Indian Minerals Yearbook 2022

(Part- II : Metals & Alloys)

61st Edition

COBALT

(ADVANCE RELEASE)

GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES

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February, 2024

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 to 0.15% Co along with 1.5 to 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 seabed 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 1.4.2020 have been estimated at 44.91 million tonnes under Remaining Resources category 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 Volume-I "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 superalloys 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

Table – 1: Reserves/Resources of Cobalt Ore as on 1.4.2020 (P)
(By Grades/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	**0**	**30.63**	**2**	**0.28**	**12**	**44.91**	**44.91**
By States							
Jharkhand	0	0	2	0	7	9	9
Nagaland	0	0	0	0	5	5	5
Odisha	0	30.63	0	0.28	0	30.91	30.91

Figures rounded off

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 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 cellphone, 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 lifecycle 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. Considering the need and significance of the problem related to energy materials like Ni and Co, CSIR-IMMT has developed suitable process flow sheets for the processing of secondary resources, such as, alloy scrap and spent catalyst to produce Ni/Co based precursor material that can be used for battery applications particularly in preparing electrodes of Li-ion batteries. In addition to this CSIR–IMMT has taken up another project from MIDHANI to produce high purity cobalt metal from impure cobalt hydroxide.

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 ITC (HS), 2022 Scheduled Import Policy, 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 is restricted.

WORLD REVIEW

The world cobalt reserves are estimated at 8.3 million tonnes of cobalt metal content. Cobalt reserves are mainly in the Congo (Kinshasa) which contributes (48%) to the total reserves followed by Australia (18%). Besides, major reserves are also located in Indonesia (7%), Cuba (6%) and Philippines, Russia & Canada (3% each). The world reserves of cobalt are provided in Table-2.

The world mine production of cobalt in terms of metal content increased by 3% to 131 thousand tonnes in 2021 as compared to 127 thousand tonnes in the preceding year. The Democratic People's Republic of Congo (DRC) was the principal producer contributing about (71%) which is followed by Russia (6%), Australia (4%) and Cuba, Canada & Philippines (3% each) (Table-3).

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

(In tonnes of metal content)

Country	Reserves
World: Total (rounded off)	**8300000**
Australia	1500000
Canada	220000
China	140000
Congo (Kinshasa)	4000000
Cuba	500000
Indonesia	600000
Madagascar	100000
Morocco	13000
Papua New Guinea	47000
Philippines	260000
Russia	250000
Turkey	36000
USA	69000
Other countries	**610000**

Source: *USGS Mineral Commodity Summaries, 2023*
[a]For Australia, Joint Ore Reserves Committee-compliant reserves were 6,70,000 tonnes.

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

(In tonnes of metal Content)

Country	2019	2020	2021
World:Total (rounded off)	**119000**	**127000**	**131000**
Congo, Dem. P.R.	77964	86591	93011
Finland	1454	1559	1084
Russsia	5500	5700	8000
Turkey	115	250	*200
Australia[b]	5693	5796	5426
Cuba	5200	5500	*4400
Canada	5132	4279	3834
Philippines	3750	3600	3200
Papua New Guinea	2911	2941	2955
Madagascar	2930	833	2111
Morocco[(a)]	2397	2416	1796
South Africa [(a)]	1027	960	355
Zambia	379	316	247
Zimbabwe	400	956	230
USA	500	600	700
Brazil	30	20	20
China	2000	1750	1750
Indonesia	350	350	350
Other countries	8705	9489	6436

Source: *BGS, World Mineral Production, 2017-21*
a:Metal and/refined
b:Years ended 30 June of that stated:

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 in respect of cobalt, the countrywise description, as sourced from the latest available publication of 'USGS 2018' Minerals Yearbook, Release is furnished below:

