MERCURY

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Years of reducing demand as a result of environmental restrictions and pressure have left only three suppliers of primary mercury of any significant volume, and during 2002 concerns over the availabilities of secondary material finally saw market prices strengthen.

Elemental mercury is a dense naturally occurring silver-coloured metallic element that is liquid at room temperature. Sometimes called 'quicksilver', liquid mercury has been used extensively in manufacturing processes because it conducts electricity, reacts to temperature changes, and alloys with many other metals.

Examples of products that contain mercury include electrical switches, hospital equipment and supplies, fluorescent lights, switches for automobile lighting, and dental fillings. While mercury has many uses, it is designated a hazardous substance and must be stored and managed appropriately.

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; 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 2002 at US$145-160/flask (as published by the *Metal Bulletin*) to which level they had risen slowly during the previous two years. With the few remaining producers of prime mercury experiencing production problems, prices increased steadily and by the end of the year the quotation stood at US$155-175/flask which was perhaps on the low side compared with actual levels and, indeed, early in 2003 the quotation moved up again to US$165-185/flask.

Most countries do not report their mercury production, and world production figures have a high degree of uncertainty. In 2002, about seven or eight countries produced mercury, with Spain, China, Algeria and Kyrgyzstan the dominant nations, and their production is all from mines where mercury is the primary product.

In some countries, such as Finland and Italy, a few base metal operations recovered small quantities of mercury as a by-product 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 declined steadily to an estimated level of only 1,370 t (39,710 flasks) in 2001.

Overall world consumption is impossible to calculate, given the lack of information from so many countries, particularly 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/y (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, which in recent years has been made up from secondary or recycled mercury as well as substantial quantities from Russian/CIS stockpiles. These stockpiles are, however, now mostly exhausted and during 2002 the availability of secondary mercury was greatly reduced. Nevertheless, the primary producers were able to increase their production sufficiently to compensate (see Table 1).

Primary world mercury resources are estimated at nearly 600,000 t (approximately 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 be mined economically (reserves) and 240,000 t (7.0 million flasks) recovered if costs were not considered (reserve base). These reserves at present production rates would be sufficient for some 50 and 100 years respectively.

The only mines left operating and contributing significantly to the current level of production are all state-owned, being Minas de Almaden in Spain, the Khaidarkensky mine in Kyrghyzstan and Sonarem in Algeria owned by L'Entreprise Nationale des Produits Miniers Non-Ferraux et des Substances Utiles (ENOF).

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 per annum. In recent years, however, production levels have varied as the company employed a strategy, as the world's largest mercury producer, of varying output in an effort to avoid large market over-supply or under-supply.

Privatisation of Almaden remained on the agenda and the Spanish state-owned holding company Sociedad Estatel de Participaciones Industriales (SEPI), which wholly owns Almaden, reached agreement with three trade unions on the early retirement of around 200 workers in February. At the same time it announced plans to invest a total of €20 million by 2005, targeting environmental issues and the restoration of buildings owned by the historic miner. Of this total, approximately €1.0 million was being spent on a desulphurisation system at its metallurgical plant which, as well as making operations more environmentally friendly, would increase productivity to counteract the reduced number of

employees. The company also planned to end non-core activities such as exploration and research. Production was stopped at the end of June, reportedly to carry out the work, and was scheduled to restart in October when the work programme had been completed.

Despite reports in the Spanish media that production had been restricted as a consequence of reduced reserves, Almaden announced it had no plans to suspend mercury production permanently and certainly had sufficient material to supply all of its customers. Much of this material probably came from stocks, and earlier in the year Almaden had reached agreement with Bayer AG to purchase all of the secondary mercury arising from the closure of Bayer's mercury-based chlor-alkali cells at its Leverkusen plant in Germany where the production of chlorine for the manufacture of caustic soda is being changed to a more environmentally friendly, non-mercury process. The collection of this mercury by Almaden from Leverkusen continued regularly throughout the year as the old plant was dismantled. The total quantity of mercury to be recovered is not known but estimates of around 600 t (17,400 flasks) would not seem unreasonable. Thus, although mining continues to be restricted at Almaden, it appears that the company increased its production in 2002 by using secondary mercury as its main raw material.

