

ARSENIC

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As has been the case since 1985, the United States had no domestic production of arsenic in 2000 and, consequently, remained dependent on imports to meet its arsenic needs. Although the United States imported some arsenic metal, most domestic arsenic imports were in compound form, primarily arsenic trioxide. China remained the principal supplier of arsenic and its compounds to the U.S. market.

Legislation and Government Programs

The U.S. Geological Survey (USGS) in 2000 was directly involved in a broad range of national and international studies related to arsenic and its distribution and mobility in the environment. Activities included data collection, long-term assessments, ecosystem analysis, predictive modeling, and process research on the occurrence, distribution, transport, and fate of arsenic as well as the impacts of contaminants on biota. Much of this work was conducted in partnership with other Federal and State agencies.

The location and extent of arsenic occurrence in ground water across the United States was the subject of a USGS map published in 2000 (Focazio and others, 2000). The presence of arsenic in ground water is largely due to minerals dissolving naturally over time as rocks and soils weather. Data on nearly 19,000 samples of potable ground water used to develop the map indicated that the arsenic concentration was nearly always lower than the U.S. Environmental Protection Agency (EPA) standard of 50 micrograms per liter. Additionally, the USGS found that approximately 10% of the samples exceeded the more stringent World Health Organization standard of 10 micrograms per liter. At yearend, the EPA was in the process of designating a new drinking water standard for arsenic.

Additionally, the USGS published a map showing the distribution of arsenic in the Warrior coalfield in Alabama

(Goldhaber and others, 2000). Using data from over 900 chemical analyses contained in the USGS National Coal Resources Data System, the authors found that the Warrior field contained higher levels of arsenic and a suite of other trace elements when compared to the average for all U.S. coal. The map used three-dimensional plots of Warrior coalbeds to show arsenic abundance and concentration.

Consumption

Trade data indicated that the United States, with an estimated demand of more than 24,000 metric tons (t) in 2000, probably remained the world's largest consumer of arsenic. The estimated value of arsenic consumed domestically during the year was approximately \$25 million. More than 95% of the arsenic consumed was estimated to have been in compound form, primarily arsenic trioxide. The largest end use for arsenic trioxide was in the production of wood preservatives. The three principal producers of arsenical wood preservatives were Hickson Corp., Smyrna, GA; Chemical Specialties Inc., Harrisburg, NC; and Osmose Wood Preserving, Inc., Buffalo, NY. Osmose also produces arsenic acid that is used by the glass industry as a fining agent to disperse air bubbles. Arsenic also was used in some herbicides for weed control.

Arsenic metal was used as an additive to improve corrosion resistance and tensile strength in copper alloys and as a minor additive (0.01% to 0.5%) to increase the strength of the posts and grids in some lead-acid storage batteries. An estimated 40 t of high-purity arsenic metal (99.9999%-pure or higher) was used in the manufacture of gallium arsenide, a semiconductor used in various electronic devices including wireless phones and high-speed computers.

Arsenic in the 20th Century

In 1901, the United States began production of arsenic trioxide, with an output of approximately 270 metric tons. Previously, the U.S. was import dependent, relying on shipments from Canada and Europe. U.S. imports of arsenic metal, arsenic trioxide, and arsenic sulfides in 1901 totaled 3,170 tons. Arsenic was used primarily as a herbicide, insecticide, and pesticide. During the century that followed, U.S. arsenic production and use changed significantly. For a number of years, the United States was the world's largest arsenic producer. Because of its toxic nature, however, various rules and regulations were enacted, especially in the 1970s, to eliminate or curtail human exposure to arsenic.

Consequently, U.S. production of arsenic declined significantly, from a high of 32,700 tons in 1944 to 2,200 tons in 1985, when the sole domestic refiner ceased production.

By the end of the century, the United States no longer produced arsenic and was import dependent. About 20,000 to 30,000 tons per year of arsenic was imported in the late 1990s, mostly in the form of arsenic compounds. During 2000, China was the largest supplier of arsenic to the United States, accounting for most imports of arsenic trioxide. Nearly all of the arsenic consumed domestically was used as a preservative in the production of pressured-treated wood.

World Review

Arsenic trioxide was recovered from the smelting or roasting of nonferrous metal ores or concentrates in at least 16 countries in 2000. High-arsenic smelter or roaster dusts and residues that usually are not processed to commercial-grade trioxide were recovered in several other countries as well as at plants in countries producing commercial-grade material. Much of this material was stockpiled and could be available for future processing. Most countries did not report their arsenic production, and world production values had a high degree of uncertainty. China apparently remained the world's largest producer in 2000.

Commercial-grade (99%-pure) arsenic metal, produced through the reduction of arsenic trioxide, accounted for most world arsenic metal output. China accounted for nearly all the world's production of commercial-grade arsenic metal.

