ARSENIC

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The United States was the world's largest consumer of arsenic in 1996, accounting for about two-thirds of world demand. Domestic apparent demand for arsenic metal and compounds has remained relatively stable over the past 4 years, averaging about 2,000 metric tons of contained arsenic per year. All domestic arsenic requirements were met by imports; arsenic production in the United States was last reported in 1985. On a contained metal basis, arsenic trioxide accounted for 99% of imports in 1996. China, the world's largest producer of both arsenic trioxide and arsenic metal, was the leading source of U.S. imports of both products. Including material shipped through Hong Kong, China accounted for 44% and 84%, respectively, of trioxide and metal imports.

Legislation and Government Programs

Because of the toxicity of arsenic and its compounds, several environmental and workplace regulations proposed or amended during 1996 specify limitations for arsenic releases or exposure levels. In May, the Environmental Protection Agency (EPA) issued rules that raised the minimum level of substance release that requires public notification for 202 substances under the Community Right-to-Know Act of 1986, for its list of extremely hazardous substances (EHS); the list includes four arsenic compounds. However, the reportable quantities for these compounds remained unchanged at the minimum 1 pound per occurrence (U.S. Environmental Protection Agency, 1996b). In July, EPA proposed adding seven groups to the list of industry groups subject to the reporting requirements of the Community Right-to-Know Act, including coal mining, metal mining, and electric utilities. Arsenic compounds were cited as contaminants in coal and oil combustion products at electric powerplants (U.S. Environmental Protection Agency, 1996a).

In July, the Occupational Safety and Health Administration (OSHA), as part of a Presidential directive to remove or revise standards that are out of date, duplicative, or not needed to maintain employee health and safety, proposed revision of medical surveillance requirements for certain workers exposed to inorganic arsenic, including elimination of the semiannual sputum cytology examinations and reduction from semiannual to annual the frequency of required chest x-rays for workers 45 years of age or older or workers having had 10 or more years of exposure to arsenic at levels above the action level. In reevaluating the sputum-cytology provision, OSHA found no studies that addressed the efficacy of this test as a screening tool for lung cancer for employees specifically exposed to inorganic arsenic. Similarly, the efficacy of providing semiannual chest x-rays as a screening tool had not been established (U.S.

Department of Labor, 1996).

Consumption

Overall consumption of arsenic remained relatively unchanged in 1996, for the third consecutive year. Estimated demand for arsenic in wood preservatives, which accounted for about 90% of total arsenic demand, was essentially unchanged from that of 1995, despite growth in the domestic housing industry; housing starts and construction spending rose by about 9% and 4%, respectively. Demand for arsenic by wood preservative formulators in 1995 had been boosted by inprocess construction and restocking by distributors of pressuretreated lumber following the 1994 surge in housing. Arsenic trioxide was consumed in the production of arsenic acid for formulation of chromated copper arsenate (CCA) wood preservatives by the three principal producers of arsenical wood preservatives: Hickson Corp., Conley, GA; CSI, Harrisburg, NC; and Osmose Corp., Memphis, TN. Osmose also produces arsenic acid for the glass industry as a fining agent to disperse air bubbles.

The demand for arsenic metal for nonferrous alloys especially battery-lead alloys, plummeted for the second consecutive year. Consumers, fearing disruption from Chinese suppliers, may have over-brought in 1994, reducing their need for metal purchases in the 2 subsequent years. Some of the surplus metal inventories may have been exported in 1995, accounting for a rise in metal exports. Also, continued growth in market share for maintenance-free automotive batteries, which require little or no arsenic, may be further lowering demand for arsenic metal. Commercial grade arsenic metal 99% pure, is used in lead- and copper-based alloys as a minor additive (0.01% to 0.5%) to increase strength in the posts and grids of lead-acid storage batteries and to improve corrosion resistance and tensile strength in copper alloys. About 15 tons of high-purity arsenic metal, of 99.9999% or higher purity, was used in the manufacture of crystalline gallium arsenide, a semiconducting material used in optoelectronic circuitry, high-speed computers, and other electronic devices.

Arsenic consumed in agricultural uses continued to decline following the EPA's 1993 cancellation of arsenic acid for use as a cotton desiccant. The remaining agricultural use for arsenic was as an herbicide for control of weeds. ISK Bioscience, Mentor, OH, produced the arsenical herbicide monosodium methanearsonate (MSMA) at a plant in Houston, TX.