Australia

In 2018, cobalt mine production as a byproduct of nickel mining in Western Australia decreased by 3% and Australian production of refined cobalt increased by 7%. BHP Group Ltd.'s Nickel West operations in Western Australia consisted of open pit and underground nickel sulfide mines; concentrators, which processed ores mined by BHP and other companies; the Kalgoorlie smelter, where nickel matte was produced from concentrates; and the Kwinana nickel refinery, which produced cobalt in intermediate cobalt-nickel sulfide. In 2018, BHP produced 920 tonnes of salable cobalt (full-year data for 2017 were not available). During the year, BHP began preparatory work on a 100,000-tonnes/year nickel sulfate plant at its Kwinana refinery and continued with solvent extraction test work for a potential cobalt sulfate circuit at the plant

Independence Group NL owned the Nova underground nickel-copper-cobalt sulfide mine east of Norseman, Western Australia. During the calendar year, the company ramped up production to 969 tonnes of cobalt in nickel concentrate, an increase from 400 tonnes in 2017. Production from the first 3 years of operation was committed for sale to BHP's Nickel West operation and to Glencore plc. During the year, Independence Group studied the potential to refine its nickel concentrate using a hydrometallurgical process to produce nickel and cobalt sulphates. Production guidance for the fiscal year beginning July 1, 2018, was 850 to 950 tonnes of cobalt in concentrate

Minara Resources Ltd. (Glencore plc) produced 3,200 tonnes of cobalt metal at its Murrin Murrin nickel-cobalt laterite mining and pressure-acid-leaching operation in Western Australia, 7% more than the 3,000 tonnes produced in 2017. Production in 2017 was less because of a scheduled maintenance shutdown during that year. In 2017 and 2018, approximately 300 tonnes of Murrin Murrin's production was from third-party feed .

First Quantum Minerals Ltd. (Canada) kept its Ravensthorpe nickel-cobalt laterite mine and hydrometallurgical processing plant in Western Australia on care-and-maintenance status throughout the year. The company planned to monitor nickel market conditions to determine when it might restart production. In 2017, the plant produced intermediate nickel-cobalt hydroxide containing 17,837 tonnes of nickel and an estimated 620 tonnes of cobalt.

Canada

Vale's global cobalt production was 5,093 tonnes in 2018, 12% less than the 5,811 tonnes produced in 2017. Vale produced 1,288 tonnes (1,675 tonnes onnes in 2017) of refined cobalt metal at its Port Colborne, Ontario, refinery; 1,630 tonnes (1,231 tonnes in 2017) of refined cobalt metal at its Long Harbour, Newfoundland and Labrador, refinery; 2,105 tonnes (2,780 tonnes in 2017) of cobalt in a cobalt intermediate product at its nickel operation in New Caledonia; and 70 tonnes (125 tonnes in 2017) of cobalt contained in other, intermediate products such as nickel concentrates. Vale's cobalt supply was produced from company-owned nickel-sulfide mines at Sudbury in Ontario, Thompson in 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 520 tonnes (840 tonnes in 2017) of cobalt came from Sudbury, 198 tonnes (138 tonnes in 2017) came from Thompson, 1,902 tonnes (1,829 tonnes in 2017) came from Voisey's Bay, 2,104 tonnes (2,780 tonnes in 2017) came from New Caledonia, and 371 tonnes (224 tonnes in 2017) came from external sources, including 173 tonnes of cobalt in ore from PT Vale Indonesia Tbk (6 tonnes in 2017)

In 2018, all of Vale's Voisey's Bay nickel concentrate was shipped to its hydrometallurgical refinery in Long Harbour, where cobalt was produced in the form of electrolytic metal rounds. In June, Vale established a cobalt streaming transaction with Wheaton Precious Metals Corp. and Cobalt 27. Vale agreed to sell 75% of future cobalt production from Voisey's Bay ore to Wheaton and Cobalt 27, starting January 1, 2021, for $690 million and payments averaging 20% of cobalt prices upon delivery. Vale planned to use the funds to complete the Voisey's Bay underground mine extension project, which would extend the operation's mine life and increase average annual production to an estimated 45,000 tonnes of nickel, 20,000 tonnes of copper, and 2,600 tonnes of cobalt.

