

NICKEL



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NICKEL

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

Indira Bhavan, Civil Lines,
NAGPUR – 440 001

PHONE/FAX NO. (0712) 2565471
PBX : (0712) 2562649, 2560544, 2560648
E-MAIL : cme@ibm.gov.in
Website: www.ibm.gov.in

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12 Nickel

Nickel is a lustrous, silvery-white metal having a high melting point of 1455°C. It exhibits high resistance to corrosion and oxidation, excellent strength and toughness at elevated temperatures; is capable of being magnetised and readily alloys with many other metals. When added in small quantity to iron, increases its properties manifold and makes the product hard and stainless. Owing to these qualities, nickel is used in number of products for consumer, industrial, military, transport/aerospace marine and architectural applications.

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 & 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 UNFC, as on 1.4.2013, the total resources of nickel ore have been estimated at 189 million tonnes. About 92% resources; i.e., 175 million tonnes are in Odisha. The remaining 8% resources are distributed in Jharkhand (9 million tonnes) and Nagaland (5 million tonnes). Nominal resources are reported from Karnataka (0.23 million tonnes) (Table- 1).

EXPLORATION & DEVELOPMENT

Exploration was carried out by GSI in the states of Karnataka, Maharashtra, and Nagaland. The details of exploration is given in Table-2.

INDUSTRY

Nickel sulphate is 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 (Thoothukudi) had developed innovative method to produce pure commercial grade nickel sulphate from electrolyte by solvent crystallisation.

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

(In million tonnes)

Grade/State	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	–	13.38	7.37	–	17.9	3.48	42.13	42.13
0.5 to 0.9% Ni	–	7.46	13.25	30.62	21.44	20.76	93.53	93.53
(+) 0.5% Ni, unclassified	–	–	–	–	13.72	39.25	52.97	52.97
Not-known	–	–	–	0.23	–	–	0.23	0.23
By States								
Jharkhand	–	–	–	–	2	7	9	9
Karnataka	–	–	–	–	–	0.23	0.23	0.23
Nagaland	–	–	–	–	–	5	5	5
Odisha	–	20.84	20.62	30.85	51.06	51.26	174.63	174.63

Figures rounded off.

NICKEL

Table – 2 : Details of Exploration Activities for Nickel, 2014-15

Agency/ State/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
GSI							
Karnataka	Sasivala,	LSM	100	-	-	-	Reconnaissance Stage (G-4) investigation was carried out. The Archaean greenstone belt (Sargur type) rocks exposed in area. Yellow/green-spottings (high Ni) in Serpentinite and meta-pyroxenite are common.
Hassan & Tumakuru	Rampura, Tumbapura, Near Kamasamundra, Mallenahalli, Rudrapura, Borinakere, Rattanahalli	DM	0.5				
Maharashtra							
Sindhudurg	Kudal-Kankavle-Vagre areas Dabachiwadi	1:5,000	1	-	-	-	Predominant rock type are BIF, Serpentinite, amphibole. The serpentinite/dunite exposed in the area exhibits chrome concentration. Few Nickel sulphide was also seen. These bodies appear to be potential sources for Ni-Cr-PGE. The investigation will continue in FS 2015-16.
Telangana							
Khammam	Chimalpahad Ultramafic Complex	-	-	-	-	-	The area represented by anorthosite, leucogabbro, gabbro, pyroxenite which are intruded within amphibolites of Khammam schist belt. The analysis of samples so far received shows: Cr - 100 - 3807 ppm Cu - 10 - 389 ppm Ni - 10 - 1540 ppm Float chromite - Cr 41.09%
West Bengal							
Purulia	Around Bagalia-Sonajuri area Lalpur-Hurabishpuria area	-	-	-	-	-	Reconnaissance Stage (G-4) investigation was carried out for search of Ni,Cr and PGE of mineralisation. The Chottanagpur Gneissic Complex (CGC) suite of rocks amphibolite, mafic granulite granite gneiss and hornblende gneiss. The analytical results of powdered samples from pyroxenite-gabbro-anorthosite gabbro suite of rocks revealed Ni-36-475 ppm. Cr-34-275 ppm, Pt <10 to 35 ppb and Pd from <5 to 17 ppb.