Prices

Prices for arsenic trioxide are not published. The average customs value for imported arsenic trioxide in 1996 was 22 cents per pound, down by about 2 cents per pound from that of 1995. The decline was attributed mostly to the lower value of some off-grade material imported from Chile for blending with high-purity material. High-purity trioxide from Mexico averaged 33 cents per pound. Prices for high-grade (minimum 99%) arsenic trioxide generally are quoted at an 8- to 12-cent-per-pound premium to low-grade (minimum 95%) arsenic trioxide. Owing to lowered demand and surplus supplies, prices for arsenic metal declined sharply, the Chinese import price averaging 40 cents per pound, down almost 40% from that of 1995.

World Review

Commercial-grade arsenic trioxide was recovered from the smelting or roasting of nonferrous metal ores or concentrates in at least 18 countries. High-arsenic smelter or roaster dusts and residues that usually are not processed to commercial-grade trioxide are recovered in several other countries as well as at plants in countries producing commercial-grade material. This material is frequently stockpiled and could be available for future processing. Ghana is one such country that has the estimated capacity to produce about 9,000 tons per year of crude trioxide from gold roasting operations. Most countries do not report their arsenic production, and world production values have a high degree of uncertainty. China was the world's largest producer as well as the major source of U.S. imports. Chinese production was estimated to have declined sharply in 1996 owing to the combined impact of environmental constraints, treatment of lower arsenic content ores, and weather-related problems. In France, Societe d'Exploitation Pyrometalurgie Salsigne, formed in November 1992, began commercial production of arsenic trioxide in 1993. The company which purchased the gold smelter and roaster formerly operated by Mines et Products Chimiques de Salsigne, has the capacity to produce significant quantities of refined arsenic trioxide. However, the company faced financial difficulties in 1995 and had filed for bankruptcy. Production had been halted by yearend 1995, and the plant remained idle throughout 1996. A second producer, Metaleurop SA, with capacity to produce about 6,000 tons per year of high purity trioxide, reportedly processed some imported crude trioxide from Ghana.

In Chile, production from the roasting of gold-copper ores at the El Indio Mine increased in 1996, countering the decline in Chinese production. U.S. imports from Chile rose more than 270%, making it the second largest source for domestic imports of arsenic trioxide. Included in both imports and production from Chile in 1996 were an estimated 2,000 tons of stockpiled off-grade material, not previously counted as production, that was imported for blending with high-grade trioxide.

Arsenic metal, which accounts for only 3% of world demand for arsenic, was produced by the reduction of arsenic trioxide.

Commercial-grade arsenic metal, 99% pure, accounted for the majority of world arsenic metal production and was produced only in China. High-purity arsenic, 99.9999% pure or greater, for use in the semiconductor industry was produced by about 10 companies. Furukawa Electric Co. Ltd. in Japan and Preussag AG in Germany were believed to be the world's largest producers, with capacities of 30 and 15 metric tons per year, respectively.

Outlook

With the major market for arsenic being the production of arsenical wood preservatives, the demand for arsenic is closely tied to the home construction market, where wooden decks containing arsenical preservatives have become ubiquitous. According to data published by the American Wood Preservative Institute, demand for treated wood rose precipitously in the 5-year period ending in 1988. In 1988, about 450 million cubic feet of wood were treated with waterborne preservatives (98% estimated to be CCA), compared with 300 million cubic feet in 1984. Demand softened in the 1989-91 period before resuming its upward trend. In 1995, the last year for which data are available, the quantity of wood treated with waterborne preservatives, was about 450 million cubic feet, down from about 500 million in 1994. In 1995, waterborne preservatives were used for about 75% of all treated lumber.

The apparent demand for arsenic trioxide in wood preservatives declined slightly in 1996 despite an increase in housing starts. Restocking by wood preservative manufacturers and carry-over from the 13% growth in housing starts in 1994 may have served to boost apparent demand in 1995. Future demand for arsenic is expected to closely follow that for new home construction, although the replacement and renovation markets could increase as a percentage of total market share. The prohibition on use of CCA preservatives in certain applications and the greater acceptance of alternative preservatives could negatively affect future demand.

Despite environmental regulation that has led to global dislocations of production over the past decade, including cessation of production in two historically large producing countries, Sweden and the United States, new suppliers have emerged to fill the voids. Although environmental pressures may continue to cause curtailment of existing capacity, given the abundance of high-arsenic residues from nonferrous metal processing, world supplies of arsenic trioxide are expected to remain adequate to meet projected need. Environmental regulation may, in fact, encourage commercial production from existing stockpiles of noncommercial material.

