MERCURY

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In 1901, the US, with an output of more than 1,000 t was the world's largest mercury producer. Mercury imports were insignificant and with shipments of nearly 390 t, the US was a net mercury exporter of the metal. Among the largest uses for mercury during the first half of the century were the production of explosives, pharmaceuticals, various fungicides and bactericides, dental amalgams, batteries, switches, and measuring and control instruments such as barometers. For much of the century, the US remained among the largest mercury producing countries. Because of mercury's toxic nature, however, various rules and regulations were enacted, especially in the 1970s, to eliminate or curtail human exposure to the metal.

100 years later there are no longer any mines in the US producing mercury as a primary product. However, some mines and plants located in areas that historically produced large amounts such as California, Nevada, and Utah still recover small amounts of mercury.

Nearly all the mercury now produced in the US is derived from secondary sources, including spent batteries, mercury vapour and fluorescent lamps, switches, dental amalgams, measuring devices, control instruments, laboratory and electrolytic refining wastes the recovered mercury is mostly exported. This brief history of mercury in the US to a great extent mirrors what has happened to the metal worldwide.

Mercury, chemical symbol Hg and also known as quicksilver, is one of the few metals that is liquid at room temperature. It is silvery white with a faint bluish tinge. Mercury is produced by mining the ores then processing and calcining to vaporise the mercury which is then condensed to produce the liquid metal.

The three categories of mercury supply are: primary, being prime virgin mercury produced from mercury mining operations; by-product production from copper, gold and zinc mining operations; and secondary or recycled mercury that is recovered from previous uses.

Mercury is packed in cast, wrought iron, or spun steel bottles known commonly as flasks, and is sold and priced on the basis of a flask containing 34.50 kg nett and market quotations cover prime virgin mercury only.

Prices started 2001 at US$145 -155/flask (as published by *Metal Bulletin*) to which level they had risen slowly through 2000 from US$133.00-140.00/flask as availabilities from Russian/CIS stockpiles became exhausted. With the few remaining world producers of prime mercury, particularly the Spanish, continuing to manage their production to avoid large surpluses in the market, prices remained stable throughout 2001. There was a slight increase in mid-September to US$145-160/flask at which level it remained to the end of the year.

During the past ten years, annual world mercury production has averaged about 2,500 t (72,500 flasks) nearly all of which was produced at mines where mercury is the primary product. Most countries do not report their mercury production, and world production values have a high degree of uncertainty. In 2001, about ten countries produced mercury, with Spain, China, Algeria and Kyrgyzstan the dominant nations.

In some countries, a few base metal operations recover small quantities of mercury to meet environmental standards and avoid environmental releases of the metal.

From a ten-year peak in 1987 of 7,250 t (210,300 flasks) world primary and by-

product mine production has declined steadily to an estimated level of 1,370 t (39,710 flasks) in 2001.

Primary world mercury resources are estimated at nearly 600,000 t (approx. 17 million flasks) principally in China, Italy, Kyrgyzstan, Russia, Slovenia, Spain and Ukraine. Of the total resources it is estimated that around 120,000 t (3.5 million flasks) could economically be mined (reserves) and 240,000 t (7.0 million flasks) recovered if costs were not considered (reserve base) - See second table. These reserves at present production rates would provide sufficient resources for between 50 and 100 years respectively.

World Primary and By-product Mine Production by Country (t)

	1997	1998	1999	2000	2001[e]
Algeria	447	224	240[r]	240[r]	220
China	830	230	200[r]	200	229
Finland	63[r]	54[r]	40[r]	76[r]	71
Kyrgystan	610[e]	620	620	260[r]	250
Mexico	15	15	15[e]	25[r]	25
Russia	50	50	50	20[r]	20
Slovakia	na	20 e	na	na	na
Slovenia	5[e]	5[e]	na	na	na
Spain	863	675	433[r]	484	500
Tajikistan	40	35	35[r]	40[r]	50
Ukraine	25	20	na	na	na
US	2	5	5	5	5
TOTALS	**2,950[r]**	**1,953[r]**	**1,638**	**1,350**	**1,370**
Flasks	**85,507**	**56,608**	**47,478**	**39,130**	**39,710**

[r] *Revised*

[e] *Estimated*

na =not available

Sources: US Department of The Interior Geological Survey on mercury, Mining Annual Review 2001 and US Geological Survey Mineral Commodity Summaries (January 2002) much of which contains estimated figures. Accordingly adjustments have been made where more accurate information has been obtained.