Glencore reported that 900 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 2017)

The Fort Saskatchewan refinery, a joint venture of Sherritt and General Nickel Co. S.A., produced 3,234 tonnes of cobalt as metal powder and briquettes in 2018 (3,601 tonnes in 2017). The decrease was attributed to a disruption in the supply of hydrogen sulfide needed for refining, reduced availability of intermediate nickel-cobalt sulfide because of high rainfall in Cuba, and delays in rail transportation to the refinery. Approximately 89% of the cobalt originated from Moa, Cuba, and the remainder was from purchased materials. As a result of a United States embargo on imports of products originating from Cuba, cobalt and nickel produced by Sherritt could not be sold to customers in the United States.

China

China was the world's leading producer and consumer of refined cobalt. In 2018, China's total production, including an estimate for Umicore's Ganzhou Yi Hao plant, increased by 11% from that in 2017 and was estimated to constitute about two-thirds of world refined cobalt production. Most production was in the form of cobalt salts (84%); the remainder was metal (10%) and metal powder (6%). China's consumption of refined cobalt increased to 64,000 tonnes, 11% more than that in 2017; 81% of 2018 consumption was used to make cathode materials for rechargeable batteries.

Congo (Kinshasa)

Congo (Kinshasa) was the world's leading producer of mined cobalt and was estimated to represent 70% 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. Artisanal mining filled the role of a swing producer, increasing during periods of supply deficits and higher prices. Although analysts agreed that artisanal mining increased in 2018 compared with that in 2017, their estimates of the amount of cobalt produced by artisanal methods in 2018 varied widely, from 15,000 tonnes to 17,000 tonnes of contained cobalt to one forecast of nearly 30,000 tonnes of contained cobalt.

The state-owned mining company La Générale des Carrières et des Mines SA (Gécamines) held a minority share in most of the copper-cobalt operations in Congo (Kinshasa) and had been the sole producer of refined cobalt in the country since late 2015, when Kamoto Copper Company SA (KCC) halted metal production at its Luilu cobalt refinery. In 2018, Gécamines was estimated to have produced 60 t of refined cobalt at its Shituru refinery in Likasi (based on reported exports), down from 120 tonnes in 2017.

Mutanda Mining SPRL (Glencore, 100%) mined copper-cobalt oxide ore from open pits near Kolwezi and produced a record-high 27,300 tonnes of cobalt in concentrate and crude cobalt hydroxide, 14% more than the 23,900 tonnes produced in 2017.

Tenke Fungurume Mining S.A.R.L. [China Molybdenum Co., Ltd. (CMOC), BHR Equity Investment Fund Management Co. (BHR Partners), and Gécamines] mined copper-cobalt ore, which it processed onsite to produce 18,747 tonnes of cobalt in crude cobalt hydroxide, 14% more than the 16,419 tonnes produced in 2017.

The increased production was attributed to investments to optimize production. Most of the hydroxide was sold to Freeport Cobalt Oy's Kokkola refinery in Finland under a long-term agreement; the remainder was sold to refiners in China. CMOC forecast a cobalt production volume of 16,500 to 19,000 tonnes of cobalt in hydroxide in 2019.

KCC [Katanga Mining Ltd. (a subsidiary of Glencore plc), Gécamines, and La Société Immobilière du Congo] restarted cobalt processing as part of commissioning the whole ore leach project at its copper-cobalt mining and refining operation in Lualaba Province and produced 11,112 tonnes of cobalt in hydroxide. The company also worked on a cobalt debottlenecking project, which included adding a magnesium oxide reagent plant within the cobalt circuit, new filter presses, and new cobalt hydroxide dryers. The project was intended to align cobalt-processing capacity with the life-of-mine plan to produce an average of 30,000 tonnes/year of cobalt in hydroxide and a maximum processing capacity of 40,000 tonnes /year of cobalt in hydroxide.

The remainder was exported to Zambia to be refined at ERG's Chambishi Metals plc plant. In 2018, Boss Mining exported 5,970 tonnes gross weight of cobalt carbonate, 34,600 tonnes gross weight of cobalt concentrate, and 2,320 tonnes gross weight of copper-cobalt concentrate.

