 3:[2]				
Petroleum and coke	4,810 r	4,850 r	4,910	4,900
Natural gas	446	426	434	434
Total	5,250 r	5,280 r	5,350	5,330
PAD 4 and 5:				
Petroleum and coke	1,350 r	1,360 r	1,410	1,420
Natural gas	562	560	561	559
Total	1,910 r	1,920 r	1,970	1,980
Grand total	8,410	8,450	8,600	8,590
Of which:				
Petroleum and coke	7,370	7,430	7,580	7,570
Natural gas	1,040	1,020	1,020	1,020

[r]Revised.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes the U.S. Virgin Islands (2012).

TABLE 4

BYPRODUCT SULFURIC ACID PRODUCED IN THE UNITED STATES[1]

(Thousand metric tons of sulfur content and thousand dollars)

Type of plant	2012	2013
Copper[2]	545	574
Zinc, lead, and molybdenum[3]	41	41
Total:		
Quantity	586	616
Value	109,000	101,000

[1]May include acid produced from imported raw materials. Data are rounded to no more than three significant digits, may not add to totals shown.

[2]Does not include acid made from pyrites concentrates.

[3]Does not include acid made from native sulfur.

TABLE 5

CONSUMPTION OF SULFUR IN THE UNITED STATES BY TYPE[1]

(Thousand metric tons of sulfur content)

Type	2012	2013
Elemental sulfur:		
Shipments[2]	8,450	8,590
Exports[2]	1,850	1,750
Imports[e]	2,930	2,990
Total	9,520	9,830
Byproduct sulfuric acid:		
Shipments	586	616
Exports[3]	53	54
Imports[3]	933	972
Total	1,470	1,530
Grand total	11,000	11,400

[e]Estimated.

[1]Crude sulfur or sulfur content. Data are rounded to no more than three significant digits; may not add to totals shown. Consumption is calculated as shipments minus exports plus imports.

[2]Includes the U.S. Virgin Islands (2012).

[3]May include sulfuric acid other than byproduct.

TABLE 6

SULFUR AND SULFURIC ACID SOLD OR USED IN THE UNITED STATES, BY END USE[1]

(Thousand metric tons of sulfur content)

SIC[3] code	End use	Elemental sulfur[2] 2012	Elemental sulfur[2] 2013	Sulfuric acid (sulfur equivalent) 2012	Sulfuric acid (sulfur equivalent) 2013	Total 2012	Total 2013
102	Copper ores	--	--	420	284	420	284
1094	Uranium and vanadium ores	--	--	7	5	7	5
10	Other ores	--	--	77	62	77	62
26, 261	Pulp mills and paper products	W	W	168	168	168	168
28, 285, 286, 2816	Inorganic pigments, paints, and allied products; industrial organic chemicals; other chemical products[4]	W	W	107	101	107	101
281	Other inorganic chemicals	W	W	76	76	76	76
282, 2822	Synthetic rubber and other plastic materials and synthetics	W	W	70	70	70	70
2823	Cellulosic fibers including rayon	--	--	--	--	--	--
284	Soaps and detergents	--	--	2	2	2	2
286	Industrial organic chemicals	--	--	37	32	37	32
2873	Nitrogenous fertilizers	--	--	163	168	163	168
2874	Phosphatic fertilizers	--	--	5,420	5,270	5,420	5,270
2879	Pesticides	--	--	8	7	8	7
287	Other agricultural chemicals	1,630	2,030	42	47	1,670	2,080
2892	Explosives	--	--	11	9	11	9
2899	Water-treating compounds	--	--	36	36	36	36
28	Other chemical products	--	--	69	68	69	68
29, 291	Petroleum refining and other petroleum and coal products	2,070	1,980	423	1,270	2,490	3,250
331	Steel pickling	--	--	11	11	11	11
33	Other primary metals	--	--	--	--	--	--
3691	Storage batteries (acid)	--	--	21	21	21	21
	Exported sulfuric acid	--	--	73	73	73	73
	Total identified	3,700	4,000	7,250	7,790	10,900	11,800
	Unidentified	372	340	165	199	537	539
	Grand total	4,070	4,340	7,410	7,990	11,500	12,300

W Withheld to avoid disclosing company proprietary data; included with “Unidentified.” -- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

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

[3]Standard Industrial Classification.

