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MERCURY

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MERCURY

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There were no mercury mines in production in the United States in 2005. The McDermitt Mine in Nevada, the last mine to produce mercury as its principal product, closed in 1992. Mercury was produced in 2005 in the United States as a byproduct of domestic gold and silver processing, mainly in Nevada, and may have been produced as a byproduct of processing other metals. Mercury was also produced from reclaiming and recycling fluorescent lamps and a declining supply of mercury-containing dental amalgam, medical devices, and thermostats. The chlorine-caustic soda industry, the leading domestic user of mercury, recycled some of its mercury in-plant. Data on domestic byproduct and recycled mercury production were not available.

In 2005, mercury imports totaled 212 metric tons (t), and exports totaled 319 t. Peru (128 t) and Chile (31 t) were the leading sources of imported mercury, and the Netherlands (156 t), Mexico (25 t), Spain (21 t), Guyana (19 t), and India (19 t) were the principal destinations for mercury exported in 2005.

Since 1927, the common unit for measuring and pricing mercury has been the "flask," which was set to conform to the system used at Almaden, Spain (Meyers, 1951). One flask weighs 34.5 kilograms, and 1 t of mercury contains approximately 29 flasks.

Legislation and Government Programs

In June, the U.S. Environmental Protection Agency (EPA) sponsored a workshop entitled "Global Partnership for Mercury Management in Artisanal and Small-Scale Gold Mining." Papers were presented on health issues in mining areas that use mercury and nonmercury alternatives for small-scale gold mining. For example, in Guyana, the use of mercury for gold recovery was common; however, because of a proposed ban on mercury use in the gold mining sector, several mercury-free methods, such as gravity concentration, sluice boxes, centrifuges, and shaking tables, were recommended (Viera, 2005, p. 5).

Under current U.S. law, powerplants that emit 10 metric tons per year (t/yr) of a single toxin, such as mercury or arsenic, or 25 t/yr or more of a combination of toxins must install technology that would cut those emissions by 95%. A draft rule proposed by the EPA would lift that requirement from plants that keep their emissions under the 25 t/yr limit. Critics, however, argued that if the draft rule were to be put in place, plants could run their controls at one-half speed and continue to emit toxic elements (Eilperin, 2006).

Mercury has been used as a component of dental amalgam for more than a century, but because of mercury's toxicity, its continued use is controversial. U.S. Government-funded studies on children in New England and Portugal found no evidence that mercury-containing dental fillings cause brain damage or other neurological problems in children (DeRouen and others, 2006§[1]).

At yearend 2005, the Defense Logistics Agency's (DLA) National Defense Stockpile (NDS) held an inventory of 4,436 t of mercury at several sites in the United States. Mercury sales from the NDS stockpile were suspended in 1994 in response to environmental concerns. In early 2004, the DLA indicated that the mercury would be consolidated at one site in Nevada (Joseph Johnson, specialist, Defense Logistics Agency, written commun., April 30, 2004).

Production

Mercury has not been mined as a principal product in the United States since closure of the McDermitt Mine in Nevada in 1992. In 2005, byproduct mercury and calomel (HgCl) were produced at several gold and silver mines in Nevada. Byproduct mercury from gold mines in Chile and Peru was imported, further refined, and sold for domestic use or export. HgCl was captured by pollution-control devices at ore roasters at domestic and foreign smelters to recover mercury for resale (Bethlehem Apparatus Co., 2005§). Data on the amount of byproduct mercury and calomel produced in the United States are not available.

Consumption

For the period 1996 through 2004, an average of slightly more than 100 t of mercury was purchased annually by the chlorine-caustic soda industry (Arthur E. Dungan, Vice President, The Chlorine Institute, written commun., May 13, 2005). Annual purchases of replacement mercury indicate that some mercury-containing industrial waste, described as "amalgam" may have been landfilled in the United States or Canada or lost to the environment. 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.

Only about 200 t of mercury is consumed domestically each year. Despite human health concerns, mercury usage is not carefully tracked, and the U.S. Geological Survey does not canvass for its consumption (Brooks and Matos, 2005§). Therefore, domestic mercury consumption for 2005 was broadly estimated to be 50% for chlorine-caustic soda manufacture and 50% for dental applications, electronics, fluorescent lamps, and switches. Owing to concern for the environment, fluorescent lamps that contain from 40% to 54% less mercury, depending

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

on style of lamp, are now being manufactured (Koninklijke Philips Electronics N.V., 2005§). The chlorine-caustic soda industry purchased an average of slightly more than 100 t/yr of replacement mercury for its mercury cell plants from 1996 to 2005.