By yearend, ERG had commissioned phase 1 of its Metalkol Roan Tailings Reclamation project and began producing copper cathode and cobalt hydroxide. The project entailed recovering copper and cobalt from tailings deposited in the Kingamyambo Tailings Dam and Musonoi River Valley in Haut Katanga Province during past mining operations. In 2018, Metalkol produced 300 tonnes of contained cobalt in salable cobalt hydroxide. At full operation, Metalkol's phase 1 was expected to produce 14,000 tonnes/year of cobalt in hydroxide, which would increase to 20,000 tonnes/year during a phase 2 expansion.

Metal Mines SARL (Nanjing Hanrui Cobalt Co., Ltd.) reportedly expanded the cobalt hydroxide production capacity of its processing plant in Likasi, Haut Katanga Province, to 5,000 tonnes/year of cobalt in hydroxide. The plant processed copper-cobalt ore from mines leased by Metal Mines as well as some ore from other companies. In 2018, Metal Mines exported 19,600 tonnes gross weight of cobalt hydroxide and 14,800 tonnes gross weight of cobalt concentrate.

Somika SPRL (Société Minière de Katanga, Vinmart Group, India) produced cobalt hydroxide at its plant in Lubumbashi, Haut-Katanga Province, from copper-cobalt ores sourced from small- and large-scale mining operations. In 2018, the company exported 10,400 tonnes gross weight of cobalt hydroxide, exported 5,430 tonnes gross weight of cobalt concentrate, and sold 6,960 tonnes gross weight of cobalt mineral to the local market.

China Railway Group Ltd. had shares in three copper-cobalt mining and refining operations in Congo (Kinshasa)—La Sino-Congolaise des Mines S.A. (Sicomines) (a joint venture with Gécamines, Sinohydro Corp., and Zhejiang Huayou Cobalt Co., Ltd.), Compagnie Minière de Luisha S.A.S., and La Minière de Kalumbwe Myunga sprl (MKM). In 2018, Sicomines exported 1,630 tonnes gross weight of cobalt hydroxide and 34 tonnes gross weight of cobalt concentrate and MKM exported 3,110 tonnes gross weight of cobalt hydroxide.

Congo Dongfang International Mining SPRL (CDM) was responsible for procuring cobalt feed materials for Huayou's refineries in China and produced crude cobalt hydroxide at its La Minière de Kasombo SPRL (MIKAS) hydrometallurgical plant in Lubumbashi. In 2018, CDM and MIKAS exported about 35,400 tonnes gross weight of cobalt hydroxide. The ores and concentrates reportedly were sourced from CDM's mines and other Congolese mining operations, including artisanal miners

Compagnie Minière de Kambove (COMIKA) (Wanbao Mining Ltd. and Gécamines) mined copper-cobalt ore from the open pit Kamoya copper-cobalt mine near Kambove, Haut-Katanga Province. In 2018, COMIKA exported 46,200 tonnes gross weight of copper-cobalt concentrate and 1,460 tonnes gross weight of cobalt hydroxide. Wanbao Mining planned to expand the operation in 2019

The Lualaba Copper Smelter SAS joint venture (LCS) [composed of subsidiaries of China Nonferrous Mining Corp. Ltd. (CNMC) and Yunnan Copper Industry Group Co., Ltd.] began construction of a blister copper smelter. As part of the project, LCS was constructing a "cobalt recycling system" to produce 10,000 tonnes/year of crude copper-cobalt alloy.

Cuba

Moa Nickel S.A. (part of the 50–50 joint venture between Sherritt and General Nickel) mined nickel-cobalt laterites at Moa, Holguin Province, and produced intermediate nickel-cobalt sulfide, which was sent to the joint venture's Fort Saskatchewan refinery in Canada. In 2018, the sulfide contained 35,125 tonnes of nickel and cobalt (34,595 tonnes in 2017).

