

69 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 as 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 are recovered as allied products at Ghatsila Copper Smelter of HCL in Jharkhand. The installed capacity of the plant to produce selenium is 14,600 kg. The purity of these metals produced currently is around 99.95 percent. However, the electronic industry needs a purity of 99.9999 percent. Production of selenium and tellurium in the country during the last five years is given in Table-1.

Table - 1 : Domestic Production of Selenium and Tellurium 2003-04 to 2007-08

(In kg)

Year	Selenium	Tellurium
2003-04	2357	31
2004-05	-	-
2005-06	7719	-
2006-07	-	-
2007-08	-	-

USES

Selenium

In glass manufacturing, selenium powder in traces is used as a decolourant and for removing impurities in container glass and other soda-lime silica glasses. Approximately 1 kg selenium is used for about 150 tonnes of glass production. High-purity selenium compounds are 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. Also, selenium may be added to fertilizer.

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.

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. By increasing substitution of selenium for sulphur, yellow cadmium pigment becomes more red. 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 remains strong. The use in copiers continues to decline while the use in metallurgical additives has increased. The use of selenium as an alloy with bismuth is in demand. The use of selenium as an additive to no-lead, free-matching brasses for plumbing applications has continued to increase as more stringent regulations on lead in drinking water are followed. A new use of selenium is in amorphous selenium (aSe) detector technology. The aSe detector enables the direct conversion of x-ray to digital information.

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, usually in conjunction with lead, greatly improve machinability. Tellurium catalysts are used chiefly for the oxidation of organic compounds and also in hydrogenation, halogenation and chlorination reactions. It is also used as a minor additive in copper alloys to improve machinability without reducing conductivity. Tellurium chemicals are used as vulcanising and accelerating agents in rubber compounding. 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.

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.

The chief substitutes for tellurium were selenium, bismuth and lead in metallurgical applications, selenium and sulphur in rubber compound applications and selenium, germanium and organic compounds in electronic applications.

WORLD REVIEW

Selenium

The world resources of selenium at 170,000 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-2).

**Table - 2 : World Resources of Selenium
(By Principal Countries)**

(In tonnes of metal content)

Country	Reserve base
World : Total (rounded)	170000
Canada	10000
Chile	37000
Peru	8000
Philippines	3000
USA	19000
Other countries*	92000

Source: Mineral Commodity Summaries, 2008.

* In addition to the countries listed, Belgium, Finland, Germany, India, Japan and Sweden are known to produce refined selenium.

The Selenium-Tellurium Development Association is promoting new uses of these two metals. Selenium was recovered in Canada and UK from used electronic and photocopier components and recycled. In 2007, the production of selenium metal in respect of 9 countries for which data is available was estimated at 1,527 tonnes. The chief producers were Japan, Belgium, Sweden, Canada, Poland and Russia (Table - 3).

**Table - 3 : World Production of Selenium Metal
(By Principal Countries)**

(In tonnes)

Country	2005	2006	2007
Belgium ^(e)	200	200	200
Canada	107	117	62
China	65 ^(e)	65	65
Finland	66	70	52
Germany ^(e)	12	12	12
Japan	625	730	806
Poland	82	87	90
Russia	100	110	110
Sweden	122	135	130

Source : World Mineral Production, 2003-2007.

Note : In addition to the countries listed, Chile Rep. of Korea and Zimbabwe are believed to produce selenium metal.

SELENIUM AND TELLURIUM

Tellurium

The world resources of tellurium were 47,000 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 subeconomic grade is several times the amount of tellurium contained in identified economic copper deposits (Table-4).

**Table - 4 : World Resources of Tellurium
(By Principal Countries)**

(In tonnes of metal content)

Country	Reserve base*
World : Total (Rounded)	47000
Canada	1500
Peru	2800
USA	6000
Other countries	37000

Source: Mineral Commodity Summaries, 2008.

* Estimates include tellurium contained in copper resources only.

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). The chief producers of refined tellurium in the world in 2007 were Canada, USA, Japan and Peru, contributing an estimated 113 tonnes to the world production which is low as compared to 122 tonnes they produced in 2006 (Table-5).

**Table - 5 : World Production of Tellurium Metal
(By Principal Countries)**

(In tonnes)

Country	2005	2006	2007
Canada	11	11	8
Japan	23	24	20
Peru	33	37	35
USA	50	50	50

Source : World Mineral Production, 2003-2007.

Note : In addition to the countries listed, Germany is believed to produce tellurium metal.

FOREIGN TRADE

Exports of selenium increased to 589 tonnes in 2007-08 from 129 tonnes in the previous year. Exports were mainly to China, USA and Hong Kong. In 2007-08, 12 tonnes of tellurium was exported mainly to Nigeria (Tables - 6 and 7).

Imports of selenium decreased to 152 tonnes in 2007-08 from 238 tonnes in the previous year. Imports were mainly from Japan, Germany and Belgium. Tellurium imports in 2007-08 were 6 tonnes against 3 tonnes in the previous year. Imports were mainly from Belgium, China and USA (Tables - 8 and 9).

**Table - 6 : Exports of Selenium
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	129	244781	589	289616
China	69	137897	313	145786
Hong Kong	7	15389	116	44371
Belgium	13	20218	11	34429
UK	-	-	13	25220
USA	++	944	125	20027
Indonesia	++	714	2	7276
France	38	62034	2	4298
Brazil	++	687	++	826
Taiwan	1	2268	-	-
Saudi Arabia	1	2705	-	-
Other countries	++	1925	7	7383

**Table - 7 : Exports of Tellurium
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	-	-	12	127
Nigeria	-	-	12	103
Nepal	-	-	++	24

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**Table - 8: Imports of Selenium
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	238	481428	152	629660
Australia	8	19256	-	-
Belgium	55	100515	33	98458
Canada	4	9918	-	-
Chile	-	-	1	3418
China	9	18520	9	26990
Germany	64	152448	27	92638
Japan	82	147552	68	360087
Korea, Rep. of	11	20685	9	24159
UK	2	5421	4	15710
USA	2	3327	2	7547
Other countries	1	3786	++	653

**Table - 9 : Imports of Tellurium
(By Countries)**

Country	2006-07		2007-08	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	3	13829	6	25915
Belgium	3	12301	4	19056
Canada	-	-	++	195
China	-	-	1	2957
Germany	++	129	++	155
Israel	-	-	++	10
Japan	++	353	++	614
Philippines	++	629	++	647
UK	++	417	++	210
USA	-	-	1	2071