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COBALT

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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. It is a chemical element with the symbol Co and atomic no.27. 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 usually is found to contain 0.08-0.15% Co along with 1.5-4% Ni in many parts of the world.

RESERVES/RESOURCES

Occurrences of cobalt are reported from Singhbhum district, Jharkhand; Kendujhar and Jajpur districts, Odisha; Jhunjhunu district, Rajasthan; Tuensang district, Nagaland; and Jhabua & Hoshangabad districts, Madhya Pradesh. Cobalt occurring with nickeliferous limonite/laterite in Sukinda area, Jajpur district, Odisha and copper slags produced by HCL are two possible sources of cobalt. The sea-bed multimetal nodules which contain 0.3% Co (Av) along with other minerals are the other sources of cobalt.

As per NMI data based on UNFC system, reserves/resources of cobalt in terms of ore as on 1.4.2015 have been 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). The Reserves/ Resources of cobalt as per UNFC system are furnished below in Table-1.

EXPLORATION & DEVELOPMENT

The exploration and development details, if any, are covered in the Review on "Exploration & Development" under "General Reviews".

USES

Major use of cobalt is in metallurgical applications, in Special alloy/Superalloy Industry, in magnets and cutting tools industries. Cobalt is used as precursors (cobalt compounds) for cathodes in rechargeable batteries. Largest demand for cobalt has been from the Rechargeable Battery Industry. It was initially used in NiCd and NiMH cells, however, post the invention of the Lithium ion battery, there was phenomenal growth in cobalt consumption in the Battery Sector (CRU). Cobalt-based super alloys normally contain 45% or more cobalt, while nickel and iron-based superalloys contain 8 to 20% cobalt. Cobalt oxide is used in chemical applications, such as, catalyst, dyes & pigments, paint driers/adhesives and glass & ceramics. Cobalt catalyst, mostly cobalt acetate is used in the manufacture of Terephthalic acid (TPA) and Dimethyl terephthalate (DMT).

Superalloys made of cobalt have improved strength and wear & corrosion-resistance characteristics at elevated temperatures. Another use of cobalt-based superalloys 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

Table – 1: Reserves/Resources of Cobalt Ore as on 1.4.2015
(By States)

(In million tonnes)

State	Reserves	Remaining Resources					Total
	Total (A)	Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	Resources (A+B)
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

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 application improves the coating/adhesive property of enamel in steel appliances and is used 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 the manufacturing of Alnico magnets, magnetic recording media, soft magnetic material, alloys for spacecraft, etc. Cobalt is alloyed with aluminium and nickel to manufacture powerful magnets. Permanent magnets are used in wind turbines and electric motors for automobiles & aircraft. Other significant uses of cobalt are in battery electrodes, airbags in automobiles, etc. Further, as per Avicenne (CRU), 2015, different types of lithium ion batteries with composition of cobalt are available in the market, i.e. Lithium-Cobalt Oxide (LCO) which contains 60% of cobalt oxide is used in high capacity storage cell phone, iPad cameras and wearables; NMC-Lithium-Nickel-Manganese-Cobalt oxide that contains 10-20% of cobalt sulphate is used in the manufacturing of low capacity but high specific power batteries which have longer cycle life have found applications in laptops and electronic vehicle (EVs); and NCA Lithium-Nickel-Cobalt Aluminium-oxide that contains 9% cobalt sulphate is used in EVs, electric grid storage (Tesla's EVs and Smart Grid/ home storage and laptops).

INDUSTRY & PRODUCTION

Presently, there is no production of cobalt in the country from primary cobalt resources. The demand for cobalt is usually met through imports.

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

Nicomet Industries Ltd manufactures cobalt cathodes of LME-approved specifications under NICO Brand along with nickel cathodes & sodium sulphate in Mumbai, Maharashtra. Vedanta Group is also exploring ways to produce cobalt for batteries as the Group has become the latest entrant among companies that seeks to capitalise on the anticipated electric vehicle boom. 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. In some applications, substitution for cobalt would result in a loss in product performance. Potential substitutes include barium or strontium ferrites, neodymium-iron-boron, or nickel-iron alloys in magnets; cerium, iron, lead, manganese, or vanadium in paints; cobalt-iron-copper or iron-copper in diamond tools; copper-iron-manganese for curing unsaturated polyester resins; iron, iron-cobalt-nickel, nickel, cermets, or ceramics in cutting and wear-resistant materials; iron-phosphorous, manganese, nickel-cobalt-aluminum, or nickel-cobalt-manganese in lithium-ion batteries; nickel-based alloys or ceramics in jet engines; nickel in petroleum catalysts; and rhodium in hydroformylation catalysts.