The only mines left operating and contributing significantly to the current reduced level of mine production are Minas de Almaden in Spain, the Khaidarkensky mercury State Joint Stock Company in Kyrghyzstan and L'Entreprise Nationale des Produits Miniers Non-Ferraux et des Substances Utiles (ENOF) in Algeria.

The Almaden mines are based in the heart of Spain's La Mancha region and the plant's capacity, which over the years has produced 7.5 million flasks, is some 100,000 flasks/y.

In recent years, however, production has been limited with the company using its strategy, as the world's largest mercury producer, of varying output in an effort to avoid a large market oversupply.

Mercury ore mining at Almaden is not believed to have been restarted since the last scheduled halt in July although the company was believed to be recycling some material with other sales being covered from stockpiles. In May last year, the Spanish Government transferred the ownership of the producer, along with the other companies in preparation for its privatisation. The company was put under the umbrella of Sociedad Estatel de Participaciones Industriales (SEPI) although any sale was still expected to be some way in the future.

In the meantime, SEPI presented a feasibility plan to the unions in January 2002 in order to guarantee the continued mining of mercury. The plan included a reduction of 70% of the workforce from 266 to 80, through voluntary redundancy. This will help to reduce the exhaustion of the Cinabrio's deposit Ciudad Real which has reserves sufficient for only two years. SEPI proposes investing a total of €20 million in Almaden which has announced plans for a €7 million desulphurisation system at its metallurgical plant. Minas de Almaden will continue to operate in the mercury market as well as in farming and will start new projects such as going into external mining and drilling new deposits.

The Khaidarkensky mercury mine enterprise is located in Khaidarkan town, Kadamjay region, Osh Oblast, in the Kyrgyz Republic and has a capacity of up to 20,000 flasks per annum. Since re-opening in 1995, with support from the World Bank, production has been at a reasonable if haphazard pace. Output was reported to have stopped altogether at the end of 2000 although as most of the mercury is sold directly into China where domestic prices increased, it is difficult to know exactly the situation. The rise in Chinese prices was caused by the imposition of import licences by the Chinese Government.

The Chinese Government is becoming increasingly concerned about mercury's negative environmental impact and has introduced licensing for both production and importation. This has resulted in the closure of a number of small producers. However, for environmentally sound producers, business has been brisk as import licences were used up.

A new round of import licences was expected to be issued after the Chinese New Year celebrations in February 2002 with the likely recipients being medical import and export companies as demand continues to be strong. A number of shipments were diverted from main Chinese ports to other destinations, such as Haiphong in Vietnam, from which the mercury is undoubtedly destined to be smuggled over the border into China. Some customs controls in China, however, appear to be effective, as there were reports of Kyrgyz mercury arriving without import licences being impounded on the border at Alashankou/ Turgat. This would explain why, towards the end of the year and into early 2002, supplies from Khaidarken were finding their way onto Western markets confirming that production had started again.

By-product mercury results from the occurrence of mercury ores with some gold and silver deposits, particularly in the US, zinc mining in Finland and Italy, and in copper ore in Slovakia.

The recovery process used these days is a leach process where gold and silver is captured by a cyanide solution. Mercury is also captured, unintentionally. Before the gold and silver can be refined, the mercury must be removed. This is done using a retort in which the material is heated to drive off the mercury as a vapour. It is then condensed and recovered for sale as a by-product. Mercury is also recovered from copper, zinc and gold mining by smoke-stack scrubbing, using the Boliden/Norzink process. Mercury is collected in scrubbing towers to prevent air pollution and then sold as by-product from the mine or sent off site for final recovery and resale.

World Mercury Reserves (t)

	Reserves	Reserve Base
Spain	76,000	90,000
Italy	na	69,000
Slovenia	12,000	17,200
Turkey	na	6,900
Finland and Other Europe	700	1,000
US	na	7,000
Canada	na	5,500
Mexico	4,800	8,600
Zimbabwe	700	1,000
Algeria	2,000	3,000
Philippines	na	900
China	16,800	15,700
Kyrgystan	7,500	13,000
Other FSU Countries including Russia, Ukraine		
Tajikistan & Slovakia	3,000	4,200
TOTALS	**123,500**	**243,000**
Flasks	3.5 million	7 million

Source: US Geological Survey Mineral Commodity Summaries (January 2002).

Quantities are difficult to determine because it is not the intent of the mining activity to produce the metal which is an unwanted by-

product. It is estimated that 3,000 to 5,000 flasks per year are recovered as such a by-product. The amounts are strictly determined by the amount of impurity in the ore. Boliden/Norzink air scrubbing is only done by the more conscientious companies and only 38 operations worldwide are known to carry out this practice. Some dispose of the recovered mercury rather than resell into the world market. Sweden is the primary example. Others recover small amounts and sell it locally, or as with the larger operations, they recover and resell the mercury.