NICKEL

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

HCL has identified technology to recover nickel from the waste generated during the copper refining process. Pilot scale study to recover Nickel salts from the spent electrolyte of ICC Refinery plant was completed. The plant is under commissioning at Ghatsila smelter and refinery plant. The project will facilitate the production of primary nickel in the country for the first time.

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 preeminently 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 percent 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, 2009-2014, imports of nickel ores & concentrates (heading no. 2604) and metal (heading no. 7503) are allowed, freely. 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 79 million tonnes of metal content. Australia (24%), Brazil (13%), New Caledonia (11%), Russia (10%), Cuba (7%), Indonesia (6%) and South Africa (5%), Canada & China (4% each) together accounted for around 84% nickel reserves (Table-3). 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 : World Reserves of Nickel
(By Principal Countries)**

(In '000 tonnes of nickel content)

Country	Reserves
World: Total (rounded)	79000
Australia	19000
Brazil	10000
Canada	2900
China	3000
Columbia	1100
Cuba	5500
Guatemala	1800
Indonesia	4500
Madagascar	1600
New Caledonia	8400
Philippines	3100
Russia	7900
South Africa	3700
USA	160
Other countries	6500

Source: Mineral Commodity Summaries, 2016.

NICKEL

In 2014, world mine production of nickel decreased to 2.06 million tonnes of metal content as compared to 2.61 million tonnes of metal content in the previous year. Philippines (18%), Russia & Canada (13% each) and Australia (12%) were the principal producers (Table-4).

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

(In '000 tonnes of metal content)			
Country	2012	2013	2014
World: Total	2361	2610	2057
Australia	244	281	245
Botswana	18	23	15
Brazil	90	77	86
Canada	212	223	235
China	93	93	90
Colombia	52	49	41
Cuba	65	66 ^e	50 ^e
Dominican Rep.	15	9	-
Finland	19	19	20
Greece	22	19	21
Guatemala ^e	3	12	48
Indonesia	720	869	216
Madagascar	6	25	37
Myanmar ^e	-	2	21
New Caledonia	132	164	178
Papua New Guinea	10	13	18
Philippines	318	316	363
Russia	269	264	264
South Africa	46	51	55
Zimbabwe	8	13	17
Other countries	19	1	37

Source: World Mineral Production, 2010-14.

FOREIGN TRADE

Exports

Exports of nickel ores and concentrates increased considerably to 41 tonnes as compared to 32 tonnes during the previous year. Exports of nickel and alloys including waste & scrap increased to 46,771 tonnes in 2014-15 from 26,459 tonnes in the previous year. Out of the total alloys and scrap exported in 2014-15, nickel & alloys were 46,462 tonnes, while nickel waste & scrap were 309 tonnes. Exports were mainly to Singapore (50%), Malaysia (24%) and UAE (22%) (Tables - 5 to 8).

Imports

During 2014-15, imports of nickel ores & concentrates increased considerably to 4,185 tonnes in comparison to 1,343 tonnes in the previous year. Imports were mainly from Australia (62%), Guinea (20%) and China (14%). Imports of nickel & alloys including scrap were 76,200 tonnes in 2014-15 compared to 53,532 tonnes in the previous year. Out of total alloys and scrap imported in 2014-15, nickel & alloys were 73,646 tonnes as compared to 56,322 tonnes in the previous year, while nickel waste & scrap was 2,554 tonnes as compared to 2,790 tonnes in the previous year. Imports in 2014-15 were mainly from Singapore (26%), Malaysia (18%), China (13%), Norway & Australia (7% each) (Tables- 9 to 13).

