

SELENIUM AND TELLURIUM



# Indian Minerals Yearbook 2021

(Part- II : Metals & Alloys)

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**SELENIUM AND TELLURIUM**

**(ADVANCE RELEASE)**

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# 14 Selenium and Tellurium

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Selenium and tellurium are rare elements widely distributed within the Earth's crust. They 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. Selenium decolorises the green tint caused by iron impurities in glass bottles. 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 compounds were 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. Also, selenium is known to be added to fertilizer to enrich selenium-poor soils.

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) as a current efficiency enhancer wherein about 2 kg of  $\text{SeO}_2$  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 naphtha.

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 one substitute of selenium used as 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 or 0.1 million 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. Selenium reserves are mainly found in China (26%), Russia (20%), Peru (13%), USA (10%) and Canada (6%) (Table-1).

The world production of refined selenium is furnished in Table-2. The chief producers of selenium in the world in 2020 were China, Germany, Japan and Belgium. In addition to the countries listed, Australia, Iran, the Republic of Korea and Zimbabwe are believed to produce refined selenium.

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
<b>World: Total (Rounded off)</b>	<b>100000</b>
Belgium	-
Canada	6000
China	26000
Finland	-
Germany	-
Japan	-
Peru	13000
Poland	3000
Russia	20000
Sweden	-
Turkey	-
United States	10000
Other countries	22000

*Source: USGS, Mineral Commodity Summaries, 2022.*

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**Table – 2: World Production of Selenium, Refined (By Principal Countries)**

(In tonnes)			
Country	2018	2019	2020
China	1150	1358	1400
Germany <sup>(e)</sup>	300	300	300
Japan	768	740	750
Belgium <sup>(e)</sup>	200	200	200
Russia	176	184	190
USA <sup>(e)</sup>	152	144	66
Kazakhstan <sup>(e)</sup>	130	130	130
Mexico	107	127	106
Finland	109	115	84
Other countries	515	389	458

*Source: BGS, World Mineral Production, 2016-2020  
(h): Includes selenium produced from imported material*

### Tellurium

The world reserves of tellurium were at 31,000 tonnes contained in copper resources. Tellurium reserves are mainly located in China (21%), USA (11%), Canada (3%) and Sweden (2%). In addition to the countries listed, Australia, Belgium, Chile, Colombia, Germany, Kazakhstan, Mexico, Philippines and Poland produce refined tellurium, but output was not reported and available information was inadequate to make reliable production and reserves estimates. Concentration of tellurium could also be found in lead and gold deposits. The quantity 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).

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 2020 were China, Japan, USA, Russia, Sweden, Canada and Bulgaria. These countries together contributed as an estimated 633 tonnes to the world production in 2020 as compared to 620 tonnes produced in 2019. In addition to the countries listed, Germany and Belgium are also believed to produce refined tellurium (Table-4).

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

(In tonnes of Tellurium content)	
Country	Reserves
<b>World: Total (rounded off)</b>	<b>31000</b>
Bulgaria	NA
Canada	800
China	6600
Japan	-
Russia	NA
South Africa	-
Sweden	670
USA	3500
Other countries	19000

*Source: USGS, Mineral Commodity Summaries, 2022.*

**Table – 4 : World Production of Tellurium, Refined (By Principal Countries)**

(In tonnes)			
Country	2018	2019	2020
China	357	461	460
Japan	58	50 <sup>(e)</sup>	50
Russia	46	50	55
Sweden	45	41	42
Canada	17 <sup>(e)</sup>	15	23
Bulgaria	4	3	3

*Source: BGS, World Mineral Production, 2016-2020.*

To give a generalised view of the development in various countries, the countrywise description as sourced from latest available publication of Minerals Yearbook 'USGS' 2018 is furnished below.

### China

China was the leading global producer of selenium and tellurium and accounted for 33% and 61% of world production, respectively. China produced an estimated 930 tonnes of selenium in 2018, unchanged from that in 2017. Estimated production of tellurium in China was 280 tonnes, a 3% decrease from 290 tonnes in 2017. In 2018, the Government of China's National Development and Reform Commission (NDRC) announced the installation of 30 GW of solar capacity, down from the 53 GW of solar capacity in 2017. The NDRC also announced a cut in the national subsidy for solar power generated, in order to reduce overcapacity of photovoltaic power stations. This shift in policy was to be kept in place until at least 2020

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and new solar projects that required subsidies were unlikely to be approved.

