Indian Minerals Yearbook 2016

(Part- II : Metals & Alloys)

55th Edition

SELENIUM AND TELLURIUM

(FINAL RELEASE)

GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

Indira Bhavan, Civil Lines,
NAGPUR – 440 001

PHONE/FAX NO. (0712) 2565471
PBX : (0712) 2562649, 2560544, 2560648
E-MAIL : cme@ibm.gov.in
Website: www.ibm.gov.in

February, 2018

14 Selenium and Tellurium

Selenium and tellurium are rare elements widely distributed within the Earth's crust which do not occur in concentrations high enough to justify mining solely for their content. They are recovered as by-products mostly from anode mud or slime obtained during electrolytic refining of copper. Tellurium is found mostly in tellurides associated with metals such as bismuth, lead, gold and silver. It is found with selenium in the anode slime from electrolytic copper refineries.

EXTRACTION

Selenium and tellurium metals were being recovered as allied products at Ghatsila Copper Smelter of HCL in Jharkhand where the annual installed capacity to produce selenium was 14,600 kg. HCL has not reported production of selenium since 2006-07 and that of tellurium since 2004-05. HCL has developed its own Precious Metal Recovery Plant at ICC successfully. Presently, the plant is not operational. A tellurium recovery plant has also been developed by R & D Wing. Hindalco Industries Ltd reported 73,870 kg production of selenium from imported copper concentrates at its Dahej Smelter in Gujarat during 2010-11 and thereafter no production data is available.

USES

Selenium

Selenium is used as a decolourising agent in the glass industry. Approximately, 1 kg selenium is used for about 150 tonnes of glass production. It is also used in architectural plate glass to reduce solar heat transmission. High purity selenium compoundswere used principally as photoreceptors on the drums of older plain paper copiers which are gradually being replaced by newer models that do not use selenium in the reproduction process. Dietary supplement for livestock is the largest agricultural usage of selenium. Selenium also finds applications as fertilizer to enrich soils where it is deficient.

Selenium is added to steel, copper and lead alloys to improve machinability which enables faster production with better surface finish and casting properties. Selenium is added to low antimony-lead alloys used in the support grids of lead acid storage batteries. The addition of 0.02% selenium by weight as a grain refiner improves the casting and mechanical properties of alloy. Metallurgical applications of selenium also include its use in the production of Electrolytic Manganese Metal (EMM) wherein about 2 kg of SeO_2 is required per tonne of electrolytic manganese metal produced.

Selenium is proving to be a useful Solar PV material in increasing the efficiency of absorption of light.

Chemical uses of selenium are in industrial and pharmaceutical applications. The principal pharmaceutical use of selenium is in anti-dandruff hair shampoos. Selenium is also used as a human dietary supplement. Other industrial chemical uses are as lubricant, rubber compounding catalysts and as a promoter in the reformation of naptha.

In pigment applications, selenium is used to produce colour changes in cadmium sulphide-based pigments. Sulphoselenide pigments have good heat stability, resistant to light and chemical attack and hence are used in ceramics, plastics, paints, inks and enamels. Selenium is used in catalysts to enhance selective oxidation and in plating solutions to improve appearance and durability. It is also used in blasting caps and gun bluing.

The use of selenium in glass has increased due to higher colourless glass production. The use of selenium in fertilizer and supplements in the plant-animal human chain and as human vitamin supplements increased as its health benefits were documented. The use of selenium in Copper-Indium-Gallium-Diselenide (CIGD) solar cell has increased.

Selenium is recovered from used electronic and photocopier components and recycled. The estimated global use of selenium was in metallurgy (40%), glass (25%); agriculture; chemicals & pigments; electronic (10% each) and other industries (5%).

Tellurium

Tellurium (Te) demonstrates properties similar to those of elements known to be toxic to humans and has application in industrial processes which is rapidly growing in importance and scale. Tellurium is used principally as an alloying element in the production of free-machining low carbon steel where additions up to 0.1% tellurium greatly improves machinability. It is also used as a minor additive in copper alloys to improve machinability without reducing conductivity. Tellurium catalysts are used chiefly for the oxidation of organic compounds and also in hydrogenation and halogenation reactions. Tellurium chemicals are used as vulcanising and accelerating agents in processing of rubber compounds. It finds use as a component of catalysts for synthetic fibre production that is increasingly used in cadmium-tellurium-based solar cells. In plain paper copiers and in thermoelectric and photoelectric devices, tellurium is used along with selenium. Mercury-cadmium telluride is used as a sensing material for thermal imaging devices. Tellurium is also used as an ingredient in blasting caps and as a pigment to produce colours in glass and ceramics. High purity tellurium is used in alloys for electronic applications.