RECYCLING

Recycling technologies for recovery of cobalt especially from waste Li-ion batteries have been an evolving process. The need for technologies which can recover valuable metals and the commercialisation of that technology by the industry is highly desirable. The technology related to "Recovery of cobalt from Li-ion batteries of mobile phones" developed by National Metallurgical Laboratory (NML), Jamshedpur reportedly claims up to 95% recovery of pure cobalt from Li-ion batteries. The present technology uses Hydrometallurgy process for the recovery of cobalt from waste Li-ion batteries. In this process metal is extracted using sulphuric acid as it is less hazardous to the environment as compared to other materials. Hydrometallurgical processes are considered better than other known processes because of high proportion and purity of recovered metals, low energy requirement and minimal emission. Recovery of cobalt by this process has following benefits.

(i) Cobalt is recovered as precious metal in more pure form.

(ii) The recovery process is less hazardous.

(iii) It enables removal of Li-ion batteries from open environment and this is considered as an effective disposal mechanism by the industry.

The Mobility Mission held consultations with industry to develop battery recycling as a sustainable method for ensuring up to 95% recovery of critical minerals, such as, lithium, nickel, cobalt etc. from spent batteries, thereby ensuring regular supply of raw materials for battery maintenance.

TRADE POLICY

As per the Foreign Trade Policy 2015-2020, 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 million tonnes of cobalt metal content. Cobalt reserves are mainly in the Congo (Kinshasa) which contributes 51% to the total reserves followed by Australia (17%). Besides, major reserves are also located in Cuba (7%), Philippines & Russia (4% each) and Canada 3%. The world reserves of cobalt are provided in Table-2.

The world mine production of cobalt in terms of metal content increased by 18% to 168 thousand tonnes in 2018. The Democratic Republic of Congo (DRC) was the principal producer contributing about (65%) , followed by New Caledonia (6%), China (5%), and Australia (3 %) (Table-3).

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

(In tonnes of metal content)

Country	Reserves
World: Total (rounded off)	**7000000**
Australia	1200000[a]
Canada	230000
China	80000
Congo (Kinshasa)	3600000
Cuba	500000
Madagascar	120000
Morocco	18000
New Caledonia[b]	-
Papua New Guinea	56000
Philippines	260000
Russia	250000
South Africa	50000
USA	55000
Other countries	570000

Source: *USGS Mineral Commodity Summaries, 2020.*
- Zero
[a]For Australia, Joint Ore Reserves Committee-compliant reserves were 3,10,000 tonnes.
[b]Overseas territory of France. Although nickel-cobalt mining and processing continued, the leading producer reported zero reserves based on recent nickel prices.

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

(In tonnes of metal Content)

Country	2016	2017	2018
World:Total (rounded off)	**144000**	**142000**	**168000**
Congo, Dem. P.R.	68822	82461	109402
New Caledonia	17844	9397	9400[c]
China	9293	9000[c]	9000[c]
Australia[b]	6020	5221	5609
Philippines	4400	3700	5400
Russia	5600	4700	5330
Cuba	5514	5407	5300[c]
Canada	7148	6058	5268
Papua New Guinea	2191	3308	3275
Madagascar	3370	2840	2655
Morocco[c]	2081	1924	1806
Zambia[c]	5276	3240	1585
Finland	2260	1900[c]	1377
South Africa[c]	1101	1062	1007
Other countries	2683	1463	1387

Source *: BGS, World Mineral Production, 2014-18.*
b:Years ended 30 June of that stated:
c: Metal and/refined

In India cobalt consumption is showing rising trend. It is very important to recover cobalt from various secondary sources. At Hindustan Zinc Ltd., process for recovery of cobalt from purification cake has been explored at lab scale and cobalt sulphate crystal of about 60% purity with 50% recovery has been generated.

