

NICKEL



Indian Minerals Yearbook 2016

(Part- II : Metals & Alloys)



55th Edition

NICKEL

(ADVANCE RELEASE)

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

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December, 2017

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Nickel is a lustrous, silvery-white metal. It has a melting point of 1453°C, relatively low thermal and electrical conductivities, high resistance to corrosion and oxidation, excellent strength and toughness at high temperatures and capable of magnetised. It is attractive and very durable as a pure metal and alloys readily with other metals.

Nickel is not produced from primary sources in the country and the entire demand is met through imports. However, it is being recovered as nickel sulphate crystals, a by-product obtained during copper production.

OCCURRENCES AND RESERVES & RESOURCES

Nickel occurs principally as oxides, sulphides and silicates in India. Important occurrence is nickeliferous limonite in the overburden of chromite in Sukinda Valley,

Jajpur district, Odisha, where it occurs as oxide. A suitable process is being developed for its utilisation. Nickel also occurs in sulphide form along with copper mineralisation in East Singhbhum district, Jharkhand.

In addition, it is found associated with uranium deposits at Jaduguda, Jharkhand. Other reported occurrences of nickel are from Karnataka, Kerala and Rajasthan. Polymetallic sea nodules are another source of nickel.

As per NMI database, based on UNFC, as on 1.4.2015, the total resources of nickel ore have been estimated at 189 million tonnes. About 93% resources; i.e., 175 million tonnes are in Odisha. The remaining 7% resources are distributed in Jharkhand (9 million tonnes) and Nagaland (5 million tonnes) (Table-1).

EXPLORATION & DEVELOPMENT

The details of exploration carried out is given in Table-2.

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

(In million tonnes)

Grades/States	Total Reserves (A)	Remaining resources					Total (B)	Total Resources (A+B)
		Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333		
		STD221	STD222					
All India : Total	–	21	21	31	53	63	189	189
By Grades								
+ 0.9% Ni	–	13	8	–	18	3	42	42
0.5 to 0.9% Ni	–	8	13	31	21	21	94	94
(+) 0.5% Ni, unclassified	–	–	–	–	14	39	53	53
Not-known	–	–	–	–	–	–	–	+
By States								
Jharkhand	–	–	–	–	2	7	9	9
Karnataka	–	–	–	–	–	+	–	+
Nagaland	–	–	–	–	–	5	5	5
Odisha	–	21	21	31	51	51	175	175

Figures rounded off.

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Table – 2 : Details of Exploration Activities for Nickel, 2015-16

Agency/ State District	Location	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
GSI							
Jharkhand							
Saraikela- Kharsawan	Rargaon- Shyamramdiri Kharsawan	1:25000	350	-	-	-	The potential areas of Singhbhum and Dalma Group of rocks were mapped. The area forms part of the North Singhbhum Mobile Belt and encompasses rocks of Singhbhum Group and Dalma volcanics. The talc-tremolite schist of Dalma Group was targeted for mineralisation and samples have yielded 0.24% and 0.11% of nickel. Quartz veins present within quartzite show sulphide mineralisation in the form of arsenopyrite.
Rajasthan							
Ajmer	Mangliawas- Makrera-Rajgarh- Lachhipura- Hatundi	1:12500	100	-	-	106 Bedrock 25 petro- chemical	Large-scale mapping in the Mangliyawas-Makrera block was done. Analytical results of 30 samples (BRS) have been received so far, out of which 14 samples show Ni values ranging from 541 ppm to 0.18% and Cr values ranging from 130 ppm to 0.21%. The analytical results of PGE of all the samples are awaited.
Udaipur	Rikhabdev ultramafic rocks (Kherwara- Dhelana area)	1:12500	100	-	-	169	The ultramafic rocks are highly altered and comprise predominantly of serpentinites. These occur as large irregular lensoid bodies (Kherwara-Dhelana area) and lenticular bands more than 5 km long and are generally emplaced along lithological contacts within the Aravalli Supergroup. Analytical results received so far indicate that Ni values range from 500 ppm to 0.22% and Cr values range from 450 ppm to 0.44% in serpentinite. The analysis of PGE is awaited.
Madhya Pradesh							
Betul	Padhar mafic- ultramafic suite, Betul belt	LSM	20	-	-	-	The Padhar mafic-ultramafic suite comprises intrusive bodies of olivine websterite, websterite, pyroxenite, gabbro/hornblende gabbro, hornblendite, diorite, and its equivalent altered component like amphibole chlorite schist and talc chlorite schist. The other rock types exposed are basement granite gneiss, calc-silicate, sandstone and intrusive granite, dolerite and basaltic dyke. Beside field studies, samples were collected for petrographic and geochemical (whole rock, trace and REE) studies.

