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 were being recovered as allied products at Ghatsila Copper Smelter of HCL in Jharkhand, where the annual installed capacity to produce selenium is 14,600 kg. However, in recent years there has not been production of selenium and tellurium by HCL. HCL last reported production of selenium in 2006-07. Hindalco Industries Ltd reported 36,810 kg and 41,274 kg production of selenium from imported copper concentrates at its Dahej Smelter in Gujarat during 2008-09 and 2009-10, respectively. Installed capacity of selenium recovery plant of Hindalco is not 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 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 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.

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. Selenium is also used in amorphous selenium (aSe) detector technology.

The use of selenium in glass and in copiers in USA continued to decline. Its use as a substitute for lead in free-machining brasses also decreased due to economic downturn. 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 (CIGS) solar cell has increased.

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.

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. 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 acclerating agents in processing of rubber compounds. It finds use as a component of catalysts for synthetic fibre production and increasingly used 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.

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 material can replace tellurium in most of its uses, but usually with losses 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 noncatalytic 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 88,000 tonnes only cover the estimated contents of economic copper deposits. Selenium was obtained as a byproduct with copper. Substantial resources also exist in association with other metals, coal deposits and in uneconomic copper deposits (Table - 1).

In 2009, the production of selenium metal in respect of 9 countries for which data is available was estimated at 1,773 tonnes. The chief producers were Japan,Germany, Belgium, Canada, Sweden, Russia and Poland (Table - 2).

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

(In tonnes of metal content)

Country	Reserve*
World : Total (rounded)	**88000**
Canada	6000
Chile	20000
Peru	9000
Philippines	500
USA	10000
Other countries*	23000

Source: *Mineral Commodity Summaries, 2010.*
** Reserves are based on identified copper deposits*

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

(In tonnes)

Country	2007	2008	2009
Belgium(e)	200	200	200
Canada	144	191	173
China(e)	65(e)	65	65
Finland	52	65	66
Germany(e)	250	250	230
Japan	806	754	709
Poland	85e	82	80
Russia	110	110	110e
Sweden	126	139	140

Source: *World Mineral Production, 2005-2009.*

Tellurium

The world reserves of tellurium were 22,000 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-3).

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

(In tonnes of metal content)

Country	Reserves*
World : Total (Rounded)	**22000**
Canada	700
Japan	NA
Peru	2300
USA	3000
Other countries	16000

Source: *Mineral Commodity Summaries, 2010.*

* *Estimates include tellurium contained in economic copper deposits 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 slightly decreased in 2009. However there was an increase of demand for high purity tellurium in solar cell. In Japan, tellurium was used in steel industry to replace lead. The chief producers of refined tellurium in the world in 2009 were USA, Japan, Canada and Peru contributing an estimated 113 tonnes to the world production compared to 138 tonnes they produced in 2008 (Table-4).

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

(In tonnes)

Country	2007	2008	2009
Canada	14	20	16
Japan	41	40	40(e)
Peru	35	28	7
USA	50	50	50

Source: *World Mineral Production, 2005-2009.*

China

China was one of the principal producers and a leading consumer of selenium in 2009. China's consumption was estimated around 1,500-2,000 tpy, about 1,000 tpy of which was accounted for by electrolytic manganese industry. The refined selenium capacity was around 400 tpy which was likely to reach 600 tpy in near future. Imports of selenium were about 1,400 tonnes. Apollo Solar Energy Inc. was examining the posibility of starting two mines with tellurium as primary product. The resources at Dashuigou project are 30,200 tonnes ore grading 1.09% Te while Majiagou project resources are 13,400 tonnes grading 3.26% Te.

FOREIGN TRADE

Exports of selenium decreased substantially to 400 tonnes in 2009-10 from 5,594 tonnes in the previous year. Exports were mainly to Hong Kong and China. In 2009-10, exports of tellurium were at 44 tonnes compared to exports during the previous year (Tables 5 and 6).

Imports of selenium were 190 tonnes in 2009-10 compared to 164 tonnes in the previous year. Imports were mainly from Japan, Rep. of Korea and Belgium. In 2009-10, imports of tellurium were at 9 tonnes compared to negligible imports in the preceding year (Tables 7 and 8).

Table – 5 : Exports of Selenium (By Countries)

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	**5594**	**290309**	**400**	**417874**
China	53	115754	90	219157
Hong Kong	20	51181	190	92689
Phillipines	–	–	5	13295
Thailand	5157	4164	4	11083
Saudi Arabia	1	2739	4	11038
Bangladesh	–	–	15	10182
UAE	320	16415	50	9521
Australia	3	6960	2	5662
France	6	17182	1	3692
USA	17	49568	++	127
Other countries	17	26346	39	41428

Table – 6 : Exports of Tellurium (By Countries)

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	++	**220**	**44**	**22834**
Hong Kong	–	–	41	12813
China	–	–	1	3399
Canada	–	–	1	3353
Singapore	–	–	1	3262
Nepal	–	–	++	7
Iran	++	220	–	–

Table – 7 : Imports of Selenium (By Countries)

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	**164**	**435275**	**190**	**434583**
Japan	80	204955	80	185725
Korea, Rep. of	21	47946	44	96653
Belgium	27	75635	38	90098
Germany	28	84617	13	30739
UK	++	175	6	15306
Italy	–	–	2	6268
China	4	10921	1	2867
Mexico	1	1473	1	1098
USA	2	6219	++	790
Unspecified	1	2594	2	4289
Other countries	++	740	3	750

Table – 8 : Imports of Tellurium (By Countries)

Country	2008-09		2009-10	
	Qty (t)	Value (Rs.'000)	Qty (t)	Value (Rs.'000)
All Countries	++	**13133**	**9**	**55532**
Korea, Rep. of	–	–	6	33155
Belgium	++	2127	2	13899
U K	++	506	1	4285
China	++	2699	++	2236
U S A	++	2237	++	890
Canada	–	–	++	529
Germany	++	1001	++	77
Hong Kong	++	2725	–	–
Japan	++	642	–	–
UAE	++	1196	–	–
Other countries	–	–	++	461