To provide a generalised view of the development in various countries, the countrywise description, as sourced from the latest available publication of USGS 2016 minerals yearbook cobalt (advance Release) is furnished below:

Australia

In 2016, estimated cobalt mine production from Western Australia, that included, cobalt produced as a by-product of nickel mining and production of refined cobalt (which include production from imported nickel laterite ore) both of these reported decrease in production.

The Palmer Nickel and Cobalt Refinery (owned by Australian businessman Clive Palmer, operated by Queensland Nickel Pty. Ltd) in Townsville, Queensland, produced an estimated 150 tonnes of refined cobalt as cobalt oxide/hydroxide, a significant decrease from the 1,850 tonnes produced in 2015. In mid-January 2016, Queensland Nickel entered voluntary administration as a result of financial problems owing to the low nickel price.

In recent years, the refinery's main feed materials were laterite ore imported from New Caledonia and Philippines.

First Quantum Minerals Ltd (Vancouver, British Columbia, Canada) produced intermediate nickel-cobalt hydroxide from its Ravensthorpe nickel-cobalt laterite mine and hydrometallurgical processing plant in Western Australia. In 2016, the plant produced 23,624 tonnes of nickel and based on the hydroxide containing 40% nickel and 1.4% cobalt, an estimated 830 tonnes of cobalt as against 26,668 tonnes of nickel and an estimated 930 tonnes of cobalt produced in 2015. The Mincor Resources NL ceased production of nickel-copper sulphide ore from its Mariners and Miitel Mines in Western Australia and placed the mines on care-and-maintenance status. Prior to shutdown, all the ore was toll processed by BHP Billiton at its Nickel West Kambalda concentrator and the resulting concentrate was sold to BHP Billiton under long-term agreements.

Brazil

In early 2016, in response to a decrease in nickel prices, Votorantim Metals S.A. suspended its nickel-cobalt laterite mining operation in Niquelandia, Goias State, and refined nickel and cobalt production at Sao Miguel Paulista, Sao Paulo State, Votorantim planned to keep the operations on care-and-maintenance status until market conditions improved. Mirabela Nickel Ltd was placed under voluntary administration in September 2015, and in early 2016, the Company's Santa Rita open-pit nickel sulphide mine and concentrator in Bahia State were placed on care-and maintenance status.

Canada

Vale's global cobalt production was 5,799 tonnes in 2016, 28% more than the 4,533 tonnes produced in 2015. Vale produced 1,851 tonnes (1,448 tonnes in 2015) of refined cobalt metal at its Port Colborne, Ontario, refinery; 3,188 tonnes (2,926 tonnes in 2015) of cobalt in a cobalt intermediate product at its nickel operations in Canada and New Caledonia; and 761 tonnes (159 tonnes in 2015) of cobalt contained in other intermediate products, such as, nickel concentrates. Vale's cobalt originated from company-owned nickel sulphide mines at Sudbury, Ontario, Thomson, Manitoba, and Voisey's Bay in northeastern Labrador from Company owned nickel laterite mines in Indonesia and New Caledonia and from purchased feedstock materials. Vale reported that 882 tonnes (751 tonnes in 2015) of cobalt came from Ontario, 700 tonnes (365 tonnes in 2015) came from Manitoba, 887 tonnes (849 tonnes in 2015) came from Voisey's Bay, 3,188 tonnes (239 tonnes in 2015) came from New Caledonia, and 143 tonnes (177 tonnes in 2015) came from external sources, including ore from PT Vale Indonesia Tbk in 2016.

In 2016, some of Vale's nickel concentrate from Voisey's Bay was refined at its hydrometallurgical refinery in Long Harbour, Newfoundland and Labrador, and some was smelted and refined at Vale operations in Ontario and Manitoba. Vale continued to ramp up production at the Long Harbour refinery and began producing a cobalt intermediate product in 2016. During the quarter ending December 2016, 277 tonnes of cobalt in intermediate product was produced at Long Harbour. Production of cobalt metal began in 2017.

Glencore reported that 1,000 tonnes of the cobalt produced at its Nikkelverk refinery in Norway originated from concentrates produced from its mines at Sudbury, Ontario, and Raglan, Quebec (800 tonnes in 2015).

The Fort Saskatchewan refinery, a joint venture of Sherritt and General Nickel Co. S.A., produced 3,693 tonnes of cobalt as metal powder and briquettes in 2016.