The Government-owned Empresa Niquelífera Ernesto Che Guevara operation (also known as Punta Gorda) in Moa, Holguin Province, mined and processed nickel-cobalt laterites. The operation was expected to undergo repair and maintenance work, including the purchase of mining equipment, beginning in mid-2018 (Redacción ¡ahora!, 2018). Nickel and cobalt originating in Cuba could not be imported into the United States because of a United States embargo on imports from Cuba.

Finland

According to the Cobalt Institute (2019), in 2018, Freeport Cobalt Oy (Freeport-McMoRan Inc., Lundin, and Gécamines) produced 5% more cobalt at its Kokkola refinery than it produced in 2017. The company produced a wide range of cobalt chemicals and metal powders. In 2018, the main feed for the refinery was crude cobalt hydroxide supplied under a long-term agreement by the Tenke Fungurume operation in Congo (Kinshasa); the refinery also processed cobalt-

bearing scrap from the cemented carbide, battery, and catalyst industries. Since 2016, when it sold its share of Tenke Fungurume to China Molybdenum, Freeport-McMoRan has wanted to sell its share in Freeport Cobalt.

Boliden's Kevitsa open pit nickel-copper-PGM sulfide mine and beneficiation plant produced nickel concentrate containing 13,948 tonnes of nickel and 591 tonnes of cobalt in 2018 (compared with 13,777 tonnes of nickel and an estimated 587 tonnes of cobalt in 2017). In 2018, Boliden began producing nickel-cobalt concentrate at its underground Kylylahti copper-zinc mine and produced concentrate containing 518 tonnes of nickel and 278 tonnes of cobalt. During the year, Boliden worked to expand production at Kevitsa by 27% by yearend 2020 and evaluated the potential of extending Kylylahti's lifespan. The company's Harjavalta smelter processed nickel concentrates from Kevitsa and elsewhere and sold the resulting nickel matte.

Terrafame Ltd. [Finnish Minerals Group Ltd. (formerly Terrafame Group Ltd., Government of Finland), Trafigura Ventures V B.V., Galena Private Equity Resources Investment 2 L.P., Galena Private Equity Resources Investment 3 L.P. funds, and Sampo plc] stabilized operations at its polymetallic sulfide mining and bioheap-leaching operation in Sotkamo, central Finland. In 2018, the company produced intermediate nickel-cobalt sulfide containing 27,377 tonnes of nickel and, based on reported nickel and cobalt contents of the sulfide in 2016, an estimated 550 tonnes of cobalt (20,864 tonnes nickel and an estimated 420 tonnes cobalt in 2017).

New Caledonia

In 2018, estimated recoverable mine production decreased by 24% compared with that in 2017 because of a decrease in production from sole producer Vale Nouvelle-Calédonie S.A.S. (VNC) (Vale and Société de Participation Minière du Sud Caledonien S.A.S.). VNC continued to ramp up production at its operation in the southern tip of New Caledonia's main island, which consisted of a nickel-cobalt laterite mine, an HPAL processing plant, and a refinery. During the year, VNC added new trucks to its mining fleet, worked to update its mine plan, and evaluated ways to increase efficiency at the plant. Following rampup over the next 5 to 6 years, the operation was expected to have a nominal production capacity of 50,000 tonnes/yr of nickel contained in nickel oxide and an estimated 4,000 tonnes/year of cobalt contained in an intermediate cobalt carbonate.

Russia

Production by Nornickel, the sole producer of refined cobalt in Russia, decreased for the second consecutive year. The company mined and beneficiated nickel-copper sulfide ores and smelted the concentrates at its Polar Division on the Taymyr Peninsula and at Kola MMC on the Kola Peninsula. The resulting matte from the Polar Division was refined at Kola MMC's Severonickel refinery at Monchegorsk on the Kola Peninsula, where high-grade electrolytic cobalt (cobalt cathode) was produced. Matte from Kola MMC was refined at Severonickel and by Norilsk Nickel Harjavalta Oy in Finland. In addition to producing refined cobalt, Nornickel reportedly also produced about 1,100 tonnes of cobalt in a cobalt intermediate in 2018, which was sent to be refined at Harjavalta and Glencore's Nikkelverk operation in Norway.