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TABLE 1
ARSENIC SUPPLY-DEMAND RELATIONSHIPS 1/

(Metric tons, arsenic content)

	1992	1993	1994	1995	1996
U.S. supply:					
Imports, metal	740	767	1,330	557	252
Imports, compounds	23,300	20,900	20,300	22,100	21,200
Total	24,000	21,600	21,600	22,700	21,400
Distribution of U.S. supply:					
Exports 2/	94	364	79	430	36
Apparent demand	23,900	21,300	21,500	22,300	21,400
Estimated U.S. demand pattern:					
Agricultural chemicals	3,900	3,000	1,200	1,000	950
Glass	900	900	700	700	700
Wood preservatives	17,900	16,200	18,000	19,600	19,200
Nonferrous alloys and electronics	800	800	1,300	600	250
Other	400	400	300	400	300
Total	23,900	21,300	21,500	22,300	21,400

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

 ${\bf TABLE~2} \\ {\bf U.S.~IMPORTS~FOR~CONSUMPTION~OF~ARSENICALS~~} 1/$

	199	95	1996		
	Quantity 2/	Quantity 2/ Value		Value	
Class and country	(metric tons)	(thousands)	(metric tons)	(thousands)	
Arsenic trioxide:					
Belgium	786	\$420	579	\$314	
Bolivia			120	55	
Chile	3,210	1,260	8,790	2,930	
China	15,900	8,230	11,000	5,650	
France	2,820	1,550	2,480	1,360	
Hong Kong	1,510	619	1,380	681	
Mexico	3,560	2,560	2,980	2,140	
Philippines	1,080	430	612	231	
United Kingdom	1	2			
Other	195	90	18	20	
Total	29,000	15,200	28,000	13,400	
Arsenic acid:					
Canada			(3/)	2	
Israel	(3/)	3	1	13	
Total	(3/)	3	1	14	
Arsenic metal:					
China	491	709	212	185	
Germany	37	2,000	10	2,110	
Japan	29	1,400	29	1,480	
United Kingdom			(3/)	23	
Other	(3/)	3			
Total	557	4,100	252	3,790	

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

Source: Bureau of the Census.

^{2/} Metal only.

^{2/} Data erroneously reported as "thousand metric tons."

^{3/} Less than 1/2 unit.

TABLE 3 AVERAGE ARSENIC PRICES

(Cents per pound)

	1995	1996
Trioxide, Mexican	33	33
Metal, Chinese	66	40

Source: Calculated from Bureau of the Census import data.

 ${\bf TABLE~4}$ ARSENIC TRIOXIDE: 1/ WORLD PRODUCTION, BY COUNTRY 2/3/

(Metric tons)

Country 4/	1992	1993	1994	1995	1996 e/
Belgium e/	2,000	2.000	2,000	2,000	2,000
Bolivia	633	663	341	362 r/	370
Canada e/	250	250	250	250	250
Chile e/	6,016 5/	6,200	6,300	6,400	9,000
China e/	15,000 r/	14,000 r/	18,000 r/	21,000 r/	15,000
France e/	2,000	3,000	6,000	5,000	3,000
Georgia e/	1,500	1,000	500	400	400
Germany e/	300	300	300	250 r/	250
Ghana e/ 6/	500	500	500	500	500
Iran e/	492 5/	500	500	500	500
Japan e/	50	40	40	40	40
Kazakstan e/	2,000	2,000	1,500	1,500	1,500
Mexico	4,293	4,447	4,400 e/	4,500 e/	4,300
Namibia 7/	2,456	2,290	3,047 r/	1,661 r/	1,100
Peru 8/	644 r/	391 r/	286 r/	285 r/e/	285
Philippines e/	5,000	2,000	2,000	2,000	2,000
Portugal e/	150	150	150	100	100
Russia e/	2,500	2,000	1,500	1,500	1,500
Total	45,800 r/	41,700 r/	47,600 r/	48,200 r/	42,100

e/ Estimated. r/ Revised.

^{1/} Including calculated arsenic trioxide equivalent of output of elemental arsenic and arsenic compounds other than arsenic trioxide where inclusion of such materials would not duplicate reported arsenic trioxide production.

^{2/} World totals and estimated data are rounded to three significant digits; may not add to totals shown.

^{3/} Table includes data available through Apr. 1, 1997.

^{4/} Austria, Hungary, the Republic of Korea, South Africa, Spain, the United Kingdom, and former Yugoslavia have produced arsenic and/or arsenic compounds in previous years, but information is inadequate to make reliable estimates of output levels, if any.

^{5/} Reported figure.

^{6/} Estimated commercial byproduct of gold ore roasting. Does not include additional byproduct production of noncommercial grade material estimated at 4,000 tons in 1992, and up to 9,000 tons per year in 1993-96.

^{7/} Output of Tsumeb Corp. Ltd. only.

^{8/} Output of Empresa Minera del Centro del Perú (Centromín Perú) as reported by the Ministerio de Energía y Minas.