[4]No elemental sulfur was used in inorganic pigments, paints, and allied products.

TABLE 7
U.S. EXPORTS OF ELEMENTAL SULFUR, BY COUNTRY[1]

(Thousand metric tons and thousand dollars)

Country	2012[2]		2013	
	Quantity	Value	Quantity	Value
Brazil	749	129,000	693	75,700
Canada	33	12,200	12	10,100
Chile	235	35,200	68	6,430
China	162	41,700	296	54,900
Mexico	445	76,300	256	4,020
New Caledonia	--	--	57	3,940
Other	225	72,000	368	78,900
Total	1,850	366,000	1,750	234,000

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes value of exports from the U.S. Virgin Islands.

Source: U.S. Census Bureau.

TABLE 8
U.S. EXPORTS OF SULFURIC ACID (100% H_2SO_4), BY COUNTRY[1]

Country	2012		2013	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Canada	114,000	$14,400	108,000	$14,800
China	1,890	352	3,500	482
Dominican Republic	2,930	473	29	29
India	4	6	2	3
Israel	3,630	4,910	6,930	6,180
Jamaica	6,630	1,120	4,020	209
Kazakhstan	3,080	351	3,420	390
Mexico	5,060	1,390	7,830	2,090
Morocco	--	--	3	5
Netherlands	325	48	8	15
Philippines	3,430	616	10	17
Singapore	1,650	1,610	1,010	947
St. Maarten	3,430	634	5,040	406
Trinidad and Tobago	4,730	2,780	13,300	1,040
United Kingdom	178	78	139	79
Venezuela	596	74	--	--
Other	8,820	4,240	12,200	3,380
Total	161,000	33,000	165,000	30,100

-- Zero.

[1]Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 9
U.S. IMPORTS OF ELEMENTAL SULFUR, BY COUNTRY[1]

(Thousand metric tons and thousand dollars)

	2012		2013	
Country	Quantity	Value[2]	Quantity	Value[2]
Canada	2,440 [e]	163,000	2,420 [e]	135,000
Mexico	366	56,000	448	48,200
Venezuela	115	14,200	115	13,400
Other	6	4,600	11	5,750
Total	2,930 [e]	238,000	2,990 [e]	202,000

[e]Estimated.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Declared customs valuation.

Source: U.S. Census Bureau and ICIS PentaSul North American Sulphur Service; data adjusted by the U.S. Geological Survey.

TABLE 10
U.S. IMPORTS OF SULFURIC ACID (100% H_2SO_4), BY COUNTRY[1]

	2012		2013	
Country	Quantity (metric tons)	Value[2, 3] (thousands)	Quantity (metric tons)	Value[2] (thousands)
Belgium	36	$5	26,100	$1,190
Canada	1,980,000	155,000	2,050,000	145,000
Chile	--	--	10,000	541
China	1,020	928	1,000	928
Finland	19,100	1,850	12,400	502
Germany	100,000	7,770 [r]	89,500	4,800
Iraq	--	--	5,350	3,970
Japan	18,500	982	50	11
Mexico	470,000	33,700	555,000	34,800
Norway	--	--	7,880	71
Poland	111,000	9,370	53,700	1,370
Saudi Arabia	4,570	3,550	12,100	8,840
Spain	55,800	8,630	54,900	2,430
Sweden	52,800	2,980	65,100	3,920
Switzerland	29,100	2,120	25,600	618
Taiwan	1,010	1,100	1,130	1,180
Venezuela	14,900	10,600	--	--
Other	659 [r]	329 [r]	1,390	980
Total	2,860,000	239,000	2,970,000	211,000

[r]Revised. -- Zero.
[1]Data are rounded to no more than three significant digits; may not add to totals shown.
[2]Declared cost, insurance, and freight paid by shipper valuation.
[3]May include revisions to previously published data.

Source: U.S. Census Bureau.

