

# ARSENIC

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The United States was the world's largest consumer of arsenic in 1995, accounting for about one-half of world demand. For the second consecutive year, domestic total apparent demand for arsenic metal and compounds remained relatively unchanged. 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 97% of imports. China, the world's largest producer of both arsenic trioxide and arsenic metal, was the leading source of U.S. imports of both products, accounting for 55% and 88%, respectively, of trioxide and metal imports.

## Legislation and Government Programs

In August, the U.S. Environmental Protection Agency (EPA) proposed treatment standards for the land disposal of wastes from wood preserving operations. Wastes from the wood preserving industry had been listed as hazardous in 1990. In the proposed standards, EPA recommended the application of Universal Treatment Standards to these wastes. At the same time that EPA was proposing these standards, it invited comments on wood preservative industry concerns that wastewaters, including drippings reclaimed from catchment pads, were not wastes but were part of the production process, and therefore should receive a variance from the proposed regulation. (Federal Register, v. 60, No. 162, Aug. 22, 1995).

Under provisions of the Clean Air Act Amendments of 1990, EPA was to determine whether regulation of the atmospheric emissions of air toxics by electric utilities is warranted. Air toxics is a category of pollutants that includes both carcinogenic and noncarcinogenic substances. Of the almost 200 hazardous substances targeted, arsenic is believed to present the greatest potential carcinogenic health risk. A study completed in 1994 by the Electric Power Research Institute (EPRI) in collaboration with EPA and the Department of Energy, concluded that nationwide utility emissions of the targeted substances pose no significant health risks to humans. The EPRI study also concluded that a standard value used by EPA to calculate the cancer risk from inhaled arsenic over-estimates the risk by a factor of 3. EPA's risk factor had been based on studies of U.S. worker exposure to arsenic from smelter dust generated by now defunct copper smelters in Montana and Washington. According to EPRI, the EPA risk factors apparently failed to reflect significant revisions to exposure calculations at the Washington smelter. (EPRI Journal, Jan./Feb. 1995). While EPA was to have recommended to Congress whether utilities should be regulated for such emissions by November 1995, no recommendation had been published by yearend.

## Consumption

Overall consumption of arsenic remained relatively unchanged in 1995, for the second consecutive year. Apparent demand for arsenic in wood preservatives, which accounted for about 88% of total arsenic demand, continued its upward trend. However, wood preservative formulators reported a flat year for shipments and attributed the increase in apparent demand to restocking of raw materials. Arsenic trioxide was consumed in the production of arsenic acid for formulation of wood preservatives by the three principal producers of arsenical wood preservatives; Hickson Corp. in Conley, GA; CSI in Harrisburg, NC; and Osmose Corp., in Memphis, TN. Osmose also produces arsenic acid for the glass industry as a fining agent to disperse air bubbles.

Apparent demand for copper metal in nonferrous alloys and electronics declined sharply from the anomalously high 1994 level. Strong demand and curtailed Chinese shipments led to concern over future supply availability and to overstocking by consumers in 1994. Surplus metal inventories may have been reexported in 1995, accounting for a rise in metal exports. Commercial grade arsenic metal, 99% pure, was 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, although historical prices from 1955 to 1991 are listed in the Chemical Economics Handbook, published by SRI International, Menlo Park, CA. Prices for high-grade (minimum 99%) arsenic trioxide generally are quoted at an 8 to 12 cents per pound premium to low-grade (minimum 95%) arsenic trioxide. The average customs value for imported arsenic trioxide in 1995 was 24 cents per pound, while high-purity trioxide from Mexico averaged 33 cents per pound.

Tightness in the arsenic metal market, caused by supply disruptions in China, resulted in the average December 1994 customs price for Chinese arsenic metal surging to 92 cents per pound, compared with an average of only 33 cents per pound during the first 10 months of that year. During the first half of 1995, the tightness eased and prices declined; the customs price averaged 72 cents per pound during the first 6 months of 1995. For the whole year the customs price averaged 66 cents per pound.

## **World Review**

Commercial-grade arsenic trioxide was recovered from the smelting or roasting of nonferrous metal ores or concentrates in at least 18 countries. Several other countries recover high-arsenic smelter or roaster dusts and residues that usually are not processed to commercial grade. Ghana is one such country that has the estimated capacity to produce about 9,000 tons of crude trioxide from gold roasting operations, some of which may be processed to refined trioxide in France. 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 for U.S. imports.

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 Produits Chimiques de Salsigne, has the capacity to produce significant quantities of refined arsenic trioxide. However, the company faced financial difficulties in 1995, and was facing bankruptcy proceedings. Production had been curtailed by yearend 1995. 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.

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, as the market for CCA treated wood matured. 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 1989-92 period before resuming its upward trend. In 1994, the last year for which data are available, about 500 million cubic feet of wood were treated with waterborne preservatives, or almost 80% of all treated lumber.

The apparent demand for arsenic trioxide in wood preservatives was unchanged in 1995 despite a decline in housing starts. Restocking by wood preservative manufacturers and carry-over from the 13% growth in housing starts in 1994, may have served to maintain apparent demand. Future demand for arsenic is expected to closely follow that for new home construction, though 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 impact future demand.