China

China was the world's leading producer and consumer of refined cobalt. In 2016, China's total production including an estimate for Umicore's Ganzhou Yi Hao plant, was estimated to constitute more than one-half of world refined cobalt production.

China's production decreased from that of 2015, reportedly in response to poor market conditions during the first half of the year; low demand for cobalt oxide combined with excessive inventories and decreasing prices of cobalt oxides and salts. China's imports of cobalt raw materials were lower than those of 2015, primarily because of decreased imports of cobalt concentrate from Congo (Kinshasa) and of raw materials from nickel operations. In spite of reduced imports and production, China's consumption increased in 2016 from that of 2015 and stocks of cobalt oxides were drawn down. Nearly 80% of China's cobalt consumption was used in the production of cathode materials from rechargeable batteries.

Numerous companies refined and (or) processed cobalt in China. In 2016, approximately 85% of China's refined cobalt was produced by 10 companies and nearly 60% was produced by 3 companies-Jinchuan, Shenzhen GEM High-Tech Co. Ltd. (including subsidiary Jiangsu Cobalt Nickel Metal Co. Ltd), and Zhejiang Huayou Cobalt Co. Ltd. Only a small portion of China's cobalt production originated from domestic mines. Most of the production was from imported cobalt concentrate and intermediate chemical compounds, the majority of which was sourced from Congo (Kinshasa). China also imported cobalt raw materials sourced from nickel operations in Australia and elsewhere and has been recovering increasing amount of cobalt from scrap in recent years.

China's State Reserve Bureau (SRB) continued to add cobalt metal to its national stockpile in 2016. In addition to receiving deliveries of cobalt purchased in November 2015, the SRB purchased 2,800 tonnes in late February 2016, with delivery due before mid-july. The cobalt reportedly was sourced from domestic producers Jiangsu Cobalt Nickel Metal, Jinchuan and Yantai CASH Industrial Co. Ltd and the trading division of Wanbao Mining Ltd.

Congo (Kinshasa)

Congo (Kinshasa) was the world's leading producer of mined cobalt and was estimated to represent more than one-half of global production. Most of the country's cobalt mine production was from copper-cobalt ores mined by industrial or mechanised methods; a lesser amount was gathered by tens of thousands of artisanal miners by handpicking cobalt-rich ores. Some of Congo (Kinshasa) ores and concentrates were exported, some were processed in Congo (Kinshasa) to intermediate materials (crude cobalt carbonate, crude cobalt hydroxide, or cobalt-bearing alloys, such as, alliage blanc), and some were refined in Congo (Kinshasa) to cobalt metal. China was the leading destination for Congo (Kinshasa)'s cobalt exports. The Government of Congo (Kinshasa) reportedly extended a moratorium on its 2013 ban on exports of copper and cobalt concentrates until December 31, 2016. The justification for the moratorium was inadequate power supply to process the concentrates in the country.

State-owned La Generale des Carrieres et des Mines SARL (Gecamines) held a minority interest in most of the copper-cobalt operations in Congo (Kinshasa). In 2016, Gecamines produced 50 tonnes of refined cobalt at its Shituru refinery in Likasi, down from 240 tonnes in 2015.

Boss Mining's oxide concentrates were exported, primarily to China, and its sulphide concentrates were sent to the Chambishi Metals plc refinery in Zambia. The Company's cobalt production has steadily decreased because of changes in ore mineralogy and in August 2016, it ceased shipments of concentrate to China. Boss Mining's copper-cobalt operation included an electrowinning plant where crude cobalt carbonate was produced.

In 2016, Tenke Fungurume Mining S.A.R.L. Freeport-McMoRan Inc.(FCX), Lundin and Gecamines] extracted copper-cobalt ore from an open-pit mine, which it processed onsite to produce 16,053 tonnes of cobalt in crude cobalt hydroxide (16,014 tonnes in 2015). The hydroxide was sold under contract or on the spot market and included sales to Freeport Cobalt (Oy's Kokkola refinery in Finland and to refineries in Belgium (Umicore), China (Jinchuan and others) and Zambia.

