

CADMIUM



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**CADMIUM**

**(FINAL RELEASE)**

**GOVERNMENT OF INDIA  
MINISTRY OF MINES  
INDIAN BUREAU OF MINES**

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# 3 Cadmium

Cadmium is a soft, bluish-white metal of low melting point which is 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 during 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, the concentration of 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 tpy capacity. Binani Zinc Ltd (Edayar Zinc Ltd) reported the remaining 80 tpy capacity (Table-1). HZL produces cadmium of high quality in its zinc smelters which is 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. High purity cadmium is typically used for nuclear shielding applications.

**Table – 1 : Installed Capacity for Recovery of Cadmium**

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

\* Operation suspended since 2002.

\*\* Operation suspended since April-2014.

## USES

Cadmium is used to control the fissionable elements in nuclear reactors. Along with nickel, it is used in electrical storage/rechargeable 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 where 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 fission, television and offshore industries. Cadmium plating is used mainly in the aviation and aerospace industries to protect fasteners exposed to hostile environments.

## PRODUCTION & PRICES

Production of cadmium is reported as a by-product of zinc smelting and is 35 tonnes in 2016-17 as compared to nil production in the previous year. The entire production in 2016-17 was reported from the state of Rajasthan (Tables-2 and 3). The foreign market prices of cadmium are furnished in the General Review on "Prices".

**Table – 2 : Production of Cadmium 2014-15 to 2016-17 (By States)**

State	(Quantity in tonnes; Value in `'000)					
	2014-15		2015-16		2016-17 (P)	
	Qty	Value	Qty	Value	Qty	Value
<b>India</b>	<b>69</b>	<b>9610</b>	-	-	<b>35</b>	<b>4463</b>
Kerala	-	-	-	-	-	-
Rajasthan	69	9610	-	-	35	4463

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**Table – 3 : Production of Cadmium, 2015-16 and 2016-17  
(By Sector/States/Districts)**

(Quantity in tonnes; Value in `000)

State/District	Smelter	2015-16		2016-17 (P)	
		Quantity	Value	Quantity	Value
<b>India</b>		-	-	<b>35</b>	<b>4463</b>
Private sector		-	-	35	4463
<b>Rajasthan</b>		-	-	<b>35</b>	<b>4463</b>
Chittorgarh	HZL	-	-	35	4463
Rajsamand	Chanderiya				
Udaipur	Dariba				
	Debari				

## RECYCLING

National Waste and Recycling Associations (NWRAs) have been created around the world to promote the collection and recycling of all batteries, both from the general public and industrial consumers. Nickel-cadmium batteries which account for about three-fourth of the cadmium consumed, 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. This includes copper-cadmium alloy scrap, some complex non-ferrous alloy scrap and cadmium containing dust from electric arc furnace. India imports cadmium & scraps. However, the details of the recycling units are not available.

## 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 lead-acid, fuel cells 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 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 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 cadmium consuming industry. Silver mixed with cadmium is used in the making of silver 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. Quantitative estimates of reserves are not available.

The world production of cadmium was estimated at 26,500 tonnes in 2016. Most of the world's primary cadmium is produced mainly in China, Republic of Korea, Japan, Kazakhstan, Mexico, Canada, Russia and Peru. As per mineral commodity summary, 2018 of USGS Report, the world refinery production of cadmium was estimated at 23,900 & 23,000 tonnes in 2016 & 2017 respectively.

World's secondary cadmium production accounted for 20% of the total metal production. Most secondary metal is 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 2014 to 2016 by principal countries is furnished in Table-4.

### Australia

Nyrstar produces cadmium as by-product from its Hobart zinc smelter in Tasmania and its Port Pirie integrated multi-metals recovery plant in South Australia. Following the completion of mining at MMG Ltd's Century zinc-lead mine in Australia in August, Nyrstar was reconfiguring its Hobart smelter to allow it to treat increased volumes of cadmium and zinc smelting residues generated from newly sourced, more complex feedstock. The project was expected to be commissioned in the second half of 2015. The Century Mine operated for 16 years and, at full production, was one of the leading global zinc-producing mines. Nyrstar had plans in place to step-up its cadmium cake production capacity at Port Pirie. The expansion project was expected to be completed in the third quarter of 2016.