SUBSTITUTES

The use of selenium as an alloy to substitute for lead in plumbing continued to increase in response to requirements of Public Law for safe drinking Water Act Amendment 1996. High-purity silicon has replaced selenium in high-voltage rectifiers and is the major substitute for selenium in low and medium voltage rectifiers and solar photovoltaic cells. Other inorganic semi-conductor materials such as, silicon, cadmium, tellurium, gallium and arsenic as well as organic photoconductors are the substitutes for selenium in photoelectric applications. Cerium oxide is substitute of selenium as either a colorant or decolorant in glass. Amorphous silicon and organic photoreceptors are substitutes of selenium in plain paper photocopiers. Sulphur dioxide can be used as a replacement for selenium dioxide in the production of electrolytic manganese metal.

Several materials can replace tellurium in most of its uses, but usually with loss in production efficiency or product characteristics. Bismuth, calcium, lead, phosphorus, selenium and sulphur can be used in place of tellurium in many free-machining steels. Several of the chemical process reactions catalysed by tellurium can be carried out with other catalysts or by means of non-catalytic processes. The chief substitutes for tellurium were selenium and sulphur in rubber compound applications and selenium, germanium and organic compounds in electronic applications.

WORLD REVIEW

Selenium

The world reserves of selenium at 1,00,000 tonnes only cover the estimated contents of economic copper deposits. Selenium was obtained as a by-product with copper. Substantial resources also exist in association with other metals and in uneconomic copper deposits (Table - 1).

In 2015, the production of selenium metal in respect of the world countries for which data is available was estimated at 2,787 tonnes. The chief producers were Japan (28%), Germany (25%), Belgium (7%), Canada (6%), and Russia (5%) (Table - 2).

Global selenium and tellurium output cannot be determined easily because not all companies or countries report production and because trade in scrap and semi-refined products may be included with refined metal trade data.

Table – 1 : World Reserves of Selenium (By Principal Countries)

(In tonnes of Selenium content)

Country	Reserves
World: Total (Rounded off)	**100000**
Canada	6000
China	26000
Peru	13000
Poland	3000
Russia	20000
USA	10000
Other countries	21000

Source: *Mineral Commodity Summaries, 2017.*

Table – 2 : World Production of Selenium Metal (By Principal Countries)

(In tonnes)

Country	2013	2014	2015
World total	**2807**	**2862**	**2787**
Belgium(e)	200	200	200
Canada	159	154	154
Chile	70	41	50(e)
China	65	65	65(e)
Finland	72	94	93
Germany(e)	700	700	700
Japan	739	782	772
Kazakhstan(e)	130	130	130
Mexico	132	120	107
Poland	80	90	87
Peru	50	49	50(e)
Philippines(e)	70	70	70
Russia	114	131	143
USA(e)	150	160	90
Other countries	76	76	76

Source: *World Mineral Production, 2011-2015.*

Tellurium

The world reserves of tellurium were at 25,000 tonnes contained in copper resources. Concentration of tellurium could also be found in lead and gold deposits. The quantities of tellurium in deposits of coal, copper and other metals that are of sub-economic grade are several times the amount of tellurium contained in identified economic copper deposits (Table-3).

Table – 3 : World Reserves of Tellurium (By Principal Countries)

(In tonnes of Tellurium content)

Country	Reserves
World: Total (Rounded off)	**25000**
Canada	800
Peru	3600
Sweden	670
USA	3500
Other countries	16000

Source: *Mineral Commodity Summaries, 2017.*

More than 90% of tellurium is produced from anode slimes collected from electrolytic copper refining and the remainder is derived from skimmings at lead refineries and from flue dust and gases generated during the smelting of bismuth, copper and lead ores. The anode slimes of copper and lead refineries normally contain about 3% tellurium. The chief producers of refined tellurium in the world in 2015 were USA, Japan, Sweden, Russia and Canada contributing an estimated 167 tonnes to the world production compared to 162 tonnes produced in 2014 (Table-4).

Table – 4 : World Production of Tellurium Metal (By Principal Countries)

(In tonnes)

Country	2013	2014	2015
Canada	12	9	9
China	7	7	7[e]
Japan	31	32	34
Russia	31	33	34
Sweden	24	31	33
USA[e]	50	50	50

Source: *World Mineral Production, 2011-2015.*
Note: *Germany and Belgium are also believed to produce refined tellurium.*

China

An audit of the Fanya Metal Exchange (FME), ordered by the Kunming Government, raised concerns that 170 tonnes of tellurium could be released to the spot market and result in a significant market surplus. The FME's issues were initiated in April when clients of the FME were unable to withdraw funds from the Ri Jin Bao investment product. The product was based on metal that was to be used in electronics and had promised returns of more than 13% per year. Reportedly, more than 2,20,000 investors had purchased the Ri Jin Bao product, with an estimated value of 43 billion yuan i.e. $ 6.77 billion. In October, the Yunnan Provincial Government instructed the municipal government of Kunming to launch an official investigation into FME. The key points of the investigation were to determine if the FME had made up trading items, concealed facts, created a capital pool and taken control of the funds within and illegally possessed and used the funds that it had raised. In November, when FME's Web site was shut down, warehouses reportedly still contained 337.8 tonnes of selenium and 170 tonnes of tellurium.

