

CADMIUM



Indian Minerals Yearbook 2012

(Part- II : Metals & Alloys)

51st Edition

CADMIUM

(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

January, 2014

3 Cadmium

Cadmium is a soft, bluish-white metal present generally in zinc ore deposits as greenockite (CdS). The principal source of cadmium is zinc ore, sphalerite. Other sulphides and sulphosalts may also carry small amounts of the metal.

In India, cadmium is recovered as a by-product in zinc smelting and refining. The concentration of cadmium in sphalerite, the principal ore of zinc, ranges from 0.03 to 9.0 wt%. In zinc concentrate at Rampura Agucha, cadmium is 0.18% while in lead concentrate, it is 150 ppm. There are no separate resources of cadmium.

INDUSTRY

The total installed capacity for recovering cadmium was 913 tonnes of which HZL accounted for 833 tonnes. Binani Zinc Ltd reported the remaining 80 tonnes capacity (Table-1). HZL produces cadmium of high quality casted in the form of pencils weighing from 250 g to 500 g. The purity is 99.95% Cd, max. at Debari, 99.97% Cd, max. at Vizag and 99.99% Cd, min. at Chanderiya plants. HZL has plans to conduct R&D for production of high purity cadmium during 2011-12. High purity cadmium is typically used for nuclear shielding applications.

Table – 1 : Installed Capacity for Recovery of Cadmium

Unit	Location	Installed capacity (tpy)
Total		913
1. HZL, Debari Zinc Smelter	Debari, Dist. Udaipur, Rajasthan.	250
2. HZL, Vizag Zinc Smelter	Visakhapatnam, Andhra Pradesh.	115
3. HZL, Chanderiya Lead-Zinc Smelter	Chanderiya, Dist. Chittorgarh, Rajasthan.	468
4. Binani Zinc Ltd	Binanipuram, Dist. Ernakulam, Kerala.	80

USES

Cadmium is used to control the fissionable elements in nuclear reactors. Along with nickel, it is used in electrical storage batteries. Cadmium-based bearing alloys are used in high-speed internal combustion engines. Copper-cadmium alloys possess high strength, high conductivity and high resistance to abrasion and therefore, the alloys are used in electric transmission wires. The main use of cadmium is in electroplating wherein it can be applied as a very thin coating to protect iron, steel, copper alloys and other metals and alloys from corrosion. Cadmium sulphide forms brilliant golden yellow, orange-red, or reddish brown pigments used in paint, enamel, soap, rubber, glass and ceramic glazes. Some cadmium salts are also used in photographic films and in lithography. Cadmium coated products are preferred for a wide range of critical and safety related applications in the aerospace, electrical, defence, mining, nuclear and off-shore industries.

PRODUCTION

Production of cadmium recovered as a by-product of zinc smelting in 2011-12 was 449 tonnes. It decreased by 18% as compared to that in the previous year. The entire production was reported under private sector (Tables - 2 and 3).

Table – 2 : Production of Cadmium 2009-10 to 2011-12 (By States)

(Quantity in tonnes; value in ₹'000)

State	2009-10		2010-11		2011-12(P)	
	Qty	Value	Qty	Value	Qty	Value
India	553	105211	550	104958	449	85862
Kerala	68	12900	57	10400	57	8200
Rajasthan	485	92311	493	94558	392	77662

CADMIUM

**Table – 3 : Production of Cadmium, 2010-11 and 2011-12
(By Sector/States/Districts)**

(Quantity in tonnes; value in ₹'000)

State/District	Smelter	2010-11		2011-12 (P)	
		Quantity	Value	Quantity	Value
India		550	104958	449	85862
Private sector		550	104958	449	85862
Kerala		57	10400	57	8200
Ernakulam	Binani	57	10400	57	8200
Rajasthan		493	94558	392	77662
Chittorgarh	HZL Chanderiya &	493	94558	392	77662
Udaipur	Debari				

RECYCLING

National Collection and Recycling Associations (NCRAs) have been created around the world to promote the collection and recycling of all batteries, both from the general public and from industrial consumers. Nickel-cadmium batteries are virtually 100 percent recyclable once they have been collected.

There are 9 major Ni-Cd battery recycling plants located in the United States of America, Europe and Japan. These plants are capable of recycling approximately 20,000 million tonnes of industrial and consumer Ni-Cd batteries and other waste and scrap from which cadmium can be recovered. This includes, copper-cadmium alloy scrap, some complex non-ferrous alloy scrap and cadmium containing dust from electric arc furnace.