### Belgium

Flaurea Chemicals [owned by Aurea SA (France), formerly Floridienne Chimie] consumed cadmium to produce cadmium compounds, including cadmium chloride, nitrate and oxide as well as cadmium powder at its manufacturing facility in Ath.

### Canada

Teck Resources Ltd's metallurgical complex in Trail, British Columbia, had the capacity to produce

up to 1,400 tonnes per year of refined cadmium. Cadmium metal products included balls, billets and sticks for NiCd battery manufacturing and continuously cast cadmium sheet for radiation shielding. Teck also produced cadmium chemicals. HudBay Minerals Inc.'s copper smelting and zinc refining operations in Flin Flon, Manitoba, produced cadmium metal. Most of the cadmium metal produced in Canada is believed to be exported.

### Korea, Republic of

Korea Zinc Ltd's Onsan zinc-lead refinery does have the capacity to produce 3,000 tonnes per year of refined cadmium, and Young Poong Corp.'s Sukpo zinc refinery too has the capacity to produce 1,400 tonnes per year of cadmium. Most of the cadmium produced gets exported mainly to China.

### Mexico

The Instituto Nacional de Estadística y Geografía (2016) reported that Mexico produced about 1,300 tonnes of cadmium in 2015, 8% less than that in 2014. According to data reported by the two known producers, the total cadmium production in 2015 was about 1,230 tonnes. Industrias Peñoles S.A.B. de C.V.'s Met-Mex metallurgical complex in Torreon produced 633 t of cadmium in 2015, 9% less than that in 2014, and Grupo Mexico S.A.B. de C.V.'s zinc smelter in San Luis Potosi produced about 600 tonnes of cadmium in 2015, unchanged from that in 2014.

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

(In tonnes)			
Country	2014	2015	2016
<b>World: Total (rounded off)</b>	<b>25500</b>	<b>24900</b>	<b>26500</b>
Bulgaria	382	344	350
Canada	1187	1159	2305
China	8201	8162	8100 <sup>e</sup>
Germany <sup>e</sup>	400	400	400
Japan	2039	2188	2170
Kazakhstan	1633	1475	2682
Korea, Rep. of	5645	5600 <sup>e</sup>	4600
Mexico	1409	1283	1244
Netherlands <sup>e</sup>	620	620	620
Norway <sup>e</sup>	310	310	335
Peru	769	757	820
Poland	628	383	319
Russia <sup>e</sup>	1200	1300	1700
USA <sup>e</sup>	550	500	400
Other countries	499	439	435

*Source: World Mineral Production, 2012-16, BGS.*

## FOREIGN TRADE

### Exports

Exports of Cadmium (including waste & scrap) increased to 237 tonnes during 2016-17 from that of 115 tonnes in the previous year. Exports were mainly to Bangladesh (68%) and China (30%).

Exports of cadmium & alloys also increased to 159 tonnes during 2016-17 as against 99 tonnes in the previous year. However, exports of cadmium & scrap decreased considerably at one tonne as against 15 tonnes in the previous year. Exports of cadmium unwrought and powders increased

drastically to 77 tonnes as compared to only one tonne in the previous year (Tables-5 to 8).

### Imports

Imports of cadmium (including waste & scrap) decreased slightly to 4,737 tonnes in 2016-17 from 5,053 tonnes in the previous year. The imports comprised 3,798 tonnes unwrought, powders and 939 tonnes scrap besides nominal quantity of cadmium and alloys in 2016-17. Imports were mostly from Korea, Rep.of (41%), Japan (16%), Peru (11%), Russia (10%), Uzbekistan (6%), Brazil (5%) and France & Belgium (3% each) (Tables-9 to 12).

