

BISMUTH

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Domestic consumption of bismuth increased moderately in 1994. The domestic use pattern was similar to that for 1993, but with increases in all three major categories: chemicals, fusible alloys, and metallurgical additives. Chemical uses continued to account for more than 50% of consumption.

There was increasing interest in using bismuth as a nontoxic substitute for lead in several applications. Applications such as bismuth oxide in the fire assaying of precious metals, bismuth ceramic glazes, and bismuth shotgun pellets have been implemented. Phase I of the American Foundrymen's Society/U.S. Department of Commerce research has been completed. This work indicates that combinations of bismuth and selenium have good potential for replacing lead in certain brasses for many plumbing component applications.

Domestic consumption and production data are collected through a voluntary survey. Of the 50 firms that received the consumption form in 1994, 70% responded. The respondents accounted for 84% of the bismuth consumption figure for the United States. The amount used by the non-respondents was estimated on the basis of reports from prior years or from other sources.

Legislation and Government Programs

The Defense Logistics Agency (DLA), which maintains the National Defense Stockpile (NDS), sold 144,513 kilograms of bismuth from the Stockpile on September 14, 1994. This represented the total amount allocated for disposal in fiscal year 1994, which ended September 30, 1994. The DLA was authorized to dispose of another 136,000 kilograms of bismuth in fiscal year 1995. At the first offering on October 19, 1994, all bids were rejected by DLA as being too low. The Stockpile inventory on December 31, 1994, was 504,724 kilograms.

The U.S. Fish and Wildlife Service approved the use of 97% bismuth-3% tin shot for waterfowl hunting for the 1994-95 hunting season. The "conditional approval," was granted on the basis of initial testing which found that the shot was not toxic when ingested by waterfowl. The bismuth-tin shot is the first alternative to steel shot, which replaced lead for

waterfowl hunting several years ago. The approval may be extended, based on longer term toxicity tests.¹

Production

ASARCO Incorporated was the only domestic producer of primary bismuth. Production data are not published to avoid disclosing company proprietary information. Several firms recover bismuth from fusible alloy scrap. Secondary production data were not available.

Consumption

Domestic consumption increased moderately over that of 1993. The demand pattern remained similar to the one in 1993, with chemical uses accounting for over 50% of consumption.

The best known chemical use is that of bismuth subsalicylate, the active ingredient in over-the-counter stomach remedies. Other bismuth pharmaceuticals were used to treat burns, stomach ulcers, intestinal disorders, and for veterinary applications. Other bismuth chemical and compound uses included widely varying applications, such as pearlescent pigments in cosmetics and paints, fire assaying, ceramic glazes, varistors, and superconductors.

Bismuth metal use is categorized by fusible alloys, metallurgical additives, and other uses. Fusible (low melting point) alloys are combinations of bismuth and other metals such as cadmium, gallium, indium, lead, and tin. Applications include holding parts or lenses for machining or grinding, solders, fire sprinkler triggering mechanisms, and fuel tank safety plugs.

Bismuth is added to aluminum, copper, and steel to improve machinability. It is also added to malleable iron to prevent the formation of graphite flakes.

The discovery of an inappropriate accounting procedure resulted in revisions to U.S. Bureau of Mines figures for bismuth consumption for recent years. The error caused domestic bismuth consumption to be overreported by about 12% for the period covered in this survey, 1990-94. The revised figures are shown in table 1.

Prices

The domestic dealer price averaged \$3.25 per pound for the year. The price was about \$2.50 per pound during the first and second quarters, showing very little change since 1992. The price was increased rapidly to \$4.10 per pound in July 1994 in response to concerns over possible shortages, particularly due to decreased shipments from China. It was held steady until late December when it was lowered to \$4.00 per pound.

Foreign Trade

Imports for consumption of bismuth increased 25% by weight and 54% by value compared with those of 1993. Mexico and Belgium remained the largest suppliers to the United States. Imports from third ranked Canada increased dramatically, while those from China decreased significantly, dropping it from the third largest supplier in 1993 to sixth in 1994. Peru and the United Kingdom rounded out the top five suppliers in 1994.

Exports more than doubled by weight and increased by 34% in value in 1994 compared with those of 1993.