TABLE 11

SULFUR: WORLD PRODUCTION IN ALL FORMS, BY COUNTRY AND SOURCE[1, 2]

(Thousand metric tons)

Country and source[3]	2009	2010	2011	2012	2013
Australia, byproduct:[e]					
Metallurgy	870	800	800	800	800
Petroleum	60	60	60	60	60
Total	930	860	860	860	860
Brazil:					
Byproduct:					
Metallurgy[e]	322 [4]	322 [4]	322	322	322
Petroleum	136	143 [r]	170 [r]	223 [r]	223 [e]
Frasch	-- [r]	-- [r]	-- [r]	-- [r]	--
Total[e]	457 [r, 4]	465 [r, 4]	492 [r]	545 [r]	545
Canada, byproduct:					
Metallurgy	890	900 [e]	609	638	699
Natural gas, petroleum, oil sands	6,577	6,355	5,914	5,545	5,666
Total	7,467	7,260 [e]	6,523	6,183	6,365
Chile, byproduct, metallurgy	1,658	1,686	1,723	1,681	1,700 [e]
China:[e]					
Byproduct, all sources	4,000	4,100	3,300	3,300	3,400
Elemental	1,000	1,100	1,100	1,200	1,200
Pyrites	4,370	4,400	5,300	5,400	5,900
Total	9,370	9,600	9,700	9,900	10,500
Finland:[e]					
Byproduct:					
Metallurgy	274	275	280	280	280
Petroleum	127	125	133	130	130
Pyrites	154	150	338	330	330
Total	555	550	751	740	740
France, natural gas and petroleum:[e]	650	650	650	650	650
Germany, byproduct:					
Metallurgy	2,137	2,266	2,394	2,373	2,380 [e]
Natural gas and petroleum	1,623	1,447	1,514	1,445	1,500 [e]
Total	3,760	3,713	3,908	3,818	3,880 [e]
India:[e]					
Byproduct:					
Metallurgy (from fertilizer plants)	1,000	1,000	1,000	1,000	1,000
Natural gas and petroleum	1,400	1,400	1,400	1,400	1,400
Pyrites	31	31	30	30	30
Total	2,430	2,430	2,430	2,430	2,430
Iran, byproduct:[e]					
Metallurgy	70	80	80	90	90
Natural gas and petroleum	1,500	1,700	1,700	1,800	1,800
Total	1,570	1,780	1,780	1,890	1,890
Italy, byproduct:[e]					
Metallurgy	90	90	90	90	90
Petroleum	650	650	650	650	650
Total	740	740	740	740	740
Japan, byproduct:					
Metallurgy	1,350	1,400	1,450	1,500	1,500 [e]
Petroleum	1,864	1,892	1,755	1,747	1,800 [e]
Total	3,214	3,292	3,205	3,247	3,300 [e]
Kazakhstan, byproduct:[e]					
Metallurgy	300	300	300	300	350
Natural gas and petroleum	2,200	2,400	2,400	2,400	2,500
Total	2,500	2,700	2,700	2,700	2,850

Sese footnotes at end of table.

TABLE 11—Continued

SULFUR: WORLD PRODUCTION IN ALL FORMS, BY COUNTRY AND SOURCE[1, 2]

(Thousand metric tons)

