MERCURY

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In 2004, mercury was produced in the United States as a byproduct of domestic gold processing, mainly in Nevada, and from recycling obsolete products that contain mercury. Data on domestic primary and secondary production are not available. Mercury was reclaimed and recycled from a diminishing supply of end-of-life mercury-containing products that mainly included automobile convenience switches, dental amalgam, fluorescent lamps, laboratory/medical devices, and thermostats. Some mercury was also recycled in-plant as home scrap by the chlorine-caustic soda industry, which was the largest domestic user of mercury. An average of 115 metric tons (t) of replacement mercury was purchased annually by the chlorine-caustic soda industry for the period 1996-2002 (Arthur E. Dungan, Vice-President, The Chlorine Institute, written commun., June 15, 2003). Purchase of this replacement mercury indicates that some mercury may have been landfilled in the United States or abroad as industrial waste, lost through evaporation to the environment, or trapped within pipes in the plant. The overall market shift toward nonmercury alternatives for chlorine-caustic soda production and other mercury applications continued owing to global human health and environmental concerns about anthropogenic mercury releases. Mercury imports totaled 92 t, and exports totaled 278 t in 2004. Chile (60 t) and Germany (24 t) were the leading sources of domestic imports, and India (63 t), Mexico (64 t), Peru (47 t), and Vietnam (79 t) were the principal destinations of exports in 2004. There were no mercury mines operating in the United States, and the last mine to produce mercury as its principal product, the McDermitt Mine in Nevada, closed in 1992. Mercury may have been produced, however, as a byproduct of copper, gold, lead, and silver mining and processing. Data on mercury as a byproduct from these sources were not available. At yearend 2004, the U.S. Defense National Stockpile (NDS) contained 4,436 t of mercury.

Mercury prices rose dramatically in 2004. The average price of mercury, which was approximately $150 per flask from 2000 through 2003, rose sharply to $650 per flask in the third quarter of 2004 and, by the second quarter of 2005, was $800 per flask (Platts Metals Week, 2005). This rise in price was due to the combined effects of a diminished supply of mercury from the recycling of mercury-containing products, the rise in gold prices that stimulated the use of mercury for artisanal gold production, and a decline in world mine production of mercury.

Legislation and Government Programs

The human nervous system, brain, and kidneys, as well as fetal development may be adversely affected by exposure to mercury. In recent years, there has been much national and international attention focused on reducing anthropogenic releases of mercury and studying the pathways for bioaccumulation of mercury in humans. A link between autism in children and mercury in the environment or in vaccines remained controversial (Harris and O'Connor, 2005; Hightower, 2001§[1]). In response to rising concerns, the American Medical Association resolved that the mercury content of foods, especially fish, be labeled and that physicians educate their patients as to the potential dangers of mercury ingestion (McCaffree, 2003§). For example, research showed that for pregnant women, mercury in the umbilical cord blood may be 70% higher than the mercury content of the mother's blood (Mahaffey, 2004§). Because one in six women of childbearing age in the United States had unsafe blood mercury levels, it was estimated that more than 600,000 babies were born each year at risk of mercury-related health problems (Physicans Committee for Responsible Medicine, 2004).

In March, the U.S. Environmental Protection Agency (EPA) issued the clean air mercury rule to cap and reduce mercury emissions for coal-fired powerplants, and the Clean Air Interstate rule to reduce air pollution that crosses interstate boundaries. The combination of rules was expected to reduce utility emissions of mercury from the Nation's 11,000 coal-fired powerplants by 70%, from 48 metric tons per year (t/yr) in 2002 to 15 t/yr. These rules were issued as interim tools prior to passage of the President's proposed Clear Skies legislation, which had been introduced several times beginning in 2002, and which aimed to cap emissions of sulfur dioxide, nitrogen oxides, and mercury from power generators and permanently cap and reduce mercury emissions from coal-fired powerplants (U.S. Environmental Protection Agency, 2005§).

In 2004, the Office of Solid Waste, U.S. Environmental Protection Agency, met with dental amalgam producers, environmental service companies, recycling companies, and representatives of the American Dental Association (ADA) to advance the proper handling and recycling of mercury-containing amalgam waste that was generated at more than 100,000 dental offices in the United States. This collaborative effort, the National Partnership for Environmental Priorities Program, was intended to promote responsible management of amalgam waste by use of a specific dental office collection device ("gray bag") to store dental waste until it could be removed for recycling. The EPA and the ADA encouraged voluntary participation in the "gray bag" recycling effort to track and prevent amalgam waste from being landfilled and to avoid legislation and mandatory adherence to amalgam collection and recycling. Dental amalgam uses mercury, and the quantity of mercury released into the environment by removal

[1]References that include a section mark (§) are found in the Internet References Cited section.

or replacement of mercury amalgam fillings was unknown (District of Columbia Dental Society, 2003§). The Watson-Burton bill (H.R. 1680—Mercury in Dental Filling Disclosure and Prohibition Act), introduced in 2003, sought to prohibit the introduction of mercury for dental fillings into interstate commerce after 2008 (Burton, 2004§). No action on the bill was reported in 2004. Some public health organizations, however, required that dental amalgam be used (Carlton, 2004§). The use of amalgam was declining, and composite resin substitutes were available.