World Review

Usually bismuth is a byproduct of lead production. The Tasna Mine in Bolivia is the world's only significant primary source of bismuth. This mine has been closed since 1985, but the owners have obtained promising results from studies of the feasibility of reopening. Ore reserves of 700,000 metric tons, grading 1.7% bismuth, 0.6% copper, 0.3% tin, and 1.5 grams per ton of gold have been reported. The mine could be reopened late in 1995.

Current Research and Technology

A study and the first phase of experimental measurements have been completed to determine the feasibility of replacing lead with a bismuth/selenium combination in red brass (copper, tin, zinc, lead) in order to reduce possible toxicity from plumbing components. This work was organized, administered, and conducted by the American Foundrymen's

Society, based in Des Plaines, Illinois, and the foundry industry and was supported by a grant from the Department of Commerce as well as contributions by the companies.

The study indicated an adequate supply of bismuth if it were used at a level of not more than 2% in the red brasses and also that the supply would increase significantly if the price did.

In the experimental phase, environmental characteristics as well as the foundry behavior, mechanical properties, and machinability characteristics were measured. The new alloys had slightly higher melting temperatures. Dross rates were somewhat higher, and the ductility of the new alloys was a little lower, but the tests indicated that the experimental alloys had the same or better properties in all other respects.²

A phase II program of more detailed experiments has been proposed to further verify the ability of bismuth/selenium to replace lead in this application.³

Outlook

The outlook for bismuth remains optimistic, especially as more development occurs in the area of nontoxic replacements for lead. Demand has increased slowly in recent years despite this optimism. Since bismuth is mainly a byproduct of lead, a rapid increase in supply is not likely, especially as the total consumption of lead remains somewhat flat. Some relief would be provided by the resumption of production at the Tasna Mine in Bolivia, the only significant primary source of bismuth.

¹Cohn, L. Bismuth-Tin Shot Receives Nod from Wildlife Agency. *American Metal Market*, v.103, no. 7, Jan. 10, 1995, pg. 5.

²Twarog, D. Modified Red Brass with Bismuth and Selenium Research, Final Report, American Foundrymen's Society, Des Plaines, IL, Mar., 1995.

³Twarog, D. Modified Red Brass with Bismuth/Selenium Phase II, American Foundrymen's Society, Des Plaines, IL, May, 1995.

TABLE 1
SALIENT BISMUTH STATISTICS 1/

(Metric tons)

	1990	1991	1992	1993	1994
United States:					
Consumption	1,120 r/	1,260 r/	1,300 r/	1,300 r/	1,470
Exports 2/	122	75	90	70	160
Imports for consumption	1,610	1,410	1,620	1,330	1,660
Price, average, domestic dealer, per pound	\$3.56	\$3.00	\$2.66	\$2.50	\$3.25
Stocks, Dec. 31: Consumer	331 r/	247 r/	272 r/	323 r/	297
World:					
Mine production (metal content) 3/	3,440 r/	3,230 r/	2,740 r/	3,090 r/	3,020 e/
Refinery production 3/	4,190 r/	4,010 r/	3,670 r/	4,240 r/	4,100 e/

e/ Estimated. r/ Revised.

1/ Previously published and 1994 data are rounded by the U.S. Bureau of Mines to three significant digits.

2/ Includes bismuth, bismuth alloys, and waste and scrap.

3/ Excludes the United States.

TABLE 2
BISMUTH METAL CONSUMED IN THE UNITED STATES, BY USE 1/

(Metric tons)

Use	1993	1994
Chemicals 2/	750 r/	841
Fusible alloys	256 r/	276
Metallurgical additives	232 r/	325
Other 3/	59	26
Total	1,300 r/	1,470

r/ Revised.

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/ Includes industrial and laboratory chemicals, cosmetics, and pharmaceuticals.

3/ Includes other alloys and experimental uses.

TABLE 3
U.S. EXPORTS OF BISMUTH, BISMUTH ALLOYS, AND WASTE AND SCRAP, BY COUNTRY 1/

Country	1993		1994	
	Quantity (kilograms)	Value (thousands)	Quantity (kilograms)	Value (thousands)
Belgium	38,500	\$57	54,900	\$98
Brazil	--	--	113	4
Canada	16,800	281	44,400	782
China	--	--	20,400	36
Costa Rica	969	12	--	--
France	140	13	--	--
Honduras	--	--	8,390	26
Hong Kong	--	--	4,150	17
India	--	--	247	3
Indonesia	100	5	--	--
Ireland	264	11	309	3
Japan	6,710	223	965	12
Korea, Republic of	54	3	200	3
Netherlands	--	--	18,800	17
Singapore	5,020	162	495	7
South Africa, Republic of	--	--	2,000	7
Taiwan	872	9	--	--
Thailand	--	--	272	4
United Kingdom	642	7	4,290	29
Other	39	7	119	12
Total	70,100	790	160,000	1,060

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.