Turkey

Nikel Kobalt Madencilik Sanayi ve Ticaret A.S. (Vestel Elektronik Sanayi ve Ticaret A.S. and Zorlu Holding A.S.) produced intermediate nickel-cobalt hydroxide containing 5,001 tonnes of nickel and 259 tonnes of cobalt from its HPAL processing plant at Gordes, Manisa Province.

FOREIGN TRADE

Exports

Cobalt ores & concentrates exports were nil during the last two years.

Exports of cobalt and alloys including waste and scrap increased exponentially by 294% to 1,340 tonnes in 2021-22 from 340 tonnes in the previous year. Exports were mainly to Korea (88%), Turkey (3%) and UK & Belgium (2% each). Out of the total exports in 2020-21, exports of cobalt and alloys were at 1,309 tonnes and those of cobalt & scrap were at negligible levels. Similarly, during 2021-22 exports of cobalt powder were at 1,232 tonnes and that of cobalt (other articles) were at 76 tonnes (Tables-4 to 9).

Imports

During the period 2021-22, one tonne of cobalt ores and concentrate were imported, while it was negligible in the previous year.

Imports of cobalt & alloys including waste and scrap increased by 41% to 1,130 tonnes in 2021-22 from 802 tonnes in the previous year. Imports in 2021-22 were mainly from USA & Netherlands (16% each), Japan & Belgium (12% each), and Norway (11%). Out of the total imports in 2021-22, imports of cobalt & alloys were at 1,128 tonnes and those of cobalt & scrap were negligible. Besides, imports of cobalt in the form of cobalt powder, other articles and unwrought cobalt were at 353 tonnes, 438 tonnes and 337 tonnes, respectively (Tables-10 to 16).

Table –4: Exports of Cobalt & Alloys (Including Waste and Scrap)
(By Countries)

Country	2020-21(R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**340**	**364327**	**1340**	**895452**
Korea, Rep. of	252	55551	1179	550695
Belgium	1	2580	32	105686
UAE	3	21129	12	65548
USA	59	202658	19	56922
U K	2	8905	33	36648
Turkey	++	129	41	23427
France	1	4006	1	10010
Finland	2	8883	1	8537
Germany	1	2495	2	7482
China	15	38392	2	6783
Other countries	4	19599	18	23714

Figures rounded off

Table – 5: Exports of Cobalt & Alloys
(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**340**	**364006**	**1309**	**812402**
Korea, Rep. of	252	55551	1179	550695
UAE	3	21129	10	63861
USA	59	202658	16	53145
Belgium	1	2580	11	35141
UK	2	8840	29	31114
Turkey	++	129	41	23427
France	1	4006	1	10010
Finland	2	8883	1	8537
Germany	1	2495	2	7482
China	15	38392	2	6783
Other countries	4	19343	17	22207

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	++	**321**	**31**	**83050**
Belgium	-	-	21	70545
U K	++	65	4	5534
USA	-	-	3	3777
UAE	-	-	2	1687
Netherlands	-	-	1	1481
Nepal	-	-	++	26
Vietnam	++	256	-	-

Figures rounded off

Table –7: Exports of Cobalt Powder (By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**137**	**59805**	**1232**	**629350**
Korea, Rep. of	134	41019	1179	550039
UAE	3	18340	10	50544
Turkey	++	77	41	23427
Brazil	-	-	1	3619
Belgium	-	-	++	1243
China	-	-	1	272
Austria	-	-	++	99
U K	++	190	++	97
USA	-	-	++	10
Saudi Arabia	++	179	-	-
Other Countries	-	-	-	-

Figures rounded off

Table –8: Exports of Cobalt (Other Articles) (By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**149**	**127944**	**76**	**180381**
USA	19	63709	16	53118
Belgium	1	2580	10	32002
UK	2	8650	29	31017
UAE	++	2789	++	13317
France	1	4006	1	10010
Finland	2	8883	1	8537
Germany	1	2495	2	7482
China	1	1087	1	6511
Switzerland	2	12084	++	4581
Netherlands	++	2082	1	3473
Other Countries	120	19579	15	10333