Prices

According to Platts Metals Week (2005), mercury prices ranged from a low of $600 per flask in January-February to a high of $950 per flask in March and settled at $700 to $850 per flask in the third and fourth quarters of 2005. Mercury prices were $350 to $555 per flask in 2004. This overall rise in price, especially when compared with 2000-03 when the average price was $140 per flask, correlates with a diminished supply of mercury from recycled mercury-containing products and apparent growth in the global demand for mercury for small-scale gold mining. High gold prices encouraged increased use of mercury for gold recovery by small-scale gold miners worldwide.

Recycling

In 2005, mercury was reclaimed and recycled from automobile convenience switches, dental amalgam, fluorescent lamps, lab/medical devices, and thermostats. No data are available on the amount of mercury recycled. The mercury was reclaimed from these devices by treatment in multistep high-temperature retorts in which the mercury is first volatized and then condensed for purification and sale (Brooks and Matos, 2005§). The major companies that recycled mercury in 2005 included AERC.com, Inc., Allentown, PA; Bethlehem Apparatus Company, Bethlehem, PA; Clean Harbors Environmental Services, Inc., Braintree, MA; D.F. Goldsmith Chemical and Metal Corporation, Evanston, IL; Mercury Waste Solutions, Mankato, MN; and Onyx Environmental Services, Lombard, IL. As many as 50 companies were listed as mercury recyclers in 2002 (Mercury Recyclers, 2002§); however, their role was mainly collection of mercury-containing materials that would be moved on to larger facilities for retorting.

Some mercury used for chlorine-caustic soda manufacture was recycled and reused in-plant. However, unknown amounts of mercury-containing industrial waste from the chlorine-caustic soda plants may have been landfilled in the United States or in Canada instead of being recycled. Chlorine-caustic soda sludge was specifically included on a list of waste types accepted at a dedicated placement site in Canada (Stablex Canada Inc., 2005§). In 2005, a total of 1,160 t of amalgam (not chemically defined) was exported, mainly to Canada (970 t), the United Kingdom (28 t), and Mexico (21 t).

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 United States' nine remaining mercury-cell chlorine-caustic soda plants could make approximately 3,000 t of mercury available for recycling (Raloff, 2003§).

Copper, lead, and zinc processing produce residue and waste that may contain mercury and other byproducts. Collaboration between Oak Ridge National Laboratory and the Colorado School of Mines resulted in a process that separates mercury from sulfuric acid plant sludge at copper smelters. The process involves use of a commercially available rotary vacuum kiln that can produce mercury for recycling as well as a process stream that can also be sold to recover trace amounts of lead, gold, and silver (Berry and others, 2000§).

Foreign Trade

The total amount of mercury imported in 2005 was 212 t, which was more than double the 92 t of mercury imported in 2004. Peru (128 t) and Chile (31 t) were the principal sources. Imports of mercury from Peru increased to 128 t in 2005 from 0 t in 2004 possibly owing to stockpiling of byproduct mercury at gold smelters in Peru before shipment.

World Review

In 2005, world mercury mine production was estimated to be 1,680 t, which was somewhat more than the average amount produced from 2000 to 2004. Production estimates have a high degree of uncertainty, however, because most companies and countries do not report primary (including byproduct) or secondary production data owing to environmental and health concerns. In 2005, China (1,100 t), Spain (250 t), and Kyrgyzstan (200 t) were the apparent leaders in world mine production of mercury. In China, mercury has historically been produced as a byproduct of gold mining and from mercury mines in the Upper Yangtze, Kuniun-Qinling, Sanjiang, and South China metallogenic regions (Lixian and Ruolan, 1992, p. 147).

Mercury use for artisanal or small-scale gold mining is a significant but untracked use of the metal in Ghana, Indonesia, Peru, Venezuela, Vietnam, and elsewhere. The mercury is used to amalgamate gold flakes and may be released to the environment during mining and gold recovery from the amalgam. In 1997, it was estimated that more than 200 t/yr of mercury was released through artisanal or small-scale mining in Latin America (Viega, 1997§). Recent estimates indicated that, in Indonesia alone, up to 60 t/yr of mercury may be lost at individual gold mining concessions, or units, in gold mining areas (Alfred Whitehouse, Director, International Programs, U.S. Department of the Interior, Office of Surface Mining, oral commun., May 16, 2006).

World Industry Structure

Europe.—In April, the European Environmental Bureau (EEB) sponsored an international conference entitled "Towards a Mercury-Free World" in Madrid, Spain, to address global mercury issues. Topics included global mercury production, use, and trade; symptoms of chronic mercury intoxication; mercury in breast milk as a health hazard for infants in gold mining areas; gold mining in the Amazon; and Swedish policy for a mercury-free environment. Attendees included consultants and representatives from Brazilian, Chinese, and European environmental organizations and major mercury producers and consumers (Elena Lymberidi, Zero Mercury Project coordinator,

European Environmental Bureau, written commun., November 15, 2005).