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INDUSTRY

Nickel sulphate was produced as a by-product at the Ghatsila Copper Smelter of HCL in Jharkhand. The sulphide copper ore from Ghatsila area contains nickel in small quantity along with other important metals like gold and cobalt. The installed annual capacity of the plant to produce nickel sulphate is 390 tonnes. However, the production of nickel sulphate has not been reported since 2004-05. Sterlite Industries (India) Ltd (Thoothukudi) had developed innovative method to produce pure commercial grade nickel sulphate from electrolyte by solvent crystallisation.

The pilot-scale trials are in progress. Jhagadia Copper Ltd also has plans to recover nickel sulphate at its copper metal plant at Jhagadia, Bharuch district, Gujarat.

Nickel sulphate is an important compound used commercially in the country in nickel plating, in dip baths for enamelling, in preparation of nickel compounds and as a catalytic nickel.

RESEARCH & DEVELOPMENT

India's first facility to produce nickel, a metal for which India is completely dependent on imports, has been launched by the Hindustan Copper Limited (HCL) at its Indian Copper Complex (ICC) at Ghatsila in Jharkhand. The new facility "Nickel, Copper and Acid Recovery Plant" is the first facility in India to produce nickel metal of London Metal Exchange (LME) grade from primary resource. The annual demand for pure nickel in India is around 45,000 MT and its domestic market is totally dependent on import. The plant has been commissioned in August, 2016.

USES

Nickel is used in many specific and recognisable industrial and consumer products including stainless steel, alnico magnets, coinage, for filters & binders, rechargeable batteries, foundry, electric guitar strings, microphone capsules & special alloys. It is also used for plating and as green tint in glass. Nickel is predominantly an alloy metal & its chief use is in the nickel steel & nickel cast iron of which there are many varieties. It is also widely used in many other alloys

such as nickel bronze & brasses and alloys with copper, chromium, aluminium, lead, cobalt, silver & gold. It is used as catalyst which is key to several important reactions including the hydrogenation of vegetable oils, reforming of hydrocarbons and in the production of fertilizers, pesticides and fungicides.

CONSUMPTION

World over about 65% of nickel is used to manufacture stainless steel and 20% in other steel and non-ferrous (including super alloys) often for highly specialised industrial, aerospace and military application. About 9% is used in plating and 6% in other uses, including coins and a variety of nickel chemicals.

SUBSTITUTES

Aluminium, coated steels, plain chromium steels and plastics can replace stainless steel to a limited extent in many construction and transportation applications. Nickel-free speciality steels are sometimes used in place of stainless steel within the power-generating, petrochemical and petroleum industries. Titanium alloys or speciality plastics can substitute nickel metal or nickel-based alloys in highly corrosive chemical environments. Lithium ion batteries instead of nickel-metal hydride may be used in certain applications.

TRADE POLICY

As per Foreign Trade Policy, 2015-2020, imports of nickel ores & concentrates (heading no. 2604) and metal (heading no. 7503) are allowed, free. However, some forms of metal waste & scrap (ITC-HS Code No. 7503 0090) are restricted.

WORLD REVIEW

The world reserves of nickel are estimated at 78 million tonnes of metal content. Australia (24%), Brazil (13%), Russia (10%), New Caledonia (9%), Cuba (7%), Philippines and Indonesia (6% each). The identified land-based reserves analysing an average of 1% nickel or more contain about 130 million tonnes nickel. About 60% of nickel reserves are in laterites and 40% in sulphide deposits. In addition, extensive deep-sea resources of nickel are in manganese crusts and nodules, covering large areas of the ocean floor, particularly in the Pacific Ocean (Table-3).