Figures rounded off

Table – 9: Exports of Cobalt Unwrought (By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**54**	**176257**	**1**	**2671**
Belgium	-	-	1	1896
Korea, Rep. of	-	-	++	650
Switzerland	-	-	++	108
USA	40	138949	++	17
China	14	37305	-	-
Morocco	++	3	-	-

Figures rounded off

Table – 10: Imports of Cobalt & Alloys (Including Waste & Scrap) (By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**802**	**2898721**	**1130**	**5852552**
USA	106	563955	181	982003
U K	69	396203	80	938461
Netherlands	171	421470	176	668410
Belgium	100	277313	134	552752
Norway	26	67271	125	547533
China	85	241056	102	422343
UAE	13	42497	86	422061
Japan	96	281460	131	409178
France	8	100585	24	330325
Germany	9	178290	12	207270
Other countries	119	328621	79	372216

Figures rounded off

Table – 11: Imports of Cobalt Powder (By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**237**	**722141**	**353**	1490170
Belgium	67	203912	120	490617
Netherlands	14	34252	58	272167
Japan	33	111860	56	214086
China	29	83490	29	109629
South Africa	10	31128	17	80086
Finland	10	28304	16	76963
USA	16	41581	18	75947
France	7	25226	13	59330
Turkey	12	33692	15	54039
U K	15	53737	8	32526
Other countries	24	74959	3	24780

Figures rounded off

Table – 12: Imports of Cobalt (Other Articles) (By Countries)

Country	2020-21(R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**343**	**1612473**	**438**	2933766
USA	81	495573	161	891777
U K	54	341609	68	887078
China	27	75267	70	303765
France	1	70393	11	269757
Germany	8	170462	11	193151
Netherlands	85	221054	53	175571
Singapore	4	13786	11	73241
Belgium	12	30399	14	62135
Japan	22	65295	37	57586
Hong Kong	++	1948	2	15180
Other countries	49	126687	++	4525

Figures rounded off

Table – 13: Imports of Cobalt (Unwrought) (By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**222**	**564100**	**337**	**1426119**
Norway	-	-	125	547533
UAE	13	41548	86	421288
Netherlands	72	166164	65	220672
Japan	41	104305	38	137506
Singapore	10	28276	10	36893
U K	++	857	4	18857
Bahamas	25	60736	4	15840
USA	9	26794	2	14279
China	29	82299	3	8949
France	++	4966	++	2561
Other countries	23	53121	++	1741

Figures rounded off

Table – 14: Imports of Cobalt & Alloys (By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**802**	**2898714**	**1128**	**5850055**
USA	106	563948	181	982003
U K	69	396203	80	938461
Netherlands	171	421470	176	668410
Belgium	100	277313	134	552752
Norway	26	67271	125	547533
China	85	241056	102	422343
UAE	13	42497	86	422061
Japan	96	281460	131	409178
France	8	100585	24	330325
Germany	9	178290	12	207270
Other countries	119	328621	77	369719

Figures rounded off

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

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	**++**	**7**	**2**	**2497**
Bangladesh	-	-	2	2497
USA	++	7	-	-

Figures rounded off

Table – 16 : Imports of Cobalt Ore & Conc.
(By Countries)

Country	2020-21 (R)		2021-22 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	++	**325**	**1**	**6917**
UK	++	325	1	6917

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 has 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 in aerospace. The Aerospace Industry is 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 maximum per month in terms of cobalt content. Cobalt sulphate is mostly used in Chemical Industries.

Battery manufacturing is considered as a major segment with huge potential in India which could trigger development of new technology and product upgrading. Increase in cobalt consumption by the Battery Industry, mainly for personal electronics, have resulted in global annual growth rates in cobalt consumption exceeding growth rates for the global gross domestic product. This rate was forecast to increase to 9.5% between 2018 and 2025, driven mainly by cobalt's use in rechargeable lithium-ion batteries for electric vehicles.