

CADMIUM



Indian Minerals Yearbook 2022

(Part- II Metals and Alloys)

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CADMIUM

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**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

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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%.

INDUSTRY

The total annual installed capacity for recovering cadmium was 913 tpy 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)
Total		913
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 generally reported as a by-product of zinc smelting and is nil during both the year i.e. 2020-21 & 2021-22. The foreign market prices of cadmium are furnished in the General Review on "Prices".

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-fourths of the cadmium consumed are virtually 100 per cent recyclable once they have been collected. The recovery of cadmium from cadmium products through recycling not only ensures that cadmium be kept out of the waste stream and out of the environment, but also that there is consumption of this valuable natural resource as well. Exide Industries Ltd India's largest manufacturer of lead-acid

storage batteries and power storage solutions provider, has invested in building a battery recycling plant at Haldia (West Bengal) and has plans to expand its existing facility to manufacture Nickel-Cadmium batteries. The plant in Haldia will have a monthly capacity of 15,000 tonnes, making it the country's largest lead recycling facility. The project would give the company's recycling capacity a tremendous boost. It already operates two lead recycling plants near Pune and Bengaluru, which have a combined monthly capacity of 11,500 tonnes of recycled lead. The expansion project in Haldia is aimed at producing high-end Nickel-Cadmium batteries in technical collaboration with Furukawa of Japan. "These batteries find applications in bullet trains, metro rail and other critical installations. This plant will also produce lead-acid batteries".

As per JMK Research estimates, the lithium-ion battery market in India is expected to increase from 2.9 GWh in 2018 to about 132 GWh by 2030 (CAGR of 35.5%). Raasi Solar has announced plans to set up a 300MW plant focussing on lithium battery recycling along with battery assembling and cell manufacturing facility.

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 if ingested through food, water and air it does not get excreted easily. 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 generally recovered from zinc ores and concentrates. Sphalerite, the most economically significant zinc ore mineral, commonly contains minor amounts of cadmium, which shares certain similar chemical properties with zinc and often substitutes for zinc in the sphalerite crystal lattice. The cadmium mineral greenockite is frequently associated with weathered sphalerite and wurzite. Zinc-bearing coals of the Central United States and Carboniferous Age coals of other countries also contain large subeconomic resources of cadmium. Zinc-to-cadmium ratios in typical zinc ores range from 200:1

to 400:1. Quantitative estimates of reserves are not available. Cadmium content of typical zinc ore averages about 0.03%.

The world production of cadmium was estimated at about 25600 tonnes in 2021. China (40%), Rep. of Korea (18%) and Japan (7%), Canada (7%) & Kazakhstan (6%), and the remaining share was contributed by other countries. Quantitative estimates of reserves are not available. The cadmium content of typical zinc ores averages about 0.03%. Most of the world's primary cadmium is produced mainly in China, Republic of Korea, Japan, Canada, Kazakhstan, Mexico, Russia and Peru.

World's secondary cadmium production accounted for 20% of the total metal production. Most secondary metal is produced at NiCd 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 2019 to 2021 by principal countries is furnished in Table-3. To provide a generalised view of the development in various countries, the country-wise description sourced from latest available publication of Minerals Yearbook 'USGS' 2018 is furnished as below.

China

Supply from large cadmium-producing smelters was stable, but cadmium from smaller smelters decreased because of ongoing environmental inspections.

Korea, Republic of

Most of the cadmium produced in the Republic of Korea, the second-ranked producer after China, was exported to China and India. Korea Zinc Co. Ltd.s Onsan zinc-lead refinery had the capacity to produce 5,100 metric tonnes per year (tonnes/year) of refined cadmium, and Young Poong Corp.'s Seokpo zinc refinery had the capacity to produce 1,750 tonnes/year of cadmium.

Russia

Ural Mining and Metallurgical Co.'s Vladikavkaz zinc plant, one of two zinc smelters in Russia that produced cadmium, was closed in October because of significant damage from a fire. The cadmium capacity of the plant was about 300 tonnes/year. Repairs would take at least 6 to 8 months according to preliminary estimates from the company.

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

(In tonnes)			
Country	2019	2020	2021
World: Total (rounded)	26800	24200	25600
China	*10300	*10300	10349
Korea, Rep. of	*4500	*4500	*4500
Japan	2000	1880	1900
Canada ^(a)	1803	140	*1800
Kazakhstan ^(e)	*1400	*1500	*1500
Russia ^(e)	*1400	*1300	*1400
Mexico	952	978	1051
Netherlands ^(e)	*1100	*880	*900
USA	*550	*550	*550
Other countries	2806	2143	1650

Source: BGS World Mineral Production, 2017-21,

a) including cadmium sponge and/or secondary metal.

FOREIGN TRADE

Exports

Exports of Cadmium decreased by 10% to 169 tonnes during 2021-22 from 187 tonnes in the previous year. Exports were mainly to Bangladesh (99%), and UAE (1%). Similarly, exports of cadmium (including waste & scrap) also decreased by 19% to 169 tonnes during 2021-22 from that of 208 tonnes in the previous year.

Exports of cadmium & alloys decreased substantially by 27% to 123 tonnes during 2021-22 as against 170 tonnes in the previous year, while exports of cadmium & scrap decreased marginal tonnes in 2021-22 against 21 tonnes in 2020-21. Exports of cadmium unwrought and powders increased 46 tonnes during 2021-22 as compared to 156 tonnes in the previous year. Exports were mainly to Bangladesh (82%), Turkey (18%)(Tables- 3 to 7).

