

NICKEL



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(Part- II : Metals & Alloys)

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**NICKEL**

**(FINAL RELEASE)**

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

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# 12 Nickel

Nickel is a lustrous, silvery-white metal. It is the fifth most common element of earth's crust. 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 getting 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 exploration and development details, if any, are given in the review on "Exploration & Development" in "General Reviews".

**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    |                 |                  |                 |            |                       |
| <b>All India : Total</b>  | –                  | <b>21</b>           | <b>21</b> | <b>31</b>       | <b>53</b>        | <b>63</b>       | <b>189</b> | <b>189</b>            |
| <b>By Grades</b>          |                    |                     |           |                 |                  |                 |            |                       |
| + 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                 | –                  | –                   | –         | –               | –                | –               | –          | +                     |
| <b>By States</b>          |                    |                     |           |                 |                  |                 |            |                       |
| Jharkhand                 | –                  | –                   | –         | –               | 2                | 7               | 9          | 9                     |
| Karnataka                 | –                  | –                   | –         | –               | –                | +               | –          | +                     |
| Nagaland                  | –                  | –                   | –         | –               | –                | 5               | 5          | 5                     |
| Odisha                    | –                  | 21                  | 21        | 31              | 51               | 51              | 175        | 175                   |

Figures rounded off.

## 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 plant has been commissioned in August, 2016 and is poised to be only unit in India to produce nickel metal of LME grade. The installed annual capacity of the plant is initially poised to be 50 tonnes per annum, given the current production rate from the Surda Mines. 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.

The Nicomet Industries Ltd located at Goa is engaged in producing nickel metals and their derivatives. The present annual production capacity of the Goa plant is 5400 MTPA.

## 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 Ghatshila 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 imports.

## USES

Sectoral uses of nickel metal are for stainless steel making, catalysis chemical industries, as an electroplating material, heat resistant alloys, alloying element for non-ferrous metals, space, defence & rocket industries and nickel cadmium batteries.

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.

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. Nickel based alloys, like stainless steel with higher nickel content are used for more demanding applications such as gas turbines and some chemical plants.

## 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. Low-nickel, duplex, or ultra-chromium stainless steels are being substituted for austenitic grades in construction. 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 74 million tonnes of metal content. Australia (26%), Brazil (16%), Russia (10%), 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-2).

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

(In '000 tonnes of nickel content)

| Country                           | Reserves     |
|-----------------------------------|--------------|
| <b>World: Total (rounded off)</b> | <b>74000</b> |
| Australia                         | 19000        |
| Brazil                            | 12000        |
| Canada                            | 2700         |
| China                             | 2900         |
| Columbia                          | 1100         |
| Cuba                              | 5500         |
| Guatemala                         | 1800         |
| Indonesia                         | 4500         |
| Madagascar                        | 1600         |
| New Caledonia                     | -            |
| Philippines                       | 4800         |
| Russia                            | 7600         |
| South Africa                      | 3700         |
| USA                               | 130          |
| Other countries                   | 6500         |

*Source: Mineral Commodity Summaries, January, 2018.*

In 2016, world mine production of nickel decreased to 2.00 million tonnes as compared to 2.09 million tonnes of metal content in the previous year. Philippines (15%), Canada (12%), Russia (11%), New Caledonia & Australia (10% each) and Indonesia (9%) were the principal producers (Table-3).

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

(In '000 tonnes of metal content)

| Country                   | 2014        | 2015        | 2016        |
|---------------------------|-------------|-------------|-------------|
| <b>World Total</b>        | <b>2090</b> | <b>2085</b> | <b>2001</b> |
| Australia                 | 269         | 229         | 203         |
| Botswana                  | 15          | 17          | 14          |
| Brazil                    | 86          | 89          | 86          |
| Canada                    | 229         | 235         | 236         |
| China                     | 101         | 101         | 90          |
| Colombia                  | 41          | 37          | 37          |
| Cuba                      | 52          | 54          | 52          |
| Finland                   | 19          | 9           | 21          |
| Greece                    | 21          | 21          | 22          |
| Guatemala                 | 47          | 56          | 46          |
| Indonesia                 | 188         | 130         | 180         |
| Madagascar                | 37          | 47          | 42          |
| Myanmar <sup>e</sup>      | 21          | 26          | 12          |
| New Caledonia             | 178         | 186         | 209         |
| Papua New Guinea          | 21          | 26          | 22          |
| Philippines               | 393         | 418         | 301         |
| Russia                    | 264         | 261         | 222         |
| South Africa <sup>b</sup> | 55          | 57          | 49          |
| USA                       | 4           | 27          | 24          |
| Zimbabwe                  | 17          | 16          | 18          |
| Other countries           | 34          | 42          | 117         |

*Source: World Mineral Production, 2012-16.*

*b: Includes metal and metal content of sulphate and concentrates.*

**FOREIGN TRADE****Exports**

Exports of nickel ores and concentrates were not reported for the year 2016-17. On the other hand exports of nickel and alloys including waste & scrap decreased sharply to 8,708 tonnes in 2016-17 from 37,512 tonnes in the previous year. Out of the total alloys and scrap exported in 2016-17, nickel & alloys were 8,301 tonnes, while nickel waste & scrap were 407 tonnes. Exports were mainly to China, Malaysia and UAE (Tables-4 to 7).

**Imports**

Imports of nickel ores & concentrates decreased to 1,062 tonnes during 2016-17 as compared to 3,295 tonnes during the previous year. Imports were mainly from Guinea and Australia. Imports of nickel & alloys including scrap were 49,539 tonnes in 2016-17 compared to 71,080 tonnes in the previous year. Out of total alloys and scrap imported in 2016-17, nickel & alloys was 46,878 tonnes as compared to 69,070 tonnes in the previous year, while nickel waste & scrap were 2,661 tonnes as compared to 2,010 tonnes in the previous year. Imports of nickel and alloys including scrap in 2015-16 were mainly from Russia, Norway, Australia, Canada and South africa (Tables 8 to 11).

**Table – 4: Exports of Nickel Ores and Conc.  
(By Countries)**

| Country              | 2015-16 (R) |                   | 2016-17 (P) |                   |
|----------------------|-------------|-------------------|-------------|-------------------|
|                      | Qty<br>(t)  | Value<br>(` '000) | Qty<br>(