## **OTHER SOURCES OF INFORMATION**

### **U.S. Geological Survey Publications**

Arsenic. Ch. in Mineral Commodity Summaries. 1996  
Gallium. Ch. in 1995. Mineral Industry Surveys Annual Review.

### **U.S. Bureau of Mines Publications**

The Material Flow of Arsenic in the United States, IC 9382  
Gallium and Gallium Arsenide: Supply, Technology, and Uses, IC 9208.

### **Other Sources**

Roskill Information Services Ltd., Arsenic 1992, 8th ed.

TABLE 1  
ARSENIC SUPPLY-DEMAND RELATIONSHIPS 1/

(Metric tons, arsenic content)

	1991	1992	1993	1994	1995
<b>U.S. supply:</b>					
Imports, metal	1,010	740	767	1,330	557
Imports, compounds	20,700	23,300	20,900	20,300	22,100
Industry stocks, Jan. 1	100	--	--	--	--
Total	21,800	24,000	21,600	21,600	22,700
<b>Distribution of U.S. supply:</b>					
Industry stocks, Dec. 31	--	--	--	--	--
Exports 2/	233	94	364	79	430
Apparent demand	21,600	23,900	21,300	21,500	22,300
<b>Estimated U.S. demand pattern:</b>					
Agricultural chemicals	5,000	3,900	3,000	1,200	1,000
Glass	900	900	900	700	700
Wood preservatives	14,300	17,900	16,200	18,000	19,600
Nonferrous alloys and electronics	1,000	800	800	1,300	600
Other	400	400	400	300	400
Total	21,600	23,900	21,300	21,500	22,300

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

2/ Exports for 1991 include compounds; exports for 1992 through 1995 include metal only.

TABLE 2  
U.S. IMPORTS FOR CONSUMPTION OF ARSENICALS 1/

(Thousands metric tons and thousand dollars)

Class and country	1994		1995	
	Quantity	Value	Quantity	Value
<b>Arsenic trioxide:</b>				
Belgium	950	\$537	786	\$420
Chile	3,720	1,680	3,210	1,260
China	15,300	8,630	15,900	8,230
France	2,460	1,420	2,820	1,550
Hong Kong	336	172	1,510	619
Mexico	3,440	2,450	3,560	2,560
Philippines	351	172	1,080	430
United Kingdom	--	--	1	2
Other	257	148	195	90
Total	26,800	15,200	29,000	15,000
<b>Arsenic acid:</b>				
Canada	5	10	--	--
United Kingdom	--	--	(2/)	3
Total	5	10	(2/)	3
<b>Arsenic metal:</b>				
China	1,150	1,020	491	709
Germany	9	1,140	37	2,000
Hong Kong	106	147	--	--
Japan	33	1,060	29	1,400
United Kingdom	1	10	--	--
Other	34	28	(2/)	3
Total	1,330	3,410	557	4,100

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 3  
AVERAGE ARSENIC PRICES

(Cents per pound)

	1994	1995
Trioxide, Mexican	32	33
Metal, Chinese	40	66

Source: Calculated from Bureau of the Census import data.

TABLE 4  
ARSENIC TRIOXIDE: 1/ WORLD PRODUCTION, BY COUNTRY 2/ 3/

(Metric tons)

Country 4/	1991	1992	1993	1994	1995 e/
Belgium e/	2,500	2,000	2,000	2,000	2,000
Bolivia	463	633	663	341 r/	400
Canada e/	236 5/	250	250	250	250
Chile	6,820	6,020	6,200 e/	6,300 e/	6,400
China e/	10,000	14,000	13,000	13,000	13,000
France e/	2,000	2,000	3,000	6,000	5,000
Georgia e/	XX	1,500	1,000	500	400
Germany e/	300	300	300	300	300
Ghana e/ 6/	500	500	500	500	500
Iran	552	492	500 e/	500 e/	500
Japan e/	500	50 r/	40 r/	40 r/	40
Kazakstan e/	XX	2,000	2,000	1,500	1,500
Mexico	4,920	4,290	4,450	4,400 e/	4,500
Namibia 7/	1,800	2,460	2,290	2,300 e/	2,300
Peru 8/	661	607	610 e/	610 e/	610
Philippines e/	5,000	5,000	2,000	2,000	2,000
Portugal e/	200	150	150	150	100
Russia e/	XX	2,500	2,000	1,500	1,500
Sweden e/ 9/	2,500	--	--	--	--
U.S.S.R. e/ 10/	7,000	XX	XX	XX	XX
Total	46,000	44,800 r/	41,000 r/	42,200 r/	41,300

e/ Estimated. r/ Revised. XX Not applicable.

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

3/ Table includes data available through May 2, 1996.

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/ Byproduct of gold ore roasting. Does not include production of significant quantities of noncommercial grade material estimated at 4,000 tons in 1992, and 9,000 tons in 1993-95.

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.

9/ Based on arsenic trioxide exported plus the arsenic trioxide equivalent of the output of metallic arsenic exported.

10/ Dissolved in Dec. 1991.