Imports

The imports of cadmium also decreased by 16% to 6374 tonnes in 2021-22 from 7570 tonnes in the previous year. Imports of cadmium was mainly from Korea Rep of (22%), Japan (17%), Russia (10%), Uzbekistan (5%), Hong Kong, Peru & UAE (4% each). Imports of cadmium (including waste & scrap) decreased by 18% to 6787 tonnes in 2021-22 from 8249 tonnes in the year 2020-21. The imports also comprised 6373 tonnes of unwrought & powders and 413 tonnes of cadmium & scrap besides one tonne of cadmium & alloys in 2021-22 (Tables- 8 to 12).

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**Table –3: Exports of Cadmium
(By Countries)**

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	187	24202	169	23129
Bangladesh	180	22289	168	22814
UAE	4	1008	1	258
Saudi Arabia	-	-	++	30
Myanmar	-	-	++	16
Egypt	-	-	++	5
Kenya	++	204	++	4
Sri Lanka	-	-	++	2
Turkey	3	603	-	-
Iraq	++	38	-	-
Qatar	++	31	-	-
Other countries	++	29	-	-

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	208	24971	169	23278
Bangladesh	201	22756	168	22863
UAE	4	1139	1	294
Sudan	-	-	++	64
Saudi Arabia	++	87	++	30
Myanmar	-	-	++	16
Egypt	++	24	++	5
Kenya	++	204	++	4
Sri Lanka	-	-	++	2
Turkey	3	603	-	-
Iraq	++	38	-	-
Other countries	++	120	-	-

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	170	21746	123	16061
Bangladesh	166	20475	122	15886
UAE	4	1008	1	166
Kenya	++	204	++	4
Egypt	-	-	++	3
Sri Lanka	-	-	++	2
Iraq	++	38	-	-
USA	++	13	-	-
Nepal	++	6	-	-
Fiji Is	++	2	-	-

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	21	769	++	149
Sudan	-	-	++	64
Bangladesh	21	467	++	49
UAE	++	131	++	36
Saudi Arabia	++	87	-	-
Oman	++	31	-	-
Yemen	++	29	-	-
Egypt	++	24	-	-

Figures rounded off

**Table – 8: Imports of Cadmium
(By Countries)**

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	7570	1224090	6374	1142118
Korea, Rep.of	890	137018	1423	254599
Japan	1271	202576	1201	213381
Russia	152	22463	675	125033
China	2025	348870	363	75739
Belgium	473	66157	435	71961
UAE	284	42027	406	66511
Peru	320	52128	240	40674
France	98	12507	247	36807
Australia	40	6170	180	31778
Bulgaria	264	43187	152	29982
Other countries	1753	290987	1052	195653

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	17	2456	46	7068
Bangladesh	14	1814	46	6928
U A E	-	-	++	92
Saudi Arabia	-	-	++	30
Myanmar	-	-	++	16
Egypt	-	-	++	2
Turkey	3	603	-	-
Qatar	++	31	-	-
Jordan	++	8	-	-

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	8249	1338734	6787	1218010
Korea, Rep.of	1190	183652	1683	306004
Japan	1408	226999	1201	213381
Russia	254	39613	675	125033
Belgium	473	66157	476	75876
China	2107	365126	363	75739
UAE	284	42027	406	66511
Peru	320	52128	280	47756
Australia	60	9181	233	38453
France	98	12507	247	36807
Bulgaria	264	43187	152	29982
Other countries	1791	298157	1071	202468

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	++	17	1	5570
China	-	-	1	5524
UK	-	-	++	26
USA	-	-	++	13
Germany	++	17	++	7

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	7570	1224073	6373	1136548
Korea, Rep.of	890	137018	1423	254599
Japan	1271	202576	1201	213381
Russia	152	22463	675	125033
Belgium	473	66157	435	71961
China	2025	348870	362	70215
UAE	284	42027	406	66511
Peru	320	52128	240	40674
France	98	12507	247	36807
Australia	40	6170	180	31778
Bulgaria	264	43187	152	29982
Other countries	1753	290970	1052	196507

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	679	114644	413	75892
Korea, Rep.of	300	46634	260	51405
Peru	-	-	40	7082
Australia	20	3011	53	6675
Belgium	-	-	41	3915
USA	38	5524	19	3487
Canada	++	1646	++	3328
Japan	137	24423	-	-
Russia	102	17150	-	-
China	82	16256	-	-

Figures rounded off

FUTURE OUTLOOK

The world cadmium market based on the world production of cadmium does indicate a fluctuating 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 NiCd batteries, particularly, in industrial applications. NiCd battery had been favoured for use in less expensive consumer appliances and electronics owing to their cost advantage over other battery chemistries. During the past few years, lithium-ion batteries have significantly replaced NiCd batteries in some low-cost electronics and substitution is expected to continue as the manufacturing cost of lithium-ion batteries decreases and their electrical storage capacity increases.

NiCd batteries, however, are expected to continue to be used in certain industrial applications because of their superior reliability and stability compared with the other rechargeable battery technologies. NiCd

batteries power some battery-powered electric vehicles and are also used in a limited number of hybrid electric vehicles. NiCd batteries are also used as buffers in transportable/renewable hybrid-power systems developed to generate electricity in remote locations and in underdeveloped regions. Industrial-sized NiCd batteries potentially could be used to store energy produced by certain on-grid solar or wind systems. Excess energy generated during periods of low electricity demand could be stored in batteries, from which it would later be dispatched during periods of high electricity demand. NiCd may be a favoured battery chemistry for this use owing to its stability in offshore and harsh weather environments. NiCd 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.

Cadium pigments and stabilisers are important additives in certain specialised plastic, 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.