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**Table – 3: World Reserves of Nickel
(By Principal Countries)**

(In '000 tonnes of nickel content)

Country	Reserves
World: Total (rounded)	78000
Australia	19000
Brazil	10000
Canada	2900
China	2500
Columbia	1100
Cuba	5500
Guatemala	1800
Indonesia	4500
Madagascar	1600
New Caledonia	6700
Philippines	4800
Russia	7600
South Africa	3700
USA	160
Other countries	6500

Source: Mineral Commodity Summaries, 2017.

In 2015, world mine production of nickel decreased to 2.09 million tonnes as compared to 2.15 million tonnes of metal content in the previous year. Philippines (20%), Russia (12%), Canada and Australia (11% each) were the principal producers (Table-4).

FOREIGN TRADE

Exports

Exports of nickel ores and concentrates increased drastically to 125 tonnes as compared to 41 tonnes during the previous year. On the other hand exports of nickel and alloys including waste & scrap decreased to 37,512 tonnes in 2015-16 from 46,771 tonnes in the previous year. Out of the total alloys and scrap exported in 2015-16, nickel & alloys were 37,197 tonnes, while nickel waste & scrap were 315 tonnes. Exports were mainly to Singapore, Malaysia and Korea, Rep. of (Tables - 5 to 8).

Imports

During 2015-16, imports of nickel ores & concentrates decreased considerably to 3,295 tonnes in comparison to 4,185 tonnes in the previous year. Imports were mainly from Australia, Guinea and Singapore. Imports of nickel & alloys including scrap were 71,080 tonnes in 2015-16 compared to 76,201 tonnes in the previous year. Out of total alloys and scrap imported in 2015-16,

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

(In '000 tonnes of metal content)

Country	2013	2014	2015
World: Total	2576	2151	2092
Australia	281	299	225
Botswana	23	15	17
Brazil	77	86	89
Canada	228	229	235
China	93	101	100
Colombia	49	44	40
Cuba	56	52	56
Dominican Rep.	9	-	-
Finland	19	20	19
Greece	19	21	20
Guatemala ^e	10	47	56
Indonesia	839	216	130
Madagascar	25	37	47
Myanmar ^e	6	21	26
New Caledonia	164	178	186
Papua New Guinea	13	18	26
Philippines	316	393	416
Russia	264	264	261
South Africa	51	55	57
USA	0	4	27
Zimbabwe	13	17	17
Other countries	21	34	42

Source: World Mineral Production, 2011-15.

nickel & alloys were 69,070 tonnes as compared to 73,647 tonnes in the previous year, while nickel waste & scrap was 2,010 tonnes as compared to 2,554 tonnes in the previous year. Imports of nickel and alloys including scrap in 2015-16 were mainly from Singapore, Australia, Russia and Malaysia (Tables- 9 to 12).

**Table – 5: Exports of Nickel Ores and Conc.
(By Countries)**

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	41	1452	125	11511
Germany	-	-	84	9835
China	41	1452	40	1225
Nepal	-	-	1	451
Japan	-	-	++	++

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**Table – 6: Exports of Nickel and Alloys Incl. Scrap
(By Countries)**

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	46771	55174050	37512	32072432
Malaysia	11198	12388120	12741	11105217
Singapore	23335	28251657	9011	7372530
Korea, Rep. of	81	102963	7331	6106512
UAE	10260	12123993	4023	3356555
China	21	21609	2683	2319093
Iran	232	263892	319	303554
USA	291	423004	214	275367
Saudi Arabia	84	171392	84	154808
Thailand	107	136326	77	110018
UK	208	118326	171	91267
Other countries	954	1172768	858	877511

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

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	46462	55040521	37197	31951708
Malaysia	11198	12388120	12741	11105217
Singapore	23335	28251657	9011	7372530
Korea, Rep. of	81	102963	7331	6106512
UAE	10260	12123993	4023	3356555
China	21	21609	2683	2319093
Iran	232	263892	319	303554
USA	226	385712	191	264215
Saudi Arabia	84	171392	84	153772
Thailand	107	136326	77	110018
Mexico	66	87838	73	79533
Other countries	852	1107019	664	780709