The Khaidarkensky mercury mine enterprise is located in Khaidarkan town, Kadamjay region, Osh Oblast, in the Kyrgyz Republic and has an annual capacity of up to 20,000 flasks. Since re-opening in 1995, with support from the World Bank, production has been at a reasonable if haphazard pace and during the first half of 2002 was almost up to capacity at 1,500 flasks/mth but in late July serious flooding occurred in southern Kyrgyzstan, damaging a sub-station serving the mine at the same time that a second sub-station was down for repairs. The result was no electricity to the mine pumps so the mine flooded. Khaidarkan, however, also treats ores from Anzobsky GOK in Tajikistan so that production during the second half of the year continued, albeit at only about 50% of capacity.

It was not until January 2003 that the mine was reported to be back to full production and only then by working on higher-grade ores from the upper levels while work continued on dewatering the rest of the mine. Serious problems exist in mine planning and ore replacement, and major investment in mine development and additional exploration will be required if the mine is to continue operating. With this in mind, the Kyrgyzstan Government included Khaidarkan on a list published in December of large industrial enterprises it wished to privatise that do not have sufficient working capital to reach their potential. Almaden at first showed an interest but more to protect its mercury market than as a financial opportunity and perhaps mindful of its own privatisation plans it soon withdrew from further negotiations.

Most of Khaidarkan's production is sold into China which itself has the potential to be the world's largest producer of mercury and was so during the 1970s, flooding the market and lowering prices. The province of Guizhou has the world's third largest reserves but in recent years they have cut back output preferring the more environmentally friendly and cheaper option of importing.

During 2002, the Chinese Government, through its Environmental Protection Agency (EPA), continued its policy instigated in the previous year of controlling imports by licensing, forcing domestic prices to double and internal production to increase similarly to 495 t (14,347 flasks) according to the China Non-Ferrous Metals Association.
The Chinese authorities have reportedly set up relevant scientific institutes to conduct research into a substitute for the metal. There are, of course, already well documented substitutes: lithium and zinc-air batteries for mercury-zinc ones; indium compounds for mercury in alkaline batteries; diaphragm and membrane cells instead of mercury cells in the electrolytic production of chlorine and caustic soda; ceramic composites in dental amalgams; and digital instruments instead of mercury thermometers. But in the short to medium term it is hard to see the major consuming sectors in China, not least the gold-mining industry, existing without regular supplies of mercury.

Algerian producer Sonarem, similarly to Khaidarkan, had production problems in the latter half of the year. Believed to be producing at a capacity of 2,000 flasks/mth for most of the year sales, stopped completely during the fourth quarter due apparently to a shortage of flasks. Sonarem's usual supplier closed and the company found difficulty in finding a reliable replacement company able to supply flasks manufactured to the necessary specifications. Sales of new production were not restarted until well into 2003, and the first shipments from Algeria since September 2002 were not expected until May or June, 2003.

Of the by-product arisings, only Outokumpu in Finland was a regular producer but only of about 100 flasks/mth. Also recovering mercury, from zinc ores, was Portovesme in Italy, whilst in Slovakia and the US small amounts were recovered from copper ores and gold and silver deposits respectively.

Although no longer a producer of mercury, the US continues to have the possibility to supply the market from stocks in the National Defense Stockpile (NDS) managed by the Defense National Stockpile Center (DNSC) which is part of the Defense Logistics Agency (DLA).

After World War II, the NDS was created so that in times of national emergency the US would not have to depend on foreign sources for strategic and critical materials. Many of these materials are no longer needed for national defence and have been declared excess to requirements by Congress. Mercury was used for Lithium processing critical to the cold war development of Hydrogen bombs but these processes were shut down years ago. DNSC is scheduled to cease operation as an independent organisation in 2007 and would prefer to arrange for the disposal of the mercury before this date.

DNSC manages these excess materials, often by selling them in domestic and international markets. Sales occur through open competitions. Mercury was declared excess more than 20 years ago and Congress granted DNSC the authority to sell the entire inventory.

During the 1980s and 1990s, the DNSC sold 1,735 t (50,290 flasks) to US and foreign buyers. However, in 1994 it voluntarily halted mercury sales because of

concerns raised by the Environmental Protection Agency and others about the effect of mercury on the global environment, and 4,436 t (128,662 flasks) are still in storage. During 2002, the US Department of Defense carried out an investigation and many expected that sales would resume but the report, finally published in April 2003, strongly recommends provision be made for safe, long - term retrievable storage in the hope that “this vast quantity of mercury will not return to the market place, where industrial and commercial use would inevitably release much of it to the environment, threatening humans and wildlife alike”.