Canadian speciality metal producer 5N Plus Inc. announced at the Minor Metals Trade Association annual conference that they anticipated that tellurium was going to be oversupplied for the foreseeable future, with consumption around 450 to 550 tonnes per year and production estimated at 550 to 650 tonnes per year. With all the demand being met, 5N does not see any incentive for companies to recycle tellurium.

FOREIGN TRADE

Exports of selenium decreased considerably by 31% to 85 tonnes in 2015-16 from 124 tonnes in the previous year. Exports were mainly to China (87%), Canada (11%), Bangladesh (2%). In 2015-16, export of tellurium was negligible as in the previous year. Exports were to Singapore, Saudi Arabia & Malaysia (Tables-5 & 6). Imports of selenium slightly increased to 317 tonnes in 2015-16 as compared to 263 tonnes in the previous year. Imports were mainly from Korea, Rep. of (36%), Japan (29%), Belgium (20%), Germany (6%) and UK (3%). In 2015-16, imports of tellurium decreased to 2 tonnes from 6 tonnes in the previous year. Imports were solely from China. Canada and UK contributed negligible quantities (Tables-7 & 8).

Table – 5 : Exports of Selenium
(By Countries)

Country	2014-15 Qty (t)	2014-15 Value (L'000)	2015-16 Qty (t)	2015-16 Value (L'000)
All Countries	**124**	**350157**	**85**	**97481**
China	81	221052	74	66728
Canada	2	7513	9	28379
Bangladesh	1	139	2	1302
Oman	-	-	++	524
Australia	_	-	++	341
Malaysia	1	697	++	79
Singapore	-	-	++	38
USA	-	573	++	25
UAE	++	22	++	16
Argentina	++	13	++	15
Other countries	39	120148	++	34

Table – 6 : Exports of Tellurium
(By Countries)

Country	2014-15 Qty (t)	2014-15 Value (L'000)	2015-16 Qty (t)	2015-16 Value (L'000)
All Countries	**++**	**93**	**++**	**113**
USA	-	62	-	-
Saudi Arabia	++	31	++	95
Malaysia	-	-	++	13
Singapore	-	-	++	5

Table – 7 : Imports of Selenium (By Countries)

Country	2014-15 Qty (t)	2014-15 Value (L'000)	2015-16 Qty (t)	2015-16 Value (L'000)
All Countries	**263**	**867524**	**317**	**527903**
Japan	83	271399	93	147988
Belgium	62	207373	62	109793
Korea, Rep. of	63	199789	113	194119
Germany	23	81971	19	37798
UK	16	53626	10	14776
China	9	29844	8	8847
Russia	-	-	9	9915
USA	++	1059	2	3287
Italy	-	-	1	1167
Netherlands	++	452	++	146
Other countries	7	22011	++	67

Table – 8 : Imports of Tellurium (By Countries)

Country	2014-15 Qty (t)	2014-15 Value (L'000)	2015-16 Qty (t)	2015-16 Value (L'000)
All Countries	**6**	**42663**	**2**	**16248**
UK	2	14581	++	1446
China	2	12727	2	8641
Japan	1	7029	++	563
Belgium	++	788	++	1096
Hong Kong	1	6650	-	-
USA	++	466	++	587
Canada	++	351	++	3760
Netherlands	++	48	-	52
Germany	++	23	++	103

FUTURE OUTLOOK

The supply of selenium is dependent on the supply of main product from which it is derived i.e. copper and also to a lesser extent by the supply of nickel where the nickel production is from sulphide ore. The selenium prices are often inversely related to the supply of the major product from which it is derived-copper.

China has been purchasing large quantities of crude selenium. As this material becomes scarer, the prices for standard grade selenium may rise. The combination of these two factors, the decline of selenium containing concentrates from North America and the growth of Chinese demand, should firm up the prices for selenium in the short term.

Demand for selenium in photoreceptors is likely to continue to decline as the cost of substituting organic compounds decreases. The photoreceptor industry which was once a major consumer of selenium and tellurium has reached the replacement stage. Selenium has been substituted by alternative material in newer models.

Further, use of selenium in cancer prevention and other health applications may eventually lead to increased consumption of the metal. Dosages taken directly for human consumption will not include large increase in demand for the metal because only minute quantities are necessary for effective therapy.

The demand and supply of tellurium has remained fairly balanced for a decade. In short term, significant increases are not anticipated in either consumption or production, although reduction in copper production may have a bearing on tellurium supply. An increase in demand for high purity tellurium for cadmium telluride solar cells might have a major impact on tellurium consumption. The use of tellurium alloys used in DVD's consumes only small amounts of tellurium and will therefore have minimal impact on tellurium demand.