At yearend 2004, the Defense Logistics Agency (DLA) held an inventory of 4,436 t of mercury at several sites in the United States. Mercury sales were suspended in 1994 in response to environmental concerns. In early 2004, the DLA indicated that the mercury would be consolidated at one site (Joseph Johnson, specialist, Defense Logistics Agency, written commun., April 30, 2004).

Production

Mercury was produced in the United States as a byproduct of domestic gold mining and processing operations. Additional mercury was recovered from domestic and imported byproduct mercury and mercury-containing scrap. Since the closure of the McDermitt Mine in Nevada in 1992, mercury has not been mined as a principal product in the United States. The mine site is now included on a list of EPA superfund sites (Toxic Alert, 2003§).

In the United States, the largest amount of byproduct mercury was produced in Nevada and came from retorting the gold-silver-mercury precipitate that was recovered after cyanide was used to treat the gold ore. Calomel (HgCl), which is a mineral and a mercury-bearing byproduct released during gold processing, was captured by pollution-control devices at roasters and retorted to recover mercury (Bethlehem Apparatus Co., 2004§). Data on the amount of byproduct mercury produced are not available. Sales of mercury retort systems indicate that byproduct mercury may have been recovered from ore processed at a minimum of six mines in Nevada (Summit Valley Equipment & Engineering, Inc., 2001§).

Consumption

Domestic mercury consumption was estimated to be 33% to 50% for chlorine manufacture, 33% to 50% for electronics, and the balance for other uses, such as dental applications, fluorescent lamps, and switches. In the United States, the mercury cell chlorine-caustic soda industry purchased 115 t/yr of mercury from 1996 to 2002 to replace mercury lost in the chlorine manufacturing process. This mercury may have been lost through evaporation, landfilled in the United States, shipped abroad for landfill as industrial waste or as amalgam (whether or not chemically defined), or contained within pipes in the plant.

The total amount of mercury imported in 2004 was 92 t, which was double the 46 t of mercury imported in 2003. Chile (60 t) and Germany (24 t) were the principal sources. The increase in imports of mercury from Chile to 60 t in 2004 from 0 t in 2003 may be owing to environmental considerations that resulted in the recovery of byproduct mercury from mercury-containing copper ores.

Recycling

Reclamation and recycling of mercury from used mercury-containing products was vital to the continued, though declining, use of this metal. Mercury was reclaimed from a declining supply of mercury-containing waste by treatment in multistep, high-temperature retorts in which the mercury is volatized and then condensed for purification and sale (Brooks and Matos, 2005§). Some mercury-containing waste, such as chlorine-caustic soda sludge or mercury-containing debris may have been landfilled in the United States or in Canada. Chlorine-caustic soda sludge was included on a list of waste types accepted at a dedicated placement site in Canada (Stablex Canada Inc., 2004§). In 2003, 1,660 t of undefined amalgam was exported, mainly to Canada (455 t) and Mexico (812 t) (table 3). In 2004, only 603 t of amalgam were exported, mainly to Canada (49 t) and Mexico (194 t).

The domestic mercury recycling industry was concerned that the environment was threatened by exports of mercury-containing waste that was shipped to landfills in Canada without retorting or reclamation of the contained mercury. A 1994 EPA regulation indicated that treatment standards for all mercury-containing debris in excess of 60 millimeters were to be suspended. This unclear regulation, which is known in the hazardous waste and recycling industry as the “debris loophole,” permits unquantified amounts of secondary mercury or mercury-containing products to be landfilled in the United States (U.S. Environmental Protection Agency, 1994; Richard C. Fortuna, environmental consultant, written commun., October 8, 2004). Landfilling of mercury-containing material without reclamation of the mercury by retorting was a very serious environmental and recycling industry concern (Peder Larsen, attorney, Mercury Waste Solutions, written commun., November 7, 2004).

Some mercury was recycled “in-plant” by the chlorine-caustic soda industry, the chief end use of mercury in the United States. The yearly purchase of replacement mercury by the chlorine-caustic soda industry indicates that some mercury was released from these plants. Diaphragm and membrane cells are nonmercury alternatives for chlorine and caustic soda production (Roskill Information Services Ltd., 1990, p. 65). The ultimate closure of the nine remaining mercury-based chlorine-caustic soda plants could make approximately 3,000 t of mercury available for recycling (Raloff, 2003§).