Mutanda Mining SPRI (Glencore and Fleurette Mumi Holding Ltd) mined copper cobalt oxide ore from open pits near Kolwezi and produced 24,500 tonnes of cobalt in concentrate and crude cobalt hydroxide, 48% more than 16,500 tonnes produced in 2015. The increase in production was attributed to successful plant optimisation projects and higher cobalt grades in the material processed. Glencore had an offtake agreement for all the operations in copper and cobalt production.

Chemaf SPRI (Shalina Resources Ltd) mined copper-cobalt ore from the Etoile open-pit mine and produced concentrate using heavy media separation technology, which it processed at its solvent extraction-electrowinning (SX-EW) plant at Usoke in Lubumbashi. In 2016 Chemaf reportedly constructed an additional flotation concentrator and a roaster at the Etoile Mine. As the ore chemistry changes from oxide ores to sulphide ores at the Etoile Mine, the roaster will be needed to convert the sulphide concentrates to oxide concentrates so they can be processed at the Usoke plant. Chemaf also was commissioning a new SX-EW plant at the mine site.

Ruashi Mining SPRL (75% Jinchuan subsidiary Metorex (Proprietary) Ltd and 25% Gecamines) produced 3,391 tonnes of cobalt in crude cobalt hydroxide (4,344 tonnes in 2015) from its Ruashi operation cast of Lubumbashi. The 22% decrease in production was mainly attributed to a lower supply of third party feed, although low plant availability, processing issues, low-grade ores, and adverse ore characteristics were also identified as contributing factors. Ruashi consisted of a copper-cobalt oxide open-pit mine, a mill and an SX-EW refinery. The cobalt hydroxide was shipped to Jinchuan for refining.

The La Sino-Congolaise des Mines S.A. (Sicomines) joint venture (China Railway Group Ltd, Gecamines, Sinohydro Corp. and Zhejiang Huayou Cobalt Co., Ltd) did not report production of copper-cobalt concentrates in 2016. China Railway had two other operating copper-cobalt mines in Congo (Kinshasa) - Luishia and Miniere De Kalumbwe Myunga Province du Katanga Division Provinciale De Mines, 2017.

Congo Dongfang International Mining SPRL (CDM), a subsidiary of Zhejiang Huayou Cobalt Co., Ltd, was responsible for procuring cobalt concentrates for Huayou's refineries in China and produced crude cobalt hydroxide at its hydrometallurgical plant in Lubumbashi. The ores and concentrates were thought to have been sourced from Compagnie Miniere Du Sud Katanga, Sicomines, and other mining operations, including artisanal miners. In 2016, CDM produced 24,800 tonnes, gross weight, of cobalt hydroxide (Darton Commodities Ltd. 2017).

Compagnie Miniere de Kambove (COMIKA) (Wanbao Mining and Gecamines) completed the first phase of construction on the open-pit Kamoya copper-cobalt mine near Kambove, Haut-Katanga Province. In November, COMIKA began shipping concentrate and had produced 31,000 tonnes, gross weight, of copper-cobalt concentrate, containing an estimated 300 tonnes of cobalt, by year end.

New Caledonia

Vale Nouvelle-Caledonie S.A.S. (Vale and Societe de Participation Miniere du Sud Caledonien S.A.S.) continued to ramp up production at its Vale New Caledonia project in the southern tip of New Caledonia's main island. The project consisted of a nickel-cobalt laterite mine, a high-pressure acid leaching processing plant and a refinery. In 2016, Vale produced 3,188 tonnes of cobalt from New Caledonia (2,391 tonnes in 2015). Statistics from the Government of New Caledonia indicated that Vale produced 2,531 tonnes of cobalt in carbonate (1,568 tonnes in 2015). Following gampup, Vale New Caledonia was expected to have a nominal production capacity of 57,000 t/yr of nickel contained in nickel oxide and 4,500 t/yr of cobalt contained in an intermediate cobalt carbonate.

In August, Societe Le Nickel (a subsidiary of Eramet) ceased production of nickel matte at its Doniambo smelter and shifted its focus entirely to ferronickel production for economic reasons. The matte had been sent to Eramet's refinery in Sandouville, France, where nickel products and cobalt chloride were produced.

FOREIGN TRADE

Exports

During 2018-19 about 1 tonne of cobalt ores & concentrates was exported while it was negligible in the preceding year.