There is a new organisation of environmental professionals from federal and state EPAs that have formed what is known as the ‘Quicksilver Caucus’. This group has considerable power and is actively working on government representatives to create long-term storage facilities for excess mercury. It believes that all mercury recovered from caustic soda operations, as well as government stocks, should be stored while permanent disposal options are reviewed. The group strongly believes that excess mercury should never be resold.

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 mercury production: recovery of liquid mercury from dismantled equipment, and mercury recovery from scrap products using extractive processes. 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.

The electrolytic production of chlorine and caustic soda, and electrical applications, remained the largest uses for mercury in 2002, 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.

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. Highlighting this divide was the successful commissioning by Pakistan’s chlor-alkali producer Sitara Chemical Industries in mid-October of its new 200,000 t/y No. 3 caustic soda line. A fourth line of similar capacity is planned for mid 2003. However, the European Commission has proposed clamping down on chlor-alkali plants in the community due to environmental concerns. The announcement in January 2003 followed discussions between the Member States and the chlor-alkali industry, which concluded that the mercury-cell production process, which is still widely used in

Europe, was not the best available technology because of its environmental impact.

In 2002, approximately 68% of caustic soda production was based on mercury cells, 26% on membrane cells and 6% on diaphragm technology.
Soon after the EC announcement, the international chemical and pharmaceutical group, Solvay, announced it was to restructure its chlor-alkali business, with the focus on a small number of large-scale plants and the introduction of membrane-cell technology to replace mercury cells.

Russian chlorine producer, Sayanskkhimplast, located in the Irkutsk region, announced in December it was also planning to convert, as did Azerbaijan's national producer Azerkimya.

These initiatives came as no great surprise to observers of the industry, who have witnessed the steady closure of chlor-alkali plants in recent years. The mercury recovered from these plants is readily snapped up by mercury processors and primary producers like Almaden to refine into high-grade mercury.

With secondary mercury currently in short supply, the closure of more chlor-alkali plants would free up more material and possibly impact the market. However, the timeframe is unclear and it could be some time before this new supply of mercury is available.

More worrying, particularly for Almaden, was the EU Commissioners statement that, in addition to dealing with the problem of mercury from the chlor-alkali industry, its strategy should also include action "targeted on primary production of mercury in Europe". In October, the EU had already announced plans to ban the use of heavy metals such as cadmium, hexavalent chromium, lead and mercury in new electronic equipment from July 1, 2006.

Secondary mercury is expected to become the principal component of supply once again although its availability is erratic as it depends in particular upon activity in the chemical industry. In the long term, there is a trend to replace mercury usage in this sector wherever possible, owing to environmental concerns and the introduction of new technologies.

In the meantime, there has been a rise in demand from countries such as China, India and Indonesia. There is also concern surrounding Algeria's Sonarem which, like Khaidarkan, has acquired a reputation for unreliable delivery of material. Meanwhile, Spanish 'swing' producer Almaden stopped production again in April 2003 to effect repairs to its new gas purification system.

The immediate removal of mercury from the scene, whether in China or elsewhere, is not going to happen. In China, perhaps more than anywhere else, trying to enforce legislation will be a considerable task. Thus, with the availability of large quantities of secondary mercury still perhaps some way off, the supply to the market for the near future at least would appear to be in the hands of a

few very unreliable producers. Consequently, prices in 2003 could continue to increase.

Table 1 World Primary and By-product Mine Production by Country (t)

	1998	1999	2000	2001	2002[e]
Algeria	224	240[r]	420[r]	220	620
China	230	200[r]	200	229	495
Finland	54[r]	40[r]	76[r]	71	42
Italy	20	20	20	20	15
Kyrgyzstan	600[r]	620	308[r]	226[r]	507
Mexico	15	15[e]	25[r]	25	20
Russia	50	30[r]	20[r]	20	-
Slovakia	20[e]	na	na	na	na
Slovenia	5 e	na	na	na	-
Spain	675	433[r]	236[r]	524[r]	726
Tajikistan	35	35[r]	40[r]	30[r]	-
Ukraine	20	na	na	na	-
US	5	5	5	5	-
TOTALS	**1,953[r]**	**1,638**	**1,350**	**1,370**	**2,425**
Flasks	56,608	47,478	39,130	39,710	70,290

r Revised, e Estimated, na not available.

Sources: US Department of the Interior Geological Survey on Mercury, *Mining Annual Review* and US Geological Survey *Mineral Commodity Summaries* much of which contains estimated figures. Accordingly adjustments have been made where more accurate information has been obtained.