In Europe, there were 80 chlorine-caustic soda plants, and 48 of these were mercury-cell plants. The date for closure of the mercury-cell plants is voluntary but is expected to be no later than 2020. It was estimated that there was 11,500 t of mercury in the cells of the remaining plants (Barrie S. Gilliatt, executive director, Euro Chlor, written commun., November 25, 2005).

Latin America.—Peru was an important producer of byproduct mercury and a significant consumer of mercury. At Barrick's Pierina gold mine in northern Peru, mercury was retorted from Merrill-Crowe precipitates and then shipped to the United States for processing or refining (Michael Merry, logistics superintendent, Minera Barrick Misquichilca, oral commun., May 3, 2005). Byproduct mercury recovered from Minera Yanacocha, S.R.L.'s Yanacocha gold mine was also shipped to the United States. Before use, Minera Yanacocha's mercury flasks are drop-tested for security and measured for standard dimensions. After the flasks are filled, the mercury is chemically tagged, and the flask caps are double-sealed. Then the filled flasks are placed into a larger container that is bolted shut before shipment to the United States for recycling. In collaboration with the U.S. Department of Energy's Brookhaven National Laboratory, Minera Yanacocha was researching ways to chemically stabilize and encapsulate elemental mercury onsite (Ron Bradburn, process manager, Minera Yanacocha, S.R.L., written commun., June 1, 2005).

As part of an ongoing international environmental program between Peru and Switzerland, three retorts have been built near Arequipa, Peru. These retorts will help miners recover their gold without being exposed to mercury fumes, prevent losses of mercury to the environment, and provide better recovery of gold (Miguel Yepez, Economic Section, U.S. Embassy, Lima, Peru, written commun., April 4, 2006). The Arequipa region is an important small-scale gold mining area in Peru where both mercury and cyanide are routinely used to recover gold and has been the focus of a study by the Peruvian geological agency Instituto Geologico Minero y Metalurgico (Canepa, 2005).

In Brazil and Venezuela, mercury treatment centers have been established where artisanal miners can take their gold-mercury concentrates for retorting and recovery of the gold and mercury. These centers are important and 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.

Current Research and Technology

The United States' 11,000 coal-fired powerplants may emit as much as 48 t/yr of mercury (U.S. Environmental Protection Agency, 2005§). Officials in nine northeastern States came to a preliminary agreement to reduce mercury emissions by 10 % by 2020 (DePalma, 2005§). To meet these objectives, chemical engineers were researching pollution control technology that uses bromine, chlorine, or gold to scrub the mercury from powerplant emissions (Larry S. Monroe, pollution program manager, Southern Company Generation and Energy Marketing, oral commun., June 1, 2006).

Outlook

Global mercury use is expected to continue to decline. Mercury-containing thermometers, perhaps the most visible use of mercury, have been replaced by digital thermometers or thermometers using "galistan," an alloy of gallium, indium, and tin (Pennsylvania Department of Environmental Protection, 2004§). Ceramic material is now widely used in place of controversial, mercury-containing dental amalgam. The closure of mercury cell chlorine-caustic soda production facilities in Europe, India, South America, and the United States, which have come under pressure from international environmental and health organizations, will result in reduced demand for replacement mercury and release of large amounts of mercury for disposal, recycling, or storage. The use of mercury for artisanal gold mining in many parts of the world will likely continue. In the near term, high gold prices are expected to increase demand for use in artisanal mining and stimulate increased gold exploration and production. In turn, this will encourage byproduct mercury production as large mines open.

Releases to the environment may ultimately be lessened by the reduction of mercury emissions by coal-fired powerplants and copper, gold, and zinc mines and smelters; stricter laws and enforcement of bans on mercury use in artisanal gold mining; and monitoring of mercury releases and industrial waste by the chlorine-caustic soda industry. Recycled mercury from mercury cell chlorine-caustic soda plants, byproduct mercury recovered from domestic and foreign gold operations, and mercury contained in the DNS will be more than adequate to meet domestic needs.

