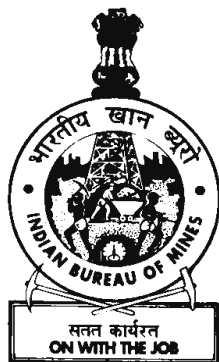


COBALT



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(Part- II : Metals & Alloys)

54th Edition

COBALT

(FINAL RELEASE)

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

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4 Cobalt

Cobalt is an important ferromagnetic strategic alloying metal having irreplaceable industrial applications. Cobalt is associated mostly with copper, nickel and arsenic ores. Cobalt is extracted as a by-product of copper, nickel, zinc or precious metals. Lateritic/limonitic nickel ore found to contain 0.08-0.15% Co along with 1.5-4% Ni in other parts of world.

RESOURCES

Occurrences of cobalt are reported from Singhbhum district, Jharkhand; Kendujhar and Jajpur districts, Odisha; Jhunjhunu district, Rajasthan; Tuensang district, Nagaland; and Jhabua and Hoshangabad districts, Madhya Pradesh. Cobalt occurring with nickeliferous limonite/laterite in Sukinda area, Jajpur district, Odisha and copper slags are two possible sources of cobalt. The sea-bed multimetal nodules are the other resources of cobalt.

As per UNFC system, resources of cobalt in terms of ore as on 1.4.2013 are estimated at 44.91 million tonnes of which about 69%, i.e. 30.91 million tonnes are estimated in Odisha. The remaining 31% resources are in Jharkhand (9 million tonnes) and Nagaland (5 million tonnes). Resources of cobalt as per UNFC system are furnished below in Table-1.

USES

Major use of cobalt is in metallurgical applications, in special alloy/super alloy industry, in magnets and cutting tools industries. Cobalt-based super alloys normally contain 45% or more

cobalt, while nickel and iron-based super alloys contain 8 to 20% cobalt. Cobalt oxide is used in chemical applications such as catalyst, dyes and pigments, paint driers/adhesives and glass & ceramics. Cobalt catalyst, mostly cobalt acetate, is used in terephthalic acid (TPA) and di-methyl-terephthalate (DMT) manufacture.

Super alloys made of cobalt have improved strength and wear & corrosion-resistance characteristics at elevated temperatures. Another use of cobalt-based super alloys is in turbines for pipeline compressors and jet aircraft engines. Hard-facing or cutting tools with cobalt alloys provide greater resistance to wear, heat, impact and corrosion. Cobalt powder finds an important application as a binder in the production of cemented tungsten carbides for heavy-duty and high-speed cutting tools. It is also used on bonded tools for diamond industry. Cobalt is used to improve the coating adhesive property of enamel in steel appliances and in manufacturing steel-belted tyres. Cobalt-molybdenum-alumina compound is used as catalyst in hydrogenation and for petroleum desulphurisation. Elemental Cobalt-60 (radioactive isotope, a production of atomic pile) is used in industrial radiography and therapeutics. Cobalt can retain ferromagnetic property up to a temperature of 1,100°C, highest for any metal. It is used in manufacturing of Alnico magnets, magnetic recording media, soft magnetic material, alloys for spacecraft, etc. The use of cobalt-rare earth permanent magnet will continue where specific advantages of reliability and good performance are required. Other significant uses of cobalt are in battery electrodes, airbags in automobiles, etc.

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**Table – 1: Reserves/Resources of Cobalt Ore as on 1.4.2013
(By States)**

(In million tonnes)

State	Reserves total (A)	Remaining resources				Total (B)	Total Resources (A+B)
		Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334		
All India	–	30.63	2	0.28	12	44.91	44.91
Jharkhand	–	–	2	–	7	9	9
Nagaland	–	–	–	–	5	5	5
Odisha	–	30.63	–	0.28	–	30.91	30.91

INDUSTRY & PRODUCTION

Presently, there is no production of cobalt in the country from indigenous ores. The demand for cobalt was met through imports.

Refining capacity of cobalt in India is estimated at about 2,060 tonnes per year. Of these, Nicomet Industries Ltd and Rubamin Ltd was India's leading producers of cobalt cathodes and compounds. Installed capacity for cobalt metal and different cobalt salts at Nicomet is 1,000 tpy.