Worldwide, approximately 10 companies produced high-purity arsenic metal for use in the semiconductor industry.

Outlook

Despite environmental regulations that led to global disruption of production during the last decades of the 20th century, new sources of supply have emerged to fill the void. Given the abundance of arsenic in various waste streams, including nonferrous metal processing, world supplies of arsenic trioxide are expected to remain adequate to meet projected needs.

Because most arsenic is consumed as a compound in the production of arsenical wood preservatives used in home construction and renovation, arsenic demand is expected to correlate with changes in this market. In the short term, prohibitions on the use of arsenical wood preservative in certain applications is not expected to have any significant impact on demand. However, these prohibitions combined with the greater acceptance of alternative preservatives may reduce long-

term demand.

Continued growth in the use of maintenance-free automotive batteries that require little or no arsenic will lower the demand for arsenic metal in this application; this decline, however, is likely to be offset somewhat by the consumption of arsenic to manufacture semiconductors.

References Cited

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GENERAL SOURCES OF INFORMATION

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TABLE 1
ARSENIC SUPPLY-DEMAND RELATIONSHIPS 1/

(Metric tons, arsenic content)

	1996	1997	1998	1999	2000
U.S. supply:					
Imports, metal	252	909	997	1,300	830
Imports, compounds	21,200	22,800	29,300	22,100	23,600
Total	21,400	23,700	30,300	23,400	24,500
Distribution of U.S. supply:					
Exports 2/	36	61	177	1,350	41
Apparent demand	21,400	23,700	30,100	22,000	24,400
Estimated U.S. demand pattern:					
Agricultural chemicals	950	1,400	1,500	1,100	1,000
Glass	700	700	700	700	700
Wood preservatives	19,200	20,000	27,000	19,000	21,000
Nonferrous alloys and electronics	250	900	1,000	1,300	800
Other	300	300	300	300	300
Total	21,400	23,700	30,100	22,000	24,000

r/ Revised.

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

2/ Metal only.

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

Class and country	1999		2000	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Arsenic trioxide:				
Belgium	724	\$429	576	\$356
Bolivia	280	159	212	118
Canada	--	--	1	2
Chile	8,870	3,340	9,110	3,620
China	15,500	8,380	15,400	7,800
France	1,410	862	1,340	871
Germany	3	34	4	15
Hong Kong	70	42	406	232
Mexico	1,680	1,090	1,900	1,330
Morocco	148	90	2,180	1,150
Spain	--	--	--	--
Switzerland	--	--	--	--
Vietnam	437	251	--	--
Total	29,100	14,700	31,100	15,500
Arsenic acid: France	4	24	--	--
Arsenic metal:				
China	1,240	1,600	612	694
Germany	16	3,210	21	3,410
Hong Kong	--	--	41	36
Japan	45	3,580	157	5,660
Taiwan	--	--	--	--
United Kingdom	(2/)	7	(2/)	2
Total	1,300	8,390	830	9,800

--Zero.

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

2/ Less than 1/2 unit.

Source: U.S. Census Bureau.

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

(Metric tons)

Country 4/	1996	1997	1998	1999	2000 e/
Belgium e/	2,000	2,000	1,500	1,500	1,500
Bolivia	255	282	284	437 r/	280
Canada e/	250	250	250	250	250
Chile	8,000	8,350	8,400	8,000 e/	8,200
China e/	15,000	15,000	15,500	16,000	16,000
France e/	3,000	2,500	2,000	1,000	1,000
Georgia e/	400	400	400	400	400
Germany e/	250	250	200	200	200
Ghana 5/	5,443	4,577	5,000	7,000 r/ e/	3,000
Iran e/	500	492 r/	500	500	500
Japan e/	40	40	40	40	40
Kazakhstan e/	1,500	1,500	1,500	1,500	1,500
Mexico	2,942	2,999	2,573	2,419 r/	2,400
Namibia 6/	1,559	1,297	175	--	--
Peru 7/	111	103	122	120 e/	120
Portugal e/	100	50	50	50	50
Russia e/	1,500	1,500	1,500	1,500	1,500
Total	42,900	41,600	40,000	40,900 r/	36,900

e/ Estimated. r/ Revised. -- Zero.

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

2/ World totals and estimated data have been rounded to no more than three significant digits; may not add to totals shown

3/ Table includes data available through March 30, 2001.

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

5/ Production ceased in mid-2000. Ashanti Goldfields Ltd. roaster closed.

6/ Output of Tsumeb Corp. Ltd. only; the mine closed in 1996 and the smelter in April 1998.

7/ Output of Empress Minera del Centro del Perú (Centromín Perú) as reported by the Ministerio de Energía y Minas.