Country and source[3]	2009	2010	2011	2012	2013
Korea, Republic of, byproduct:[e]					
Metallurgy	600	480	480	480	500
Petroleum	900	720	720	720	800
Total	1,500	1,200	1,200	1,200	1,300
Kuwait, byproduct, petroleum[e]	800	820	830	800	820
Mexico, byproduct:[e]					
Metallurgy	700	800	800	800	800
Natural gas and petroleum	1,114 [4]	992 [4]	959 [4]	1,010	1,010
Total	1,810	1,790	1,760	1,810	1,810
Netherlands, byproduct:[e]					
Metallurgy	115	115	115	115	115
Petroleum	400	400	400	400	400
Total	1,000	1,000	1,000	1,000	1,000
Poland:[5]					
Byproduct:					
Metallurgy	257	253	273 [r]	267 [r]	270 [e]
Natural gas	25	25 [e]	24 [r]	25	25 [e]
Petroleum	190	225	235 [r]	260 [r]	260 [e]
Unspecified	1	1	1 [r]	(6) [r]	(6) [e]
Frasch	263	517	657	677	526
Total	735 [r]	1,020 [e]	1,189 [r]	1,229 [r]	1,080 [e]
Qatar, byproduct, natural gas[e]	658 [4]	850	850	850 [r]	850
Russia:[e, 7]					
Byproduct:					
Metallurgy	100	100	200	300	300
Natural gas	6,000	6,000	6,000	6,000	6,000
Petroleum	600	600	600	700	700
Native	50	50	50	50	50
Pyrites	200	200	200	200	200
Total	6,950 [r]	6,950 [r]	7,050 [r]	7,250 [r]	7,250
Saudi Arabia, byproduct, all sources	3,214	3,200 [e]	4,579	4,092	3,900 [e]
South Africa:					
Byproduct:					
Metallurgy, copper, platinum, zinc plants	185	141	174	133 [e]	139 [e]
Petroleum	291	205	163	124 [e]	131 [e]
Pyrites, S content, from gold mines	60	30	--	--	--
Total	536	376	336	257 [e]	270 [e]
Spain, byproduct:[e]					
Coal, lignite, gasification	-- [r]	-- [r]	-- [r]	-- [r]	--
Metallurgy	536	539	539	133 [r, 4]	139 [4]
Petroleum	136 [4]	136	136	124 [r, 4]	131 [4]
Total	672 [r]	675 [r]	675 [r]	257 [r, 4]	270 [4]
United Arab Emirates, byproduct, natural gas and petroleum	2,175	1,829	1,885	1,900 [e]	2,000 [e]
United States, byproduct:					
Metallurgy	749	791	720	586	616
Natural gas	1,220	1,170	1,140	1,040	1,020
Petroleum	6,970	7,150	7,090	7,370	7,580
Total	8,940	9,110	8,950	9,000	9,210
Uzbekistan, byproduct:[e]					
Metallurgy	170	170	170	170	180
Natural gas and petroleum	350	350	350	370	380
Total	520	520	520	540	560
Venezuela, byproduct, natural gas and petroleum[e]	570 [4]	800	800	800	800

See footnotes at end of table.

TABLE 11—Continued

SULFUR: WORLD PRODUCTION IN ALL FORMS, BY COUNTRY AND SOURCE[1, 2]

(Thousand metric tons)

Country and source[3]	2009	2010	2011	2012	2013
Other total	3,370 r	3,440 r	3,250 r	3,360 r	3,360
Of which:					
Byproduct:					
Metallurgy	860 r	955 r	800 r	882 r	885
Natural gas, petroleum, oil sands, undifferentiated	347 r	344 r	275 r	271 r	137
Petroleum	854 r	881 r	928 r	944 r	921
Unspecified	775 r	752 r	747 r	769 r	930
Native[8]	458	470	469	465	449
Pyrites	74	34	35	32	35
Grand total	68,300 r	68,800 r	69,900 r	69,200 r	70,400
Of which:					
Byproduct:					
Coal, lignite, gasification[e]	-- r	-- r	-- r	-- r	--
Metallurgy	13,200 r	13,500 r	13,300 r	12,900 r	13,200
Natural gas	7,900	8,040	8,010	7,910 r	7,900
Natural gas, petroleum, oil sands, undifferentiated	18,500 r	18,300	17,800 r	17,600 r	17,800
Petroleum	14,000 r	14,000 r	13,900 r	14,300 r	14,600
Unspecified	775 r	752 r	747 r	769 r	930
Frasch	263 r	517 r	657 r	677 r	526
Native[9]	1,510	1,620	1,620	1,720	1,700
Pyrites	4,890	4,850	5,900	5,990	6,500
Unspecified	7,210 r	7,300 r	7,880 r	7,390 r	7,300

[e]Estimated. [r]Revised. -- Zero.

[1]Grand totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Includes data available through June 17, 2015.

[3]The term "source" reflects the means of collecting sulfur and the type of raw material. Sources listed include the following: Frasch recovery; native comprising all production of elemental sulfur by traditional mining methods (thereby excluding Frasch); pyrites (whether or not the sulfur is recovered in the elemental form or as acid); 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, oil sand cleaning, and processing of spent oxide from stack-gas scrubbers; and recovery from processing mined is excluded, because to include it would result in double counting. 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 oil 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 is not the original source country of the crude product from which the sulfur is extracted.

[4]Reported figure.

[5]Government of Poland 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.

[6]Less than ½ unit.

[7]Sulfur is believed to be produced from Frasch and as a petroleum byproduct; however, information is inadequate to formulate estimates.

[8]Includes "Belgium, elemental," "Egypt, elemental," and "Ukraine, elemental."

[9]Includes "Belgium, elemental," "China, elemental," "Egypt, elemental," and "Ukraine, elemental."