The refiners source the heterogeneite-type cobalt ores from the Democratic Republic of Congo and other countries. The units manufacture high-purity cobalt metal and salts, viz, sulphate, acetate, oxide, chloride, carbonate and nitrate of cobalt. Cobalt metal powder is reportedly recovered from cemented carbide scrap by Sandvik Asia Ltd at its pilot plant in Pune, Maharashtra. In addition, spent cobalt catalyst from plants producing DMT, TPA and oxo alcohols are also understood to be reprocessed by several small cobalt chemical processors. However, information on reprocessing of cobalt from scrap is not available. It is expected that recycled cobalt would continue to be used for domestic supply.

SUBSTITUTES

Cobalt is used in specialised applications and is difficult to be substituted. Potential substitutes include barium or strontium ferrites, neodymium-iron-boron or nickel-iron alloys in magnets; nickel, cermets or ceramics in cutting and wear-resistant materials; nickel-based alloys or ceramics in jet engines; nickel in petroleum catalysts; rhodium in hydroformylation catalysts; and cerium, lead, manganese, iron, or vanadium in paints. Presently, about one-third of cobalt is replaced by cobalt-manganese-nickel in lithium-ion batteries.

TRADE POLICY

As per the Foreign Trade Policy 2009-2014, imports of cobalt ores & concentrates under heading No. 2605 and cobalt alloys and its products under heading No. 8105 are allowed freely, except cobalt waste & scrap (ITC-HS Code No. 8105 3000) which are restricted.

WORLD REVIEW

The world cobalt reserves are estimated at 7.1 million tonnes of metal content. Cobalt reserves are mainly in the Congo D. Rep. which contributes 48% to the total reserves followed by Australia (15%). Besides, major reserves are located in Cuba, Zambia, Russia, Philippines, Canada and New Caledonia. The world reserves of cobalt are given in Table-2.

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**Table – 2 : World Reserves of Cobalt
(By Principal Countries)**

(In '000 tonnes of metal content)

Country	Reserves
World: Total (Rounded)	7100
Australia	1100
Brazil	78
Canada	240
China	80
Congo, D.Rep	3400
Cuba	500
Madagascar	130
New Caledonia	200
Philippines	250
Russia	250
South Africa	31
USA	23
Zambia	270
Other countries	610

Source: Mineral Commodity Summaries, 2016.

The world mine production of cobalt in terms of metal content decreased marginally to 129 thousand tonnes in 2014 from 133 thousand tonnes in the previous year. The Democratic Republic of Congo (DRC) was the principal producer contributing about 59%, followed by China (7%), Canada & Australia (5% each), Zambia, Philippines & Brazil (3% each) and Cuba & New Caledonia (2% each) (Table-3).

**Table – 3 : World Mine Production of Cobalt
(By Principal Countries)**

(In tonnes of metal Content)

Country	2012	2013	2014
World: Total	134696	132709	128648
Australia	5411	6855	6252
Brazil	2900	3500	3500 ^c
Canada	6676	7168	6574
China	7498	8580	8500
Congo, Dem. P.R	86433	76593	76475
Cuba	3792	3319	3210
Finland	1381 ^c	2061	2104
Morocco [@]	1314	1353	1391
New Caledonia	2631	3080	3000 ^c
Philippines	2269	2126	4094
Russia [@]	2186	2368	2302
Zambia [@]	5665	5658	4317
Indonesia	3600	4700	329
Other countries	2940	5348	6600

Source: World Mineral Production, 2010-2014.

@-Metal.

Belgium

Umicore built plants in South Korea, Japan & in Hoboken, Belgium using recycling facility for spent rechargeable batteries and battery manufacturing scrap.

China

Owing to increased demand from domestic cobalt salt producers, China's cobalt concentrate imports increased to 180080 tonnes and imports

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of intermediate cobalt products from hydro-metallurgical processing increased to 108995 tonnes in last year. The Democratic Republic of the Congo [Congo (kinshasa)] supplied more than 90% of China's total cobalt import. Last year China consumed about 35000 tonnes of cobalt, of which cobalt for use in batteries accounted for 67% of the total followed by cemented carbide, 7% ceramics, magnetics and petrochemicals 5% each, superalloys and binder, 2% each and other uses 5%.

