

ARSENIC

By Daniel Edelstein

The United States was the world's largest consumer of arsenic in 1994, accounting for about one-half of world demand. Domestic demand remained unchanged in 1994; a decline in use for agricultural products was balanced by increased demand for use in wood preservatives and nonferrous alloys. 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 94% 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.

Legislation and Government Programs

Local and state concern over the toxicity of chromated copper arsenate (CCA) wood preservatives led to State restrictions on their use in certain applications. Responding to concern that CCA could leach from timbers and accumulate in invertebrate marine life, New Jersey became the first State to restrict their use in certain marine applications. Effective July 19, 1994, restrictions on the use of CCA pressure-treated wood were imposed along four rivers that are rich in shellfish. Accordingly, CCA treated wood will be prohibited in the construction of new or rebuilt marine structures at marinas containing slips for five or more boats. However, in recognition of a lack of alternative materials, pilings were exempt from the ban.¹ Alternative materials for planking include plastic lumbers and South American hardwood.

Consumption

Consumption of arsenic remained unchanged in 1994, despite a decline in agricultural uses. In 1993, following a negotiated agreement, EPA canceled the registrations of companies producing arsenic acid desiccant for cotton crops. At that time, two companies were producing arsenic acid desiccant, Elf Atochem North America and Volunteer Purchasing Company, Inc.

Demand for arsenic in the wood preservative industry increased during 1994, and accounted for more than 80% of domestic demand. 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, which formerly purchased some arsenic acid, expanded arsenic acid facilities in 1994 to become self-sufficient in acid production. Chromated copper arsenate is the most commonly used arsenic-based wood preservative. Other arsenic-based wood preservatives include ammoniacal copper arsenate (ACA) and fluor chrome arsenate phenol (FCAP).

The remaining agricultural use for arsenic was as an herbicide (MSMA and DSMA) for control of weeds. ISK Bioscience, Mentor, OH, produced the arsenical herbicide monosodium methanearsonate (MSMA) at a plant in Houston, TX. Minor amounts of arsenic acid were consumed in glass manufacturing, as a fining agent to disperse bubbles that tend to form when certain types of glass are produced. 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. Apparent metallurgical demand increased significantly in 1994. Domestic production of automotive batteries increased by more than 13%, accounting for at least some of the increased demand. Potential supply disruptions may also have encouraged inventory building by domestic consumers. About 15 tons of high-purity arsenic metal, 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.

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 are generally quoted at an 8-12 cents per pound premium to low-grade (minimum 95%) arsenic trioxide. The average price for imported arsenic trioxide in 1994 was 26 cents per pound, while high-

purity trioxide from Mexico averaged 32 cents per pound. As well as its higher purity, Mexican trioxide had the advantage of bulk shipping via rail cars; consumers thus avoided having to handle and dispose of contaminated drums. The average customs price for imported Chinese metal, which declined slightly during 1994, rose precipitously at yearend, averaging 92 cents per pound in December. This compared with an average of only 33 cents per pound during the first 10 months of the year. The customs price rise corresponded to industry reports that low prices and flooding had caused closures or cutbacks at several Chinese plants.

World Review

Arsenic was recovered as arsenic trioxide from the smelting or roasting of nonferrous metal ores or concentrates in at least 18 countries. China was the world's largest producer as well as the major source for U.S. imports. In 1991, Ghana first reported production of a small quantity of arsenic trioxide from roasting operations at the newly commissioned Bogosu gold mine. About 1,500 tons of arsenic trioxide production were reported in 1993. In 1992, the Ashanti gold mine became the second arsenic trioxide producer in Ghana. As part of a major mine rehabilitation and expansion project at Ashanti, sulfide ore flotation and roasting capacity were upgraded and an arsenic scrubber installed. By 1993, the scrubber was reported to be recovering 25 tons per day of crude trioxide (9,000 tons per year). Production of trioxide in Ghana reportedly rose to about 9,000 tons in 1993. However, the Ashanti scrubber was reportedly closed during 1994. The majority of Ghanaian trioxide was not believed to be of commercial grade, and hence most production from Ghana has been omitted from the world table. Industry reports indicate that about 3,000 tons of Ashanti crude trioxide were processed to refined trioxide in France.

In France, Societe d'Exploitation Pyrometallurgie 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. 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. Demand for treated wood rose precipitously in the 5-year period ending in 1988, as the market for CCA treated wood matured. In 1989 about 450 million cubic feet of wood were treated with waterborne preservatives (98% estimated to be CCA), compared with 300,000 cubic feet in 1984. In 1993, the last year for which data are available, about 470 million cubic feet of wood were treated with waterborne preservatives, or about 75% of all treated lumber.²

The apparent demand for arsenic trioxide rose during 1994 on the strength of new home construction; housing starts rose by almost 13% in 1994. Future demand for arsenic is expected to closely follow that for new home construction. In the short term, higher interest rates could limit growth in demand. The prohibition on use of CCA preservatives in certain applications, and the greater acceptance of alternative preservatives, could negatively impact future demand.