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

Country	2013-14		2014-15(P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	32	541	41	1452
China	32	541	41	1452

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

Country	2013-14		2014-15(P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	26459	26246009	46771	55174050
Singapore	18459	18250393	23335	28251658
Malaysia	1213	1173974	11198	12388120
UAE	3178	3066657	10260	12123994
USA	216	356549	291	423005
Japan	181	151339	345	354360
Iran	46	53589	232	263892
Saudi Arabia	77	161871	84	171392
Thailand	80	92963	107	136326
UK	912	740616	208	118325
Korea, Rep. of	29	36905	81	102964
Other countries	2068	2161153	630	840014

NICKEL

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

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	26119	26112280	46462	55040521
Singapore	18459	18250393	23335	28251658
Malaysia	1213	1173974	11198	12388120
UAE	3178	3066657	10260	12123994
USA	180	336061	226	385713
Japan	141	131694	304	330339
Iran	46	53589	232	263892
Saudi Arabia	77	161871	84	171392
Thailand	80	92963	107	136326
Korea, Rep. of	29	36905	81	102964
Mexico	43	51516	66	87836
Other countries	2673	2756657	569	798287

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

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	340	133729	309	133529
UK	206	73094	174	64978
USA	36	20488	65	37292
Japan	40	19645	41	24021
Germany	15	4295	27	7041
Canada	-	-	2	196
Other countries	43	16207	++	1

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

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	1343	1207103	4185	3842487
Australia	1291	1168437	2599	2285708
Guinea	-	-	840	808952
China	-	-	576	694065
Austria	-	-	24	21530
Korea, Rep. of	-	-	18	15925
Uganda	-	-	78	7020
Malaysia	-	-	29	6574
Chinese	-	-	-	-
Taipei/Taiwan	-	-	21	2697
Finland	-	-	++	16
Other countries	52	38666	-	-

NICKEL

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

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	56322	54463252	76200	85078105
Singapore	1343	1268846	19864	22038092
Malaysia	7597	7450349	13764	16239345
China	1724	1784637	9755	11464990
Norway	5220	4719605	5185	5468103
Russia	12162	11685539	4593	5014216
Australia	10969	10230760	5450	4653063
Japan	1347	1304531	2613	2954209
Canada	3271	3099178	2603	2905100
UAE	2178	1708176	2565	2518954
UK	1703	2296182	1743	2356236
Other countries	8808	8915449	8065	9465797

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

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	53532	53075136	73646	83811134
Singapore	1322	1259113	19855	22033915
Malaysia	7597	7450349	13735	16213105
China	1724	1784637	9755	11464990
Norway	5220	4719605	5185	5468103
Russia	12162	11685539	4507	4970378
Australia	10969	10230760	5450	4653063
Japan	1347	1304531	2610	2950912
Canada	3224	3074779	2603	2905100
UK	1633	2258619	1546	2254607
UAE	1531	1423755	1953	2244377
Other countries	6803	7883449	6447	8652584

NICKEL

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

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	2790	1388116	2554	1266971
UAE	647	284421	612	274577
USA	114	77825	442	230264
Kuwait	169	87724	257	144600
UK	70	37562	197	101629
Saudi Arabia	1262	622867	201	97544
Lithuania	-	-	119	50158
South Africa	-	-	87	47714
Russia	-	-	86	43838
Turkey	84	38448	97	43004
Belgium	-	-	75	39420
Other countries	444	239269	381	194223

**Table – 13 : Imports of Nickel
(By Items)**

All Items	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Items	56322	54463252	76200	85078105
Nickel & alloys	53532	53075136	73646	83811134
Bars, rods, plates, sheets foils of nickel	459	871258	600	1086922
Bars, rods, plates, sheets foils of nickel alloys	2358	3584124	1411	2737182
Nickel electroplated anode	3	7021	8	7584
Nickel & alloys: worked	3725	4365738	1166	2032104
Nickel & alloys: worked NES	1083	852156	642	818087
Nickel & alloys: unwrought	619	605597	1431	1507065
Nickel: worked	73	167587	55	85245
Nickel except electroplated anode	44296	41783592	66816	75021596
Nickel mattes	8	7749	++	30
Nickel oxide sinters & qtr intermediate	908	830314	1517	515319
Nickel (scrap)	2790	1388116	2554	1266971

NICKEL

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.

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 exports nickel scrap covered by ISRI code, AROMA, BARLY, DANDY, DAUNT, DELTA, DECOV, DEPTH, HITCH, HOUSE, IDEAL, INDIAN, JUNTO, LEMON, LEMUR 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.