Nowadays, the only miners actually using mercury to recover gold are mostly illegal 'Artisanal' small-scale miners in Brazil and China. The amount and extent are difficult to determine. However the Environmental Protection Agency (EPA) in the US considered it to be significant enough to argue that for this reason the US Government should continue to suspend sales of mercury from the National Defence Stockpile pending completion of an analysis of the potential environmental impact of the sales. This leaves the stockpile of 4,435 t (128,550 flasks) of prime and 146 t (4,232 flasks) of secondary mercury held by the US Department of Energy at Oak Ridge, Tennessee, overhanging the market.

The electrolytic production of chlorine and caustic soda, and electrical applications, were the largest uses for mercury in 2001, accounting for approximately 50% and 25% of world consumption, respectively. Only in dental applications where it is the most cost effective and longest lasting dental cavity-filler, has the quantity of mercury consumed remained steady.

Lithium, nickel-cadmium, and zinc-air batteries are substitutes for mercury-zinc batteries. Indium compounds substitute for mercury in alkaline batteries. Diaphragm and membrane cells replace mercury cells in the electrolytic production of chlorine and caustic soda. Ceramic composites can replace dental amalgams; organic compounds have replaced mercury fungicides in latex paint. Digital instruments have replaced mercury thermometers in many applications.

Although demand for mercury in Europe and the US has decreased considerably, its consumption in other parts of the world seems relatively stable. Despite the industrialised nations banning the use of the metal in a range of products from batteries to pesticides, global demand appears to have stabilised. Industrial countries continue to use mercury in low-level applications, such as dental amalgams, lighting and measuring equipment. The less-industrialised countries are even increasing their consumption of cheap, mercury-based products such as paints.

Overall world consumption is impossible to calculate, given the lack of information from so many countries, particularly in China and the CIS where consumption is probably quite high. This is because their industries lag behind in technology, environmental restrictions are less rigidly applied and, particularly in China, illegal gold mining is common. However, it is generally considered that overall consumption is reducing and is probably down from recent years when it was estimated at around 3,500 t (approximately 100,00 flasks). Even if this figure has slipped to below 3,000 t (approximately 87,000 flasks), this still leaves a substantial shortfall of combined primary and by-product supply. With sales from the US stockpile continuing to be suspended and other stockpiles in FSU countries apparently exhausted, this shortfall has to be made up from secondary or recycled mercury.

Mercury was recovered from discarded products and industrial wastes such as chlor-alkali wastes, dental amalgams, fluorescent light tubes, electronic devices, batteries, and other instruments such as thermometers. There are two basic categories of secondary production: recovery of liquid mercury from dismantled equipment and mercury recovery from scrap products. Liquid extraction involves draining the liquid mercury from dismantled equipment. Recyclers use thermal

or chemical processes to extract mercury from scrap. Most commonly, the mercury is vaporised in a retort and collected by condensation. Condensed mercury is then distilled to remove impurities.

In June 2001, a contract transporter for the Yanacocha gold mine in Peru spilled about 151 kg of mercury near the town of Choropampa. Minera Yanacocha SRL undertook a comprehensive health and environmental remediation programme, agreed to provide a number of public works for nearby communities, and paid a fine of approximately US$500,000 as compensation for the spill.

On November 2, the US Environmental Protection Agency (EPA) announced a ban on discharges of various bio-accumulative chemicals, including mercury, in the Great Lakes Basin. Under the ban, the discharges into mixing zones would be phased out over a ten-year period, while new discharges were banned immediately. Mixing zones are areas where toxic chemical discharges are permitted to mix with receiving waters and be diluted.

The EPA also announced plans to develop regulations covering discharges of bioaccumulative chemicals, including mercury, through mixing zones.

On December 14, the EPA announced plans to begin regulating mercury emissions from coal-fired power plants. The agency plans to announce proposed regulations during 2003 and to issue final regulations in 2004.

The European Commission was pressing ahead with its directives to ban heavy metals including lead, cadmium and mercury unless their use is unavoidable. Adopted in 2000 the ban becomes effective by the end of 2005.

Ever stricter environmental regulations and the development of new technology are expected to be the primary factors affecting mercury supply and demand in the near future. Environmental standards and technological advances likely will work in tandem to reduce the demand for mercury in commercial products. Even as the per-unit mercury product content declines, regulations on the disposal of the metal will prompt more recycling of mercury, bearing material to recover the contained mercury. Consequently, secondary mercury is expected to remain the principal component of supply.