¹New York Times. Curbs Due on Pressure Treated Wood. July 10, 1994, p. 2.

²Micklewright, James T. Wood Preservation Statistics, 1993, A report to the Wood-Preserving Industry in the United States. May 1994.

OTHER SOURCES OF INFORMATION

U.S. Bureau of Mines Publications

Arsenic. Ch. in Mineral Commodity Summaries 1994.
Gallium in 1994. Mineral Industry Surveys,

Annual Review.

The Material Flow of Arsenic in the United States, IC 9382.

Other Sources

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

TABLE 1
ARSENIC SUPPLY-DEMAND RELATIONSHIPS, 1990-94 1/

(Metric tons, arsenic content)

	1990	1991	1992	1993	1994
U.S. supply:					
Imports, metal	796	1,010	740	767	1,330
Imports, compounds	19,900	20,700	23,300	20,900	20,300
Industry stocks, Jan. 1	100	100	--	--	--
Total	20,800	21,800	24,000	21,600	21,600
Distribution of U.S. supply:					
Industry stocks, Dec. 31	100	--	--	--	--
Exports 2/	149	233	94	364	79
Apparent demand	20,500	21,600	23,900	21,300	21,500
Estimated U.S. demand pattern:					
Agricultural chemicals	4,200	5,000	3,900	3,000	1,200
Glass	800	900	900	900	700
Wood preservatives	14,400	14,300	17,900	16,200	18,000
Nonferrous alloys and electronics	800	1,000	800	800	1,300
Other	300	400	400	400	300
Total	20,500	21,600	23,900	21,300	21,500

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

2/ Exports for 1990 include compounds; exports for 1991 through 1994 include metal only.

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

Class and country	1993		1994	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Arsenic trioxide:				
Belgium	678	\$456	950	\$537
Chile	6,050	2,880	3,720	1,680
China	11,700	6,640	15,300	8,630
France	1,890	1,250	2,460	1,420
Germany	15	26	--	--
Hong Kong	1,650	919	336	172
Mexico	3,910	2,850	3,440	2,450
Philippines	1,150	540	351	172
South Africa, Republic of	120	69	--	--
United Kingdom	17	23	--	--
Other	353	221	257	148
Total	27,500	15,900	26,800	15,200
Arsenic acid:				
Canada	--	--	5	10
Arsenic metal:				
Canada	(2/)	11	--	--
China	691	663	1,150	1,020
Germany	11	932	9	1,140
Hong Kong	17	20	106	147
Japan	47	760	33	1,060
United Kingdom	1	15	1	10
Other	--	--	34	28
Total	767	2,400	1,330	3,410

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines 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)

	1993	1994
Trioxide, Mexican	33	32
Metal, Chinese	44	40

Source: Calculated from Bureau of the Census import data.

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

(Metric tons)

Country 4/	1990	1991	1992	1993	1994 e/
Belgium e/	3,000	2,500	2,000	2,000	2,000
Bolivia	300	463	633	663 r/	670
Canada	485	236	250 e/	250 e/	250
Chile	5,830	6,820	6,020	6,200 e/	6,300
China e/	9,000	10,000	14,000	13,000	13,000
France e/	6,480	2,000	2,000	3,000 r/	6,000
Georgia e/	XX	XX	1,500	1,000	500
Germany e/ 5/	360	300	300	300	300
Ghana e/ 6/	--	500	500 r/	500 r/	500
Iran	382	552	492	500 e/	500
Japan e/	500	500	500	500	500
Kazakhstan e/	XX	XX	2,000	2,000	1,500
Mexico	4,810	4,920	4,290	4,450 r/	4,400
Namibia 7/	1,640	1,800	2,460	2,290 r/	2,300
Peru 8/	500 e/	661	607	610 e/	610
Philippines e/	5,090 9/	5,000	5,000	2,000	2,000
Portugal e/	200	200	150	150	150
Russia e/	XX	XX	2,500 r/	2,000	1,500
Sweden e/ 10/	7,000	2,500	--	--	--
U.S.S.R. e/ 11/	7,800	7,000	XX	XX	XX
Total	53,400	46,000	45,200 r/	41,400 r/	43,000

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/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits; may not add to totals shown.

3/ Table includes data available through Apr. 4, 1995.

4/ Austria, Hungary, the Republic of Korea, the Republic of 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/ All production for Germany in 1990 came from the former Western states.

6/ Byproduct of gold ore roasting. Does not include production of significant quantities of noncommercial grade material estimated at 4,000 tons in 1992, 9,000 tons in 1993, and 9,000 tons in 1994.

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/ Reported figure.

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

11/ Dissolved in Dec. 1991.