

SELENIUM AND TELLURIUM



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SELENIUM AND TELLURIUM

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14 Selenium and Tellurium

Selenium and tellurium metals are recovered as by-products during copper, lead-zinc, gold and platinum ore processing. The principal sources of selenium are sulphide deposits and 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. However, in recent years there has not been production of selenium and tellurium by HCL. HCL has not reported production of selenium since 2006-07 and that of tellurium since 2004-05. Hindalco Industries Ltd reported 41,274 kg production of selenium from imported copper concentrates at its Dahej Smelter in Gujarat during 2009-10 and thereafter no production data is available.

USES

Selenium

In glass manufacturing, selenium powder in traces is used as a decolourant for removing the green tint caused by iron impurities in container glass and other soda-lime silica glasses. 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 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.

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. Miscellaneous industrial chemical uses are as lubricant, rubber compounding and catalysts.

In pigment applications, selenium is used to produce colour changes in cadmium sulphide-based pigments. Sulphoselenide red pigments have good heat stability and hence are used in ceramics and 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 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 was recovered from used electronic and photocopier components and recycled. The estimated global consumption of selenium was in metallurgy (40%), glass (25%); agriculture; chemicals & pigments; electronic (10% each) and other industries (5%).

Tellurium

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

High-purity silicon has replaced selenium in high-voltage rectifiers and is the major substitute for selenium in low and medium-voltage rectifiers. Other inorganic semiconductor materials, such as, silicon, cadmium, tellurium, gallium and arsenic as well as organic photoconductors are the substitutes for selenium in photoelectric applications. 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 98,000 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, coal deposits and in uneconomic copper deposits (Table - 1).

Average world production of selenium is estimated at 3,000-3,500 tonnes per year. In 2011, the production of selenium metal in respect of 11 countries for which data is available was estimated at 1,911 tonnes. The chief producers were Japan, Germany, Belgium, Russia, Kazakhstan, Sweden, Poland and Finland (Table - 2).

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

(In tonnes of metal content)

Country	Reserves
World : Total (rounded)	98000
Canada	6000
Chile	25000
Peru	13000
Philippines	500
Russia	20000
USA	10000
Other countries*	23000

Source: Mineral Commodity Summaries, 2013.

**Reserves are based on identified copper deposits only.*

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

(In tonnes)

Country	2009	2010	2011
Belgium ^(e)	200	200	200
Canada	173	97	35
China ^(e)	65	65	65
Finland	59	73	86
Germany ^(e)	230	250	250
Japan	709	754	630
Kazakhstan ^(e)	120	130	130
Mexico	-	62	95
Poland	80	79	85
Russia ^(e)	160	170	265
Sweden	129	72 ^(e)	70 ^(e)

Source: World Mineral Production, 2007-2011.

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In 2011, world consumption of selenium was estimated to be greater than that in 2010. The consumption in the glass industry increased owing to increased glass production.

Tellurium

The world reserves of tellurium were 24,000 tonnes contained in copper resources. 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 is 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 metal content)

Country	Reserves*
World : Total (Rounded)	24000
Canada	800
Peru	3600
USA	3500
Other countries	16000

Source: Mineral Commodity Summaries, 2013.

* Estimates include tellurium contained in copper resources only.

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. World refinery capacity is 500 to 600 tonnes concentrated in the USA (110 tonnes), Japan (100 tonnes), Canada (40 tonnes), former USSR (70 tonnes), Belgium (60 tonnes), Germany (50 tonnes), Peru (30 tonnes) and Philippines (100 tonnes). World tellurium consumption was estimated to have increased slightly in 2011. Average world production of tellurium is estimated at 450-500 tonnes per year. The chief producers of refined tellurium in the world in 2011 were USA, Japan and Canada contributing an estimated 96 tonnes to the world production compared to 105 tonnes produced in 2010 (Table-4).

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

(In tonnes)

Country	2009	2010	2011
Canada	16	8	6
Japan ^{e)}	49	47	40
Peru	7	-	-
USA	50	50	50

Source: World Mineral Production, 2007-2011.

China

In 2011, China was the leading producer and consumer of selenium, accounting for about 40% to 50% of world consumption. China imported 1,560 tonnes of selenium products in 2011. Apollo Solar Energy, Inc. (Chengdu, Sichuan Province) started two mines where the principal product was tellurium. The indicated and inferred resources for the Dashuigou project in the Sichuan Province were 30,200 tonnes of ore grading, 1.09% tellurium containing 328 tonnes of tellurium, and the resources for the Majiagou project in Shimian County, Sichuan Province are estimated at 13,400 tonnes of ore grading, 3.26% tellurium containing 437 tonnes of tellurium.

Japan

Production of selenium and tellurium dropped because of lower grades and the fall in copper production following the Tohoku earthquake in March 2011. The major producers of selenium and tellurium were Kisan Kinzoku Chemicals Co. Ltd, Mitsubishi Materials Corp., Mitsui Metal Mining and Smelting Co. Ltd, Nippon Rare Metals Inc., Pan Pacific Copper Co. Ltd, Shinko Chemicals Co. Ltd and Sumitomo Metal Mining Co. Ltd.

Mexico

Southern Copper Corp. operated the La Caridad precious metals plant in the State of Sonora, which had a design capacity of 342 kilograms of selenium per day.

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Peru

Southern Copper produced selenium at its Ilo refinery in southern Peru. In 2011, selenium production was 56,000 kg.

FOREIGN TRADE

Exports of selenium decreased to 184 tonnes in 2011-12 from 193 tonnes in the previous year. Exports were mainly to China, UK and Philippines. In 2011-12, exports of tellurium decreased substantially to 13 tonnes from 58 tonnes during the previous year (Tables-5 & 6).

Table – 5 : Exports of Selenium (By Countries)

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	193	722450	184	1187692
China	58	203408	89	592935
UK	12	35239	24	178178
Philippines	55	220912	23	152191
Hong Kong	36	147020	15	92737
UAE	++	704	6	41422
South Africa	-	-	10	24910
Tanzania Rep	-	-	2	13457
USA	3	10414	1	9511
Sri Lanka	++	1326	1	7712
Unspecified	1	3886	9	49481
Other countries	28	99541	4	25158

Table – 6 : Exports of Tellurium (By Countries)

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	58	13331	13	836
Malaysia	-	-	6	473
Indonesia	-	-	6	338
Iraq	-	-	1	25
Other countries	58	13331	-	-

Imports of selenium decreased to 194 tonnes in 2011-12 as compared to 209 tonnes in the previous year. Imports were mainly from Japan, Belgium & Rep. of Korea. In 2011-12, import of tellurium was just 1 tonne compared to 3 tonnes in the previous year (Tables-7 & 8).

Table – 7 : Imports of Selenium (By Countries)

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	209	699503	194	1174174
Japan	68	239289	59	384307
Belgium	28	100323	32	219597
Korea, Rep. of	30	110820	28	173664
China	46	118906	20	140295
UK	8	30186	11	70829
Germany	22	74951	11	63406
Hong Kong	2	7534	4	19394
Finland	-	-	2	16069
Netherlands	-	-	5	14685
Switzerland	-	-	2	14220
Other countries	5	17494	20	57708

Table – 8 : Imports of Tellurium (By Countries)

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	3	35182	1	30262
China	++	2591	1	15924
UK	++	101	++	3682
Japan	++	1982	++	3612
Philippines	++	359	++	2719
Canada	++	371	++	1715
USA	++	30	++	1368
Germany	++	85	++	1222
Malaysia	-	-	++	10
Korea, Rep. of	2	14539	++	9
Other countries	1	15124	++	1