Zambia

Konkola Copper Mines Plc (KCM) mined copper ores from its Nchanga open pit and Konkola operations. China Non-ferrous Metal Mining Group Co Ltd (CNMC) mined and processed Cu-Co ore in the Zambian copper belt through 4 majority-owned subsidiaries namely NFCA, CLM, CCS and Sino-Metal leach Zambia Ltd.

including waste and scrap increased to 865 tonnes in 2014-15 from 758 tonnes in the previous year. Imports in 2014-15 were mainly from Belgium (13%), USA & China (12% each) and Madagascar (9%). Besides, imports of cobalt in the form of cobalt powder, other articles and unwrought cobalt also took place at 218 tonnes, 367 tonnes and 272 tonnes, respectively (Tables - 11 to 17).

**Table – 4 : Exports of Cobalt Ores & Conc.
(By Countries)**

Country	2013-14		2014-15(P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	253	47733	++	4
Netherlands	-	-	++	4
Other countries	253	47733	-	-

FOREIGN TRADE

Exports

Exports of cobalt and alloys including waste and scrap decreased slightly to 109 tonnes in 2014-15 as against 111 tonnes in the previous year. Exports were mainly to UAE (43%), USA (28%) and Iran (10%). Out of the total exports in 2014-15, exports of cobalt and alloys were 102 tonnes and those of cobalt waste & scrap were only 7 tonnes. Exports were mainly to UAE(46%), USA (26%) and Iran(11%) (Tables- 4 to 10).

Imports

Imports of cobalt ores and concentrates increased to 272 tonnes in 2014-15 from 16 tonnes in the previous year. Imports were mainly from Australia (78%). Imports of cobalt and alloys

**Table – 5 : Exports of Cobalt & Alloys
(Including Waste and Scrap)
(By Countries)**

Country	2013-14		2014-15(P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	111	32028	109	124799
UAE	-	-	47	54699
USA	11	9917	31	53552
UK	1	811	6	5297
Iran	++	423	11	4913
China	8	1298	7	2506
France	++	469	++	1797
Germany	++	28	7	654
Canada	91	18836	++	648
Russia	-	-	++	292
Austria	++	23	++	273
Other countries	++	223	++	168

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

Country	2013-14		2014-15 (P)	
	Qty	Value	Qty	Value
	(t)	(`'000)	(t)	(`'000)
All Countries	19	12500	102	119533
UAE	-	-	47	54699
USA	10	9226	27	51008
Iran	++	423	11	4913
UK	1	811	3	2574
China	8	1298	7	2506
France	++	469	++	1797
Germany	++	28	7	654
Canada	-	-	++	648
Russia	-	-	++	292
Austria	++	23	++	273
Other countries	++	222	++	169

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

Country	2013-14		2014-15 (P)	
	Qty	Value	Qty	Value
	(t)	(₹'000)	(t)	(₹'000)
All Countries	92	19528	7	5266
UK	-	-	3	2723
USA	1	692	4	2543
Other countries	91	18836	++	++

**Table – 8: Exports of Cobalt Powder
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty	Value	Qty	Value
	(t)	(`'000)	(t)	(`'000)
All Countries	2	5310	15	1645
USA	2	5113	8	721
Germany	-	-	7	607
Russia	-	-	++	292
Sri Lanka	++	89	++	24
Italy	-	-	++	1
Other countries	++	108	-	-

**Table – 9: Exports of Cobalt (Other Articles)
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty	Value	Qty	Value
	(t)	(₹'000)	(t)	(₹'000)
All Countries	17	6767	40	63189
USA	8	4113	19	50287
Iran	-	-	11	4913
UK	1	811	3	2574
China	8	1298	7	2506
France	++	469	++	1797
Canada	-	-	++	648
Austria	++	23	++	273
Luxembourg	-	-	++	113
Germany	++	28	++	47
Australia	-	-	++	21
Other countries	++	25	++	10

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**Table – 10: Exports of Cobalt Unwrought
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	++	423	47	54699
UAE	-	-	47	54699
Other countries	++	423	-	-

**Table – 11 : Imports of Cobalt Ores & Conc.
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	16	17358	272	366480
Australia	-	-	211	257373
Congo, P. Rep.	-	-	31	56855
Congo, D. Rep.	16	17358	30	52252