**Table – 8 : Exports of Nickel Waste & Scrap
(By Countries)**

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	309	133529	315	120724
UK	174	64978	146	57226
Germany	27	7041	81	28190
Japan	41	24021	64	22636
USA	65	37292	23	11152
Saudi Arabia	-	-	++	1036
Uganda	-	-	1	474
Netherlands	-	-	++	8
Canada	2	196	-	-
Other countries	++	1	++	2

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**Table – 9 : Imports of Nickel Ores & Conc.
(By Countries)**

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	4183	3842487	3295	2433862
Australia	2599	2285708	2414	1796401
Guinea	840	808952	835	632159
Japan	-	-	15	3636
Singapore	-	-	21	1251
Philippines	-	-	10	385
USA	-	-	-	25
Finland	++	16	-	5
China	576	694065	-	-
Austria	22	21530	-	-
Korea, Rep. of	18	15925	-	-
Other countries	128	16291	-	-

**Table – 10: Imports of Nickel and Alloys Incl. Scrap
(By Countries)**

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	76201	85078105	71080	58556840
Singapore	19864	22038092	15997	13362554
Australia	5450	4653064	8173	6471498
Russia	4593	5014215	6201	4567978
Malaysia	13764	16239346	5722	4376001
Canada	2603	2905100	5616	4169383
Norway	5185	5468103	5317	3998395
Japan	2613	2954208	4568	3763242
UAE	2565	2518953	4131	3028160
China	9755	11464991	2889	2502739
UK	1744	2356237	1856	2222993
Other countries	8065	9465796	10610	10093897

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**Table – 11: Imports of Nickel & Alloys
(By Countries)**

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	73647	83811134	69070	57724019
Singapore	19855	22033915	15997	13362554
Australia	5450	4653064	8171	6470572
Russia	4507	4970377	6137	4537559
Malaysia	13735	16213106	5693	4366576
Canada	2603	2905100	5556	4146788
Norway	5185	5468103	5317	3998395
Japan	2610	2950911	4568	3763242
UAE	1953	2244376	3837	2910731
China	9755	11464991	2889	2502739
UK	1547	2254608	1682	2140537
Other countries	6447	8652583	9223	9524326

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

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	2554	1266971	2010	832821
Lithuania	119	50158	484	181680
USA	442	230264	274	130731
UAE	612	274577	294	117429
UK	197	101629	174	82456
Saudi Arabia	201	97544	156	62042
Bulgaria	-	-	108	39296
Netherlands	-	-	101	38136
Russia	86	43838	64	30419
Kuwait	257	144600	59	28243
Germany	63	19886	55	25138
Other countries	577	304475	241	97251

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FUTURE OUTLOOK

Primarily World nickel demand is for the production of stainless steel where about 65% nickel is consumed. Nickel accounts for 10 to 20% input cost in stainless steel production depending on the nickel content. The future outlook for nickel depends mainly on the production of stainless steel which is one of the main drivers for nickel produced. The production of stainless steel in the country is estimated to be 5 million tonnes by 2016-17 as per the 12th Five Year Plan Report. Batteries and the ongoing Electric Vehicle revolution could prove to be a transformational event as NCA and NCM. Li-ion technology establishes itself as the battery chemistry of choice and EV penetration multiplies from a non-existent base.

India will have no option but to depend on imports for this metal till a technology to recover nickel from the overburden of chromite ore in Odisha is established on a commercial scale.

The process developed by the HCL for the production of primary nickel from waste generated during copper refining will be a breakthrough in the area of nickel production in the country.

India imports as well as exports nickel scrap covered by ISRI code, Aroma, Barly, Dandy, Daunt, Delta, Decov, Depth, Hitch, House, Ideal, Indian, Junto, Lemon, Lemur are covered under HS code 75030010. But there is hardly any statistic available for recycling and recovery of nickel from scrap. The recycling of nickel bearing scrap in organised sector will be another source for meeting the demand.