Source: Bureau of the Census.

TABLE 4
U.S. IMPORTS FOR CONSUMPTION OF METALLIC BISMUTH, BY COUNTRY 1/

Country	1993		1994	
	Quantity (kilograms)	Value (thousands)	Quantity (kilograms)	Value (thousands)
Belgium	275,000	\$1,440	512,000	\$3,150
Canada	40,600	194	145,000	743
China	264,000	1,240	80,100	543
Germany	849	50	5,890	78
Japan	--	--	1,670	81
Kazakhstan	69,300	211	38,500	128
Mexico	479,000	2,100	665,000	3,850
Morocco	--	--	158	3
Peru	117,000	564	115,000	637
Spain	7,240	92	3,010	36
Taiwan	500	6	--	--
United Kingdom	80,300	351	95,200	368
Other	--	--	77	32
Total	1,330,000	6,250	1,660,000	9,650

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.

Source: Bureau of the Census.

TABLE 5
BISMUTH: WORLD MINE AND REFINERY PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country	Mine output, metal content					Refined metal				
	1990	1991	1992	1993	1994 e/	1990	1991	1992	1993	1994 e/
Australia e/	400	400	--	--	--	--	--	--	--	--
Belgium e/	--	--	--	--	--	1,000 r/	800 r/	800 r/	950 r/	900
Bolivia	68	--	--	--	--	137	--	17 r/	16 r/	16 3/
Bulgaria e/	45	40	40	40	40	45	40	40	40	40
Canada 4/	87	65	224	144 r/	131 3/	--	--	--	--	--
China e/	1,060 r/	1,040 r/	820 r/	740 r/	700	1,060 r/	1,260	1,060 r/	1,050 r/	1,000
France e/	70	50	--	--	--	--	--	--	--	--
Italy	--	--	--	--	--	34	45	20	5 r/	5
Japan 5/	133	138	159	149 r/	150	442	461	530	497 r/	500
Kazakhstan e/	XX	XX	35	30	25	XX	XX	45 r/	40 r/	35
Korea, Republic of 5/	79	42	9	5	--	79	42	9	5	--
Mexico 6/	733	651	807	908 r/	900	549	500 e/	550 e/	650 e/	650
Peru	555 e/	610 e/	550 e/	1,000 r/ e/	1,000	521	576	418	937 r/	900
Romania e/	40	55	50	40	40	35	50	50	35	35
Russia e/	XX	XX	5	4	4	XX	XX	10 r/	9 r/	9
Serbia and Montenegro 7/	XX	XX	10 r/	5 r/	5	XX	XX	20 r/	10 r/	10
Tajikistan e/	XX	XX	20 r/	15 r/	10	XX	XX	-- r/	-- r/	--
U.S.S.R. e/ 8/	80	70	XX	XX	XX	80	70	XX	XX	XX
United Kingdom e/	--	--	--	--	--	125	100	100	--	--
United States	W	W	W	W	W	W	W	W	W	W
Uzbekistan e/	XX	XX	15	10	10	--	--	--	--	--
Yugoslavia 7/ 9/	85	70	XX	XX	XX	85	70	XX	XX	XX
Total	3,440 r/	3,230 r/	2,740 r/	3,090 r/	3,020	4,190 r/	4,010 r/	3,670 r/	4,240 r/	4,100

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data; excluded from "Total." XX Not applicable.

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/ Table includes data available through Apr. 18, 1995. Bismuth is produced primarily as a byproduct of other metals, mostly lead; Bolivia is the sole producer of primary bismuth.

3/ Reported figure.

4/ Figures listed under mine output are the metal content of concentrates produced.

5/ Mine output figures have been estimated based on reported metal output figures.

6/ Refined metal includes Bi content of imported smelter products.

7/ All production in Yugoslavia for 1990-91 came from Serbia and Montenegro.

8/ Dissolved in Dec. 1991.

9/ Dissolved in Apr. 1992.