Exports of cobalt and alloys including waste and scrap decreased drastically by 57% to 97 tonnes in 2018-19 from 222 tonnes in the previous year. Exports were mainly to Netherlands (30%), Malaysia (19%) and USA (15%). Out of the total exports in 2018-19, exports of cobalt and alloys were at 83 tonnes and those of cobalt & scrap were at 14 tonnes. Similarly, during 2018-19 exports of cobalt powder were at 21 tonnes and that of cobalt (other article) were 34 tonnes. (Tables- 4 to 10)

Imports

During the period 2018-19, about 1 tonne of cobalt ores and concentrate was imported,while it was negligible in the previous year 2017-18.

Imports of cobalt & alloys including waste and scrap decreased slightly by 4% to 835 tonnes in 2018-19 from 873 tonnes in the previous year. Imports in 2018-19 were mainly from China (19%), Netherlands (14%), USA (12%) and Belgium (11%). Out of the total imports in 2018-19, imports of cobalt & alloys were at 832 tonnes and those of cobalt & scrap were at 3 tonnes. Besides, imports of cobalt in the form of cobalt powder, other articles and unwrought cobalt were at 265 tonnes, 240 tonnes and 328 tonnes, respectively (Tables - 11 to 17).

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

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**++**	**4**	**1**	**4496**
Iran	-	-	1	4496
Netherlands	++	3	-	-
UK	++	1	-	-
China	++	-	-	-

Figures rounded off

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

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**222**	**222960**	**97**	**425188**
Netherlands	5	23757	29	107788
Malaysia	-	-	18	89053
UAE	5	24578	12	80427
USA	20	33901	14	46695
UK	89	36573	12	25879
Korea, Rep. of	++	1829	4	17727
Singapore	8	8995	4	16595
France	++	7424	1	11518
Hungary	++	5823	++	7316
Finland	1	5466	1	7267
Other countries	93	74613	2	14923

Figures rounded off

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

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**117**	**165542**	**84**	**411873**
Netherlands	5	23757	19	100258
Malaysia	-	-	18	89053
UAE	5	24578	12	80427
USA	6	16458	14	46695
UK	87	33458	11	24729
Korea, Rep. of	++	1829	4	17727
Singapore	++	42	2	13105
France	++	7424	1	11518
Hungary	++	5823	++	7316
Finland	1	5466	1	7267
Other countries	11	46718	2	13778

Figures rounded off

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

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**106**	**57418**	**14**	**13314**
Netherlands	-	-	10	7530
Singapore	8	8963	2	3490
UK	2	3115	1	1150
Germany	5	6188	1	1144
Canada	76	21651	-	-
USA	14	17443	-	-
Sri Lanka	++	57	-	-

Figures rounded off

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

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**31**	**64920**	**21**	**123549**
Netherlands	3	14794	14	85006
Korea, Rep. of	++	1829	4	17677
Singapore	-	-	2	13105
UAE	-	-	1	6292
UK	18	10356	++	659
Brazil	++	490	++	639
Bhutan	-	-	++	136
Sri Lanka	-	-	++	17
China	-	-	++	15
Uganda	-	-	++	3
Other countries	10	37451	++	1

Figures rounded off

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

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**81**	**77420**	**34**	**129874**
USA	6	15859	14	46695
UK	69	23102	11	24070
Netherlands	2	8964	5	15253
France	++	7424	1	11518
Hungary	++	5823	+	7316
Finland	1	5466	1	7267
Switzerland	++	5580	++	5024
UAE	++	2013	1	4892
Iran	-	-	++	2067
Ghana	++	744	+	1825
Other countries	1	2446	1	3947

Figures rounded off

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

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**5**	**23202**	**28**	**158451**
Malaysia	-	-	18	89045
UAE	5	22565	10	69243
Switzerland	-	-	++	74
Korea, Rep. of	-	-	++	50
Lebabon	++	9	++	29
Brazil	-	-	++	10
USA	++	599	-	-
Turkey	++	30	-	-

Figures rounded off

Table – 11: Imports of Cobalt & Alloys (Including Waste & Scrap) (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**873**	**3423424**	**835**	**4763695**
China	65	248586	155	826054
Netherlands	15	58138	118	627644
UK	82	267702	85	613210
USA	11	0425203	103	536400
Belgium	107	394248	91	500454
Japan	32	104964	67	322066
Switzerland	-	-	40	262395
Finland	46	191291	36	200603
France	34	162705	16	174829
Bahamas	-	-	30	156297
Other countries	382	1570587	94	543743