Mercury used in tilt switches in cars, fluorescent lamps, and thermostats was of environmental concern because of the potential for mercury releases during demolition, scrapping, and waste treatment. Mercury was also recovered and recycled from unbroken fluorescent lamps.

The major companies that recycled mercury in 2004 included AERC.com, Inc., Allentown, PA; Bethlehem Apparatus Company, Bethlehem, PA; D.F. Goldsmith Chemical and Metal Corporation, Evanston, IL; Mercury Waste Solutions, Mankato, MN; and Onyx Environmental Services, Lombard, IL. In 2002, 50 companies were listed as mercury recyclers (Mercury Recyclers, 2002§).

World Review

In 2004, world mercury production was estimated to be 1,260 t/yr, which was less than the 2,200 t/yr average world mercury production from 1990 to 2000. Production estimates have a high degree of uncertainty, however, because most companies and countries do not report primary or secondary production data because of environmental and health concerns. In 2004, China (610 t), Kyrgyzstan (300 t), and Spain (150 t) were the apparent leaders in world production of mercury.

In Peru, mercury recovered from gold-silver-mercury precipitates from the Pierina gold mine was shipped to the United States for processing or refining. Handlers of this mercury, including customs agents, received training in the safe handling of mercury (Michael Merry, logistics superintendent, Minera Barrick Misquichilca, oral commun., May 3, 2004). Mercury recovered from the Yanacocha gold mine was also shipped to the United States using strict shipment procedures. Minera Yanacocha S.R.L., owner of the mine, in collaboration with the U.S. Department of Energy's Brookhaven National Laboratory was researching ways to chemically stabilize and encapsulate elemental mercury (Ron Bradburn, process manager, Minera Yanacocha, written commun., June 1, 2005).

Mercury continued to be used in artisanal placer gold mining throughout the world to amalgamate gold flakes, and mercury was released to the environment during mining and amalgam treatment. Artisanal mining continued as an important end use of mercury in many parts of the world including Ghana, Peru, Venezuela, and Vietnam. In 1997, it was estimated that more than 200 t/yr of mercury was released annually through artisanal, or small-scale mining in Latin America (Viega, 1997§). In 2004, processing centers were established in Brazil and Venezuela where artisanal miners could take their gold-mercury concentrates for retorting and recovery of the gold and mercury. The centers reduce health risks to miners, who would commonly burn their amalgam in the open air to drive off the mercury, and limit mercury releases to the environment. In Ghana, artisanal gold miners may inhale the vapors from the heated pots that were used to purify the gold-mercury amalgam. Any mercury discarded in the streams bioaccumulates in fish, which are widely consumed, and may lead to physical and mental problems (Harkinson, 2003§).

As a result of chlorine production, mercury releases in India were estimated to range between 60 to 70 t/yr and 150 to 200 t/yr (Bahuguna, 2003§; Mercury in India, 2003§). The obligatory dismantling of Europe's 47 chlorine plants by 2007 will result in 15,000 t of mercury that will need to be managed, and European exports of mercury will be banned beginning in 2011 (Faversham House Group, 2003§; Zuleica Castilhos, research scientist, Centro de Tecnologia Mineral, Brazil, written commun., June 29, 2005).

Outlook

Global environmental and human health concerns and the use of mercury for artisanal gold production will continue to affect mercury demand and production. Closure of mercury cell chlorine-caustic soda production facilities in Europe, India, South America, and the United States will result in the release of large amounts of mercury for recycling or storage. The reduction of mercury emissions by coal-fired powerplants, copper, gold, and zinc mining companies, stricter controls of mercury use in artisanal gold mining, and careful monitoring of mercury releases by the chlorine-caustic soda industry are expected to lessen releases to the environment. Recycled mercury from mercury cell chlorine-caustic soda plants, byproduct mercury recovered from domestic gold processing, imported mercury from foreign gold operations, and mercury contained in the NDS will be more than adequate to meet domestic needs.

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TABLE 1
SALIENT MERCURY STATISTICS[1]

		2000	2001	2002	2003
United States:	metric tons				
Secondary production, industrial	do.	NA	NA	NA	NA
Imports for consumption	do.	103	100	209	46
Exports	do.	182	108	201	287
Industry stocks, yearend[2]	do.	NA	NA	NA	NA
Industrial consumption	do.	NA	NA	NA	NA
Price, average per flask, free market[3]	dollars per flask	140	140	140	140
World, mine production	metric tons	1,360	1,500	1,490 r	1,410 r

[r]Revised. NA Not available.
[1]Data are rounded to no more than three significant digits, except prices.
[2]Stocks at consumers and dealers not available. Mine stocks withheld to avoid disclosing company proprietary data.
[3]Source: Platts Metals Week.