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TABLE 1
SALIENT MERCURY STATISTICS[1]

(Metric tons unless otherwise specified)

	2001	2002	2003	2004	2005
United States:					
Secondary production, industrial	NA	NA	NA	NA	NA
Imports for consumption	100	209	46	92	212
Exports	108	201	287	278	319
Industry stocks, yearend[2]	NA	NA	NA	NA	NA
Industrial consumption	NA	NA	NA	NA	NA
Price, average, free market[3] dollars per flask	140	140	140	365	555
World, mine production	1,500	1,490	1,370 r	1,890 r	1,680 e

eEstimated. rRevised. 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]

Country	2004 Quantity, gross weight (metric tons)	2004 Value (thousands)	2005 Quantity, gross weight (metric tons)	2005 Value (thousands)
Imports:				
Canada	2	$15	13	$62
Chile	60	119	31	210
China	--	--	(2)	4
Germany	24	1,170	11	620
Israel	5	46	29	343
Peru	--	--	128	1,280
United Kingdom	(2)	3	(2)	12
Other	(2)	4 r	--	--
Total	92	1,350	212	2,530
Exports:				
Australia	--	--	5	144
Canada	4	28	11	87
Chile	3	11	4	30
Colombia	--	--	6	129
Guyana	--	--	19	465
Hong Kong	--	--	17	340
India	63	347	19	385
Korea, Republic of	(2)	8	1	27
Mexico	64	860	25	453
Netherlands	--	--	156	2,850
Peru	47	98	--	--
Philippines	--	--	4	129
Saudi Arabia	2	25	3	78
Spain	--	--	21	375
United Arab Emirates	--	--	14	111
Vietnam	79	546	3	62
Other	16 r	383 r	10	146
Total	278	2,310	319	5,810

rRevised. -- 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[1] OF PRECIOUS METALS, WHETHER OR NOT CHEMICALLY DEFINED, BY COUNTRY[2]

	2004		2005	
Country	Quantity, gross weight (metric tons)	Value (thousands)	Quantity, gross weight (metric tons)	Value (thousands)
Imports:				
Brazil	--	--	(3)	$334
Canada	30	$18,900	6	15,600
Colombia	--	--	(3)	22
Germany	19	15,700	4	8,050
Ireland	3	16,200	(3)	2,500
Italy	(3)	175	1	1,320
Japan	1	2,230	(3)	501
Malaysia	--	--	28	3,670
Mexico	3	370	2	526
Netherlands	18	2,680	4	675
Russia	4	29,200	4	49,600
South Africa	(3)	369 r	(3)	499
Spain	1	88	--	--
Switzerland	(3)	3	(3)	611
Taiwan	--	--	(3)	1,390
United Kingdom	(3)	14,200	2	3,810
Other	1	334	(3)	13
Total	79	100,000	51	89,100
Exports:				
Australia	6	6,770	6	7,300
Brazil	6	8,270	--	--
Canada	49	28,400	970	73,500
China	101	4,300	18	8,990
France	(3)	648	2	554
Germany	3	1,420	4	1,610
India	26	4,840	3	13,200
Ireland	1	637	(3)	861
Italy	--	--	(3)	548
Japan	2	2,170	4	1,160
Korea, Republic of	--	--	2	573
Mexico	194	79,500	21	98,600
Netherlands	16	6,810	12	8,210
Singapore	4	3,750	10	5,510
Switzerland	1	1,110	--	--
Taiwan	8	1,570	8	3,420
United Kingdom	3	3,160	28	6,460
Other	183	1,730	77	649
Total	603	155,000	1,160	231,000

rRevised. -- Zero.

[1]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
U.S. IMPORTS OF MERCURY CHLORIDE[1] BY COUNTRY[2]

Country	2004 Quantity, gross weight (metric tons)	2004 Value (thousands)	2005 Quantity, gross weight (metric tons)	2005 Value (thousands)
Canada	(3)	$10	--	--
Chile	410	729	654	$1,500
China	--	--	1	20
Czech Republic	(3)	6	--	--
India	--	--	1	32
Mexico	(3)	5	--	--
Spain	4	73	(3)	7
Total	414	824	656	1,560

-- Zero.

[1]Calomel is a mercury-bearing byproduct generated from pollution control equipment using the Norzink process.

[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 5
MERCURY: WORLD MINE PRODUCTION, BY COUNTRY[1, 2, 3]

(Metric tons)

Country	2001	2002	2003	2004	2005[e]
Algeria	321	307	176	73 [r]	(4)
China[e]	190	435	610	1,140 [r]	1,100
Finland	71	51	25 [r]	24 [r]	65
Kyrgyzstan	300	300	300	300	200
Mexico[e]	15	15	15	15	15
Morocco[e]	10	10 [r]	10 [r]	10 [r]	10
Russia[e]	50	50	50	50	50
Spain	500	300	150	250 [r]	250
Tajikistan[e]	40	20	30	30	30
United States[5]	NA	NA	NA	NA	NA
Total	1,500	1,490	1,370 [r]	1,890 [r]	1,680

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

[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, 2006.

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

[4]Less than ½ unit.

[5]Data on byproduct mercury are not available.