SUBSTITUTES

Suitable replacements of cadmium in all uses, especially in pigments and plating are being contemplated and enforced owing to the pollution hazards associated with the use of cadmium. Ni-Cd batteries, in some applications, are replaced with lithium ion and nickel metal hydride batteries. However, higher costs of these substitutes restrict their uses. Cadmium in plating applications can be substituted by coatings of zinc or vapour-deposited aluminium. Cerium sulphide is used as a replacement for cadmium pigments mostly for plastics. Cadmium Telluride (CdTe) flexible thin film solar cells are an alternative to traditional

crystalline silicon solar cells and are suitable for commercial roof top applications and large scale ground mounted utility systems. CdTe photovoltaic cells are potentially a safe, environment friendly application for cadmium.

In India, cadmium is consumed in industries like paint, glass and chemical.

HEALTH AND SAFETY

Cadmium in all its chemical forms is considered highly toxic to living species as it does not decompose and is ingested easily through food, water and air but cannot be excreted. It is both bioaccumulated and biomagnified. Ingested cadmium accumulates in liver, kidney, pancreas and thyroid. Excessive exposure to cadmium has been linked with respiratory insufficiency (via occupational exposure) and renal disturbance (via environmental and occupational exposure). Cadmium has also been implicated in the development of cancer of various types.

During the last decade, regulatory pressure to reduce or even eliminate the use of cadmium has gained momentum in many developed countries. The world recommended target guidelines for cadmium as a residual heavy metal below which no major risk is expected which could have significant or adverse impact on aquatic biota or human use, is 0.1 mg/l. In the USA, Federal and State agencies regulate cadmium content in the environment. Cadmium

CADMIUM

present in CRT screens, printer inks, toners, etc. is known to cause health hazards affecting the kidneys and causing flue like symptoms and muscular pain. In India, the silver jewellery industry is an important cottage industry. Silver is mixed with cadmium and then used to make silver jewellery.

During this process, there is a formation of cadmium fumes and the workers inhale the fumes. Cadmium being a neurotoxic and nephrotoxic heavy metal results in cadmium induced peripheral neuropathy, nephropathy and decreased bone density. Cadmium metal also known as KDM, used as a economical soldering material, may have ill effects on human health. Bureau of Indian Standard (BIS) has also banned its used in hall marked gold jewellery.

WORLD REVIEW

Cadmium is extracted from zinc ores and concentrates, and other materials like scrap. Zinc-to-cadmium ratios in typical zinc ores range from 200:1 to 400:1. The world reserves of cadmium are estimated at 0.5 million tonnes in terms of metal content, located in China (18%), Peru (11%), India (7%), USA and Kazakhstan (6%) each. The world reserves of cadmium by principal countries are furnished in Table - 4.

**Table – 4 : World Reserves of Cadmium
(By Principal Countries)**

(In tonnes of metal content)

Country	Reserves
World : Total (rounded)	500000
Australia	NA
Canada	23000
China	92000
India	35000
Kazakhstan	30000
Mexico	47000
Peru	55000
Poland	16000
Russia	44000
USA	32000
Other countries	130000

Source: Mineral Commodity Summaries, 2013.

The world production of cadmium was estimated at 21,203 tonnes in 2011. Most of the world's primary cadmium was being produced in Asia and the Pacific. China, Republic of Korea, Japan, Canada, Mexico, Kazakhstan, Russia and USA were the important producers.

World's secondary cadmium production accounted for 20% of the total metal production. Most secondary metal was produced at Ni-Cd battery recycling facilities in Asia, Europe and the United States. China, Belgium and Japan are by far the world's largest consumers of cadmium. The world production of cadmium during 2009 to 2011 by principal countries is furnished in Table-5.

Australia

Most of the cadmium metal produced was exported; only a small amount was consumed in the country by specialised electroplating industries. Sun Metals Corp. Pty Ltd, a subsidiary of Korea Zinc Co. Ltd, zinc refinery near Townsville northern Queensland had the capacity to produce 1,000 tonnes per year of cadmium cake (containing 75-80% cadmium).

Belgium

Belgium was a significant consumer of refined cadmium. Floridienne Chimic S.A. accounted for most of the Belgium consumption for the production of cadmium compounds (carbonate, nitrate and oxide) and powder which were then exported.

Canada

Teck, Resources Ltd (Vancouver, British Columbia) produced approximately 1,000 tonnes per year of refined cadmium at its metallurgical complex at Trail British Columbia. This plant was constructed in 1991.

China

China was the world's leading producer and consumer of refined cadmium.

Korea, rep. of

Korea Zinc (Seoul) was one of the leading suppliers of cadmium metal to China. Production capacity of refined cadmium at the company's Onsan zinc-lead refinery in Kyoung Nam Province was approximately 3,000 tonnes per year. Cadmium sticks were also produced at Young Poong Corp's (Seoul Sukpo zinc refinery).