TABLE 2

U.S. IMPORTS AND EXPORTS OF MERCURY BY COUNTRY[1]

	2003		2004	
Country	Quantity, gross weight (metric tons)	Value (thousands)	Quantity, gross weight (metric tons)	Value (thousands)
Imports:				
Belgium	--	--	(2)	$2
Canada	6	$8	2	15
Chile	--	--	60	119
Germany	19	861	24	1,170
India	1	5	--	--
Israel	--	--	5	46
Peru	19	23	--	--
Spain	--	--	(2)	2
United Kingdom	(2)	18	(2)	3
Total	46	914	92	1,350
Exports:				
Belgium	--	--	2	27
Brazil	7	50	2	20
Canada	5	40	4	28
Chile	--	--	3	11
Ecuador	2	32	--	--
France	3	42	--	--
Germany	4	26	4	85
Guyana	6	32	--	--
Hong Kong	17	75	--	--
India	25	80	63	347
Japan	--	--	1	7
Korea, Republic of	--	--	(2)	8
Malaysia	2	19	1	16
Mexico	35	399	64	860
Netherlands	57	270	--	--
Peru	51	185	47	98
Saudi Arabia	--	--	2	25
Singapore	22	205	--	--
Taiwan	--	--	4	182
United Kingdom	2	21	1	15
Vietnam	40	172	79	546
Other	9	47	2	31
Total	287	1,690	278	2,310

-- Zero.

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

[2]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 3

U.S. IMPORTS AND EXPORTS OF AMALGAMS OF PRECIOUS METALS, WHETHER OR NOT CHEMICALLY DEFINED, BY COUNTRY[1, 2]

Country	2003 Quantity, gross weight (metric tons)	2003 Value (thousands)	2004 Quantity, gross weight (metric tons)	2004 Value (thousands)
Imports:				
Argentina	(3)	$200	(3)	$209
Belgium	(3)	34	(3)	4
Canada	10	16,200	30	18,900
China	1	15	(3)	33
Germany	26	2,180	19	15,700
Ireland	1	2,010	3	16,200
Italy	(3)	121	(3)	175
Japan	2	3,100	1	2,230
Mexico	2	198	3	370
Netherlands	--	--	18	2,680
Russia	(3)	3	4	29,200
South Africa	(3)	248	(3)	209
Spain	--	--	1	88
Switzerland	1	2,190	(3)	3
United Kingdom	(3)	1,730	(3)	14,200
Other	(3)	38	--	--
Total	42	28,200	78	100,000
Exports:				
Australia	12	10,100	6	6,770
Brazil	3	4,510	6	8,270
Canada	455	19,100	49	28,400
China	113	8,000	101	4,300
France	1	371	(3)	648
Germany	1	1,020	3	1,420
India	15	2,260	26	4,840
Ireland	(3)	78	1	637
Japan	(3)	1,840	2	2,170
Mexico	812	60,800	194	79,500
Netherlands	65	3,940	16	6,810
Singapore	2	992	4	3,750
Switzerland	(3)	92	1	1,110
Taiwan	40	1,200	8	1,570
United Kingdom	8	3,690	3	3,160
Other	132	1,140	183	1,730
Total	1,660	119,000	603	155,000

-- Zero.

[1]An amalgam is an alloy of mercury with one or more other metals.

[2]Data are rounded to no more than three significant digits; may not add to totals shown.

[3]Less than ½ unit.

Source: U.S. Census Bureau.

TABLE 4

MERCURY: WORLD MINE PRODUCTION, BY COUNTRY[1, 2, 3]

(Metric tons)

Country	2000	2001	2002	2003	2004
Algeria	216	321	307	176 r	110 e
China[e]	200	190	435	610	610
Finland	76	71	51 r	65	65
Kyrgyzstan	257	300	300	300	300
Mexico[e]	15	15	15	15	15
Morocco[e]	10	10	9	9	9
Russia[e]	50	50	50	50	50
Spain	500	500	300	150	150
Tajikistan[e]	40	40	20	30	30
Ukraine	NA	--	NA	--	--
United States[4]	NA	NA	NA	NA	NA
Total	1,360	1,500	1,490 r	1,410 r	1,260

[e]Estimated. [r]Revised. NA Not available. -- Zero.

[1]World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

[2]Table includes data available through April 29, 2005.

[3]Canada, Chile, and Peru were believed to produce byproduct mercury, but information on their production was inadequate to make reliable estimates.

[4]Data on byproduct mercury are not available.