Figures rounded off

Table – 12: Imports of Cobalt Powder (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**272**	**1009881**	**265**	**1396427**
Belgium	91	327109	78	434562
USA	37	125320	50	250958
Finland	40	168627	36	200603
China	33	124375	30	144556
Japan	19	54394	20	91562
France	23	97355	11	71944
South Africa	18	69406	11	56499
Turkey	3	10691	13	55704
Italy	++	590	6	23670
Singapore	++	206	4	20781
Other countries	8	31808	6	45588

Figures rounded off

Table – 13: Imports of Cobalt (Other Articles) (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**270**	**1088022**	**240**	**1555476**
UK	79	255905	77	564987
USA	66	269878	50	269702
Japan	13	50570	33	170640
Congo, Dem. Rep.	21	85664	22	119773
France	9	57652	6	102534
China	11	33889	23	101826
Germany	4	63790	4	97058
Belgium	16	67140	12	62979
Netherlands	15	58138	6	30706
Morocco	15	54442	2	10751
Other countries	21	90954	5	24520

Figures rounded off

Table – 14: Imports of Cobalt (Unwrought) (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**333**	**1325519**	**328**	**1808483**
Netherlands	-	-	111	588761
China	22	90321	101	579672
Switzerland	-	-	40	262095
Bahamas	-	-	30	156297
Singapore	1	4728	13	64276
Japan	-	-	15	59863
UAE	-	-	5	32133
UK	++	1340	5	29080
USA	8	30004	3	15741
Hong Kong	-	-	3	11426
Other countries	302	1199126	2	9139

Figures rounded off

Table – 15: Imports of Cobalt & Alloys (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**873**	**3423424**	**832**	**4760385**
China	65	248586	155	8260554
Netherlands	15	58138	118	627644
UK	82	267702	85	613210
USA	110	425203	103	536400
Belgium	107	394728	91	500454
Japan	32	104964	67	322066
Switzerland	-	-	40	262395
Finland	46	191291	36	200603
France	34	162705	16	174829
Bahamas	-	-	30	156297
Other countries	382	1570587	91	540433

Figures rounded off

Table – 16 : Imports of Cobalt & Scrap (By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	**-**	**-**	**3**	**3310**
Singapore	-	-	3	3310

Figures rounded off

Table – 17 : Imports of Cobalt ore & Conc.
(By Countries)

Country	2017-18 (R)		2018-19 (P)	
	Qty (t)	Value (`'000)	Qty (t)	Value (`'000)
All Countries	-	-	**1**	**4476**
UK	-	-	1	4476

Figures rounded off

FUTURE OUTLOOK

India does not have any primary cobalt resources. Two possible secondary sources are nickel-bearing laterite deposits in Odisha and copper slag produced by HCL, which have been under R&D studies for commercial applications over the years. 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 superalloys used mainly in jet engine parts. The demand for cobalt is estimated to go up manifolds with use of superalloys 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. The global demand for lithium-ion batteries has grown rapidly as a result of the increase in demand for mobile phones, portable PCs & electronic devices. The demand projection for refined electronic devices had been staggering. As per CRU, cobalt consumption was forecasted to grow by an incredible rate of 68% in the period between 2015 and 2025.

In India, cobalt will find major applications in metallurgy due to greater demand in special alloys/ superalloys and in cutting tools and as an alloy in permanent magnets. Cobalt powder demand will continue to grow as it is extensively used in the manufacture of bonded tools that are used in the Diamond Industry.

As far as cobalt is concerned the Indian Industry is very small, but it is growing at a steady pace in various sectors, especially for aerospace. There is a big sector for cobalt in the Aerospace Industry mainly dependent on import of cobalt. Other industries are growing at a consistent level but cannot be compared to China. The total consumption could be 70 tonnes to 80 tonnes minimum and it could be 100 tonnes in maximum per month in terms of cobalt content. Cobalt sulphate is mostly used in Chemical Industries.

Battery manufacturing is considered as a huge potential in India which shall give a boost to new technology and product upgrading. There has been no rechargeable battery manufacturer in India but we hope to see new plants to be set up in the coming years.