CADMIUM

**Table – 5 : World Production of Cadmium
(By Principal Countries)**

(In tonnes)

Country	2009	2010	2011
World : Total	20200	22400	21203
Australia ^e	370	350	390
Bulgaria	413	389	430 ^e
Canada	1299	1357	1203
China	7053	7263	7360
Germany	250	300	-
India	553	550	460 ^e
Japan	1824	2053	1755
Kazakhstan	1300	1400	1400
Korea, Rep. of	2500	4166	3005
Mexico	1510	1464	1494
Netherlands ^e	490	560	560
Norway	249	300	309
Peru	289	357	572
Poland	534	451	526
Russia ^e	700	700	700
USA	633	637	600
Other countries	233	103	439

Source: World Mineral Production, 2007-2011.

**Table – 6 : Exports of Cadmium
(Including Waste & Scrap)
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	20	11027	9	3304
Australia	-	-	++	1594
Iran	-	-	3	961
Bangladesh	17	3822	6	225
UK	++	1842	++	146
Malaysia	-	-	++	127
USA	++	460	++	71
Pakistan	-	-	++	66
Afghanistan	-	-	++	54
Bahrain	++	37	++	32
UAE	++	33	++	27
Other countries	3	4833	++	1

**Table – 7 : Exports of Cadmium Unwrought,
Powders
(By Country)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	-	-	-	146
U K	-	-	++	146

FOREIGN TRADE

Exports

In 2011-12, exports of cadmium (including waste & scrap) were only 9 tonnes as compared to 20 tonnes in the previous year. Exports were mainly to Bangladesh and Iran (Table-6).

Exports also comprised nominal unwrought powders to UK (Table-7).

Imports

Imports of cadmium (including waste & scrap) decreased marginally in 2011-12 to 567 tonnes from 655 tonnes in the previous year. The imports comprised 382 tonnes unwrought, powders and 182 tonnes scrap besides nominal quantity of cadmium and alloys in 2011-12. Imports were mostly from Republic of Korea, Japan and Netherlands (Tables-8 to 11).

**Table – 8 : Imports of Cadmium
(Including Waste & Scrap)
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹ '000)	Qty (t)	Value (₹ '000)
All Countries	655	122567	567	84058
Korea, Rep. of	463	86423	265	39986
Japan	130	23333	195	26400
Netherlands	-	-	40	4598
China	1	630	3	3653
Belgium	++	105	20	2543
Mexico	60	11517	20	2258
Austria	-	-	20	2113
Canada	1	306	1	1237
Germany	++	30	3	678
Hong Kong	-	-	++	502
Other countries	++	223	++	90

CADMIUM

**Table – 9 : Imports of Cadmium & Alloys
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	1	342	3	874
Germany	++	7	3	678
Hong Kong	-	-	++	104
USA	++	29	++	39
UK	-	-	++	34
Denmark	-	-	++	16
Israel	-	-	++	3
Other countries	1	306	-	-

**Table – 10 : Imports of Cadmium : Unwrought, Powders
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	572	106673	382	53067
Japan	130	23333	195	26398
Korea, Rep. of	381	70873	86	13643
Netherlands	-	-	40	4598
Belgium	++	105	20	2543
Mexico	60	11517	20	2258
Austria	-	-	20	2113
China	1	630	1	1116
Hong Kong	-	-	++	398
Other countries	++	215	-	-

**Table – 11 : Imports of Cadmium & Scrap
(By Countries)**

Country	2010-11		2011-12	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	82	15552	182	30117
Korea, Rep. of	82	15550	179	26343
China	-	-	2	2537
Canada	-	-	1	1237
Other countries	++	2	-	-

CADMIUM

FUTURE OUTLOOK

The cadmium market in the world is in a state of uncertainty. While the primary cadmium supply is on decrease, there is a modest rise in production through recycling. Though, cadmium consumption in various applications is clamoured with concerns over its toxicity and hazardous effect on human health and environment, the production of cadmium as a by-product will however continue as long as lead and zinc are produced.

However, demand for cadmium may increase owing to several new market opportunities for Ni-Cd batteries, particularly in industrial

applications. Ni-Cd battery power is used in electrical vehicles as also in a limited number of hybrid electrical vehicles, making important contribution to the development of the electric car market in Europe.

Cadmium pigments and stabilisers are important additives in certain specialised plastics, glasses, ceramics and enamels to achieve bright colours along with long service life, even in very demanding applications. It should also be emphasised that cadmium in these applications is in a chemically very stable, highly insoluble form and embedded in the product matrix.