**Table – 12: Imports of Cobalt & Alloys
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	758	1608803	857	2042414
USA	99	265616	107	303067
Belgium	122	262316	110	276399
China	42	96243	101	217576
Madagascar	91	150383	77	147818
UK	8	22206	50	138959
France	32	111032	38	135597
Canada	91	158879	35	134989
Congo, P. Rep.	63	113305	75	126142
Norway	80	145478	60	122944
Morocco	46	78548	37	71122
Other countries	84	204797	167	367801

**Table – 13: Imports of Cobalt Powder
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	200	453163	218	536551
Belgium	57	136451	73	188752
USA	20	56353	29	80722
China	29	65578	32	71315
France	17	45887	17	48897
Zambia	-	-	20	38483
UK	2	3802	16	34080
Japan	5	18950	10	33789
South Africa	7	12007	8	11814
Finland	5	11439	6	11355
Canada	20	34786	5	9404
Other countries	38	67910	2	7940

**Table – 14 : Imports of Cobalt (Other Articles)
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	300	688526	367	960460
USA	75	194665	68	191503
Congo, P. Rep.	53	96487	75	126142
UK	6	17360	34	104879
Canada	33	56044	15	97910
Belgium	65	125437	37	86981
France	12	56722	18	78137
Australia	-	-	34	64659
Germany	4	26111	9	40574
China	8	19676	14	33077
Finland	9	22864	12	31697
Other countries	35	73160	51	104901

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**Table – 15 : Imports of Cobalt (Unwrought)
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	258	467114	272	545403
Madagascar	55	93499	77	147818
Norway	80	145478	60	122944
China	5	10989	55	113184
Morocco	35	60489	22	42940
Congo, D. Rep.	-	-	19	33323
USA	4	14598	10	30842
Canada	38	68049	15	27675
Brazil	5	8016	11	17419
France	3	8423	3	8562
Belgium	++	427	++	666
Other countries	33	57146	++	30

**Table – 16 : Imports of Cobalt & alloy(Incl waste and scrap)
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	758	1608803	865	2048322
USA	99	265616	107	303067
Belgium	122	262316	110	276399
China	42	96243	101	217576
Madagascar	91	150383	77	147818
UK	8	22206	50	138959
France	32	111032	38	135597
Canada	91	158879	35	134989
Congo, D Rep	63	113305	75	126142
Norway	80	145478	60	122944
Morocco	46	78548	37	71122
Other countries	84	204797	175	373709

**Table – 17 : Imports of Cobalt (scrap)
(By Countries)**

Country	2013-14		2014-15(P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	-	-	8	5908
UAE	-	-	8	5908
Other countries	-	-	-	-

FUTURE OUTLOOK

India does not have any primary cobalt resources. Two possible secondary sources are nickel-bearing laterite deposits in Odisha and declining copper slag produced by HCL, which have been under R&D studies for commercial applications over the years. Recovery in small quantities of cobalt from wastes like cutting-tool scrap and beta-naphtha cake from the zinc industry was carried out in the late 1980s. In addition, conversion of spent catalysts from plants producing TPA, DMT and the oxo-alcohols were also carried out as a regular source of cobalt, though, these were mostly recycled. The cobalt refiners in India have catered to the market for chemical applications or where the cobalt metal or salt is dissolved and converted to cobalt oxide for cutting tools application.

Due to specialised nature of applications and difficulty in substitution, the future demand for

cobalt is likely to follow an increasing trend. The bulk demand for cobalt in the world would be in cemented carbides used in cutting tools, catalysts in petrochemical industry, drying agent in paint industry and in super alloys used mainly in jet engine parts. The demand for cobalt is supposed to go up with use of super-alloys in civil aviation, catalysts for gas-to-liquid production of synthetic liquid fuels, rechargeable batteries for hybrid electric vehicles, cellular telephones, aerospace and energy generation industries. Last year, global demand for lithium-ion batteries has grown rapidly as a result of the increase in demand for mobile phones, portable PCs & electronic devices. In India, cobalt will find major applications in metallurgy due to greater demand in special alloys/ super alloys and in cutting tools and as an alloy in permanent magnets. Cobalt powder demand will continue to grow for bonded tools in diamond industry.