According to the China Nonferrous Industry Association, the estimated selenium consumption in China decreased by 6% to 2,100 tonnes in 2018 from 2,240 tonnes in 2017. The electrolytic manganese industry remained the leading consumer of selenium in China, accounting for 46% of selenium consumption in 2018, followed by glass production, 19%; agriculture, 15%; electronics, 12%; and pigments, 8%. The selenium consumption was estimated to be less than the supply. Estimated tellurium consumption in China in 2018 increased to approximately 150 tonnes from 130 tonnes in 2017, and consumption was expected to be less than supply. Tellurium in China was consumed for various uses: thermal coolers (53%), metallurgy (27%), chemicals and photovoltaics (6% each), and other (8%).

### Sweden

By product tellurium production at Boliden AB's Kankberg gold-tellurium mine increased by 28% in 2018 to 44,641 kg from 34,979 kg in 2017. Boliden reopened the Kankberg Mine in 2012, and the mine's life was expected to extend into 2020.

## FOREIGN TRADE

### Exports

Exports of selenium during 2020-21 increased substantially by 122% to 40 tonnes from 18 tonnes in 2019-20. Exports were mainly to Netherlands (13%), Canada (10%) and Ukraine (8%). There were negligible amount of exports of selenium from Iran, UAE, Philippines (3% each) during 2020-21. Exports of tellurium were negligible during 2020-21 (Tables-5 & 6).

### Imports

Imports of selenium during 2020-21 increased substantially by 22% to 701 tonnes as compared to 574 tonnes in the preceding year. Imports were mainly from Belgium (29%), Japan (27%), Korea (20%), Germany & Philippines (7% each) & Netherlands (3%). Imports of tellurium decreased by 33% to 2 tonnes as compared to 3 tonnes in the preceding year. Imports were mainly from China (100%). Negligible quantities were also contributed from other countries (Tables-7 & 8).

**Table – 5 : Exports of Selenium  
(By Countries)**

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
<b>All Countries</b>	<b>18</b>	<b>46422</b>	<b>40</b>	<b>43423</b>
Ukraine	-	-	3	13775
Canada	4	13611	4	12893
Iran	1	6726	1	5813
Netherlands	-	-	5	4159
Egypt	-	-	++	1670
UAE	1	47	1	1099
USA	++	661	++	923
Philippines	-	-	1	555
Vietnam	-	-	++	341
Australia	-	-	++	338
Other countries	12	25377	25	1857

*Figures rounded off*

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**Table – 6 : Exports of Tellurium  
(By Countries)**

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹000)	Qty (t)	Value (₹000)
<b>All Countries</b>	++	122	++	37
Belgium	++	106	++	37
Kenya	++	16	-	-

*Figures rounded off*

**Table – 7 : Imports of Selenium  
(By Countries)**

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹000)	Qty (t)	Value (₹000)
<b>All Countries</b>	<b>574</b>	<b>708675</b>	<b>701</b>	<b>681519</b>
Belgium	135	169693	206	200846
Japan	134	167932	186	187058
Korea	152	177782	142	128783
Germany	16	25438	48	49138
Philippines	23	25643	47	42209
Netherlands	28	36434	22	22370
Hong Kong	9	8121	17	16582
USA	4	10042	11	13220
Russia	10	8914	10	7655
China	18	25911	5	6959
Other countries	45	52765	7	6699

*Figures rounded off*

**Table – 8 : Imports of Tellurium  
(By Countries)**

Country	2019-20 (R)		2020-21 (P)	
	Qty (t)	Value (₹000)	Qty (t)	Value (₹000)
<b>All Countries</b>	<b>3</b>	<b>23332</b>	<b>2</b>	<b>21250</b>
China	2	9515	2	11901
Hong Kong	1	5632	++	2948
Canada	++	6076	++	2633
Germany	++	30	++	2494
Japan	++	580	++	387
Luxembourg	-	-	++	313
USA	++	195	++	295
Italy	-	-	++	271
Belgium	++	1073	++	8
Belarus	++	231	-	-

*Figures rounded off*

## FUTURE OUTLOOK

The supply of selenium is dependent on the supply of main product from which it is derived, 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 copper and nickel.

China has been purchasing large quantities of crude selenium. As this material becomes scarce, 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 see further 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 affect the 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 in DVD's consumes only small amounts of tellurium and will, therefore, have minimal impact on tellurium demand.