**Table – 5: Exports of Cadmium (Including Waste & Scrap)  
(By Countries)**

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value ( ` '000)	Qty (t)	Value ( ` '000)
<b>All Countries</b>	<b>115</b>	<b>9373</b>	<b>237</b>	<b>19876</b>
Bangladesh	112	7119	162	11334
China	-	-	72	7453
Saudi Arabia	-	-	2	415
UK	++	1280	++	249
Algeria	1	219	1	201
Pakistan	2	428	++	105
UAE	-	-	++	72
Tunisia	-	-	++	44
Philippines	-	-	++	2
Malaysia	-	-	++	1
Other countries	++	327	-	-

**Table – 6: Exports of Cadmium & Alloys  
(By Countries)**

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value ( ` '000)	Qty (t)	Value ( ` '000)
<b>All Countries</b>	<b>99</b>	<b>7801</b>	<b>159</b>	<b>11537</b>
Bangladesh	97	6056	159	11223
UK	++	1280	++	249
UAE	-	-	++	65
Pakistan	2	428	-	-
Indonesia	++	35	-	-
Ethiopia	++	2	-	-

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**Table – 7: Exports of Cadmium & Scrap  
(By Countries)**

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
<b>All Countries</b>	<b>15</b>	<b>1549</b>	<b>1</b>	<b>252</b>
Algeria	1	219	1	201
Tunisia	-	-	++	44
UAE	-	-	++	7
Bangladesh	14	1040	-	-
USA	++	290	-	-

**Table – 8: Exports of Cadmium :Unwrought,  
Powders  
(By Countries)**

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
<b>All Countries</b>	<b>1</b>	<b>23</b>	<b>77</b>	<b>8087</b>
China	-	-	72	7453
Saudi Arabia	-	-	2	415
Bangladesh	1	23	3	111
Pakistan	-	-	++	105
Philippines	-	-	++	2
Malaysia	-	-	++	1

**Table – 9: Imports of Cadmium (Including  
Waste & Scrap)  
(By Countries)**

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
<b>All Countries</b>	<b>5053</b>	<b>372979</b>	<b>4737</b>	<b>446607</b>
Korea, Rep. of	2054	152726	1936	188945
Japan	926	71232	773	75040
Peru	246	17341	514	47617
Russia	119	12310	478	40363
Uzbekistan	142	8575	277	24229
Brazil	-	-	223	18434
France	-	-	155	14206
Belgium	198	12070	131	12073
Australia	370	24483	100	9487
Mexico	666	47239	82	7237
Other countries	332	27003	68	8976

**Table – 11: Imports of Cadmium: Unwrought,  
Powders  
(By Countries)**

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
<b>All Countries</b>	<b>3658</b>	<b>269226</b>	<b>3798</b>	<b>353270</b>
Korea, Rep. of	1104	82297	1257	121474
Japan	806	62330	674	65803
Russia	119	12310	478	40363
Peru	166	12281	380	35310
Uzbekistan	102	5887	254	22365
Brazil	-	-	223	18434
France	-	-	155	14206
Belgium	198	12070	131	12073
Australia	370	24483	100	9487
Mexico	585	41616	82	7237
Other countries	208	15952	64	6518

**Table – 10: Imports of Cadmium & Alloys  
(By Countries)**

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
<b>All Countries</b>	<b>22</b>	<b>3462</b>	<b>++</b>	<b>91</b>
USA	1	2034	++	42
Germany	1	56	++	28
UK	++	7	++	21
UAE	20	1365	-	-

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**Table – 12 : Imports of Cadmium & Scrap  
(By Countries)**

Country	2015-16 (R)		2016-17 (P)	
	Qty (t)	Value (` '000)	Qty (t)	Value (` '000)
<b>All Countries</b>	<b>1373</b>	<b>100291</b>	<b>939</b>	<b>93246</b>
Korea, Rep. of	950	70429	679	67471
Peru	80	5060	134	12307
Japan	120	8902	99	9237
Uzbekistan	40	2688	23	1864
USA	-	-	4	1652
China	50	3558	++	715
Mexico	81	5623	-	-
UK	44	3037	-	-
Canada	8	975	-	-
Germany	++	19	-	-

## FUTURE OUTLOOK

The world cadmium market based on the world production of cadmium does indicate a fluctuate trend. 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.

The demand for cadmium is increasing owing to several new market opportunities

for Ni-Cd batteries, particularly in industrial applications. Ni-Cd battery is used in electrical vehicles albeit in limited number in hybrid electrical vehicles, and has been 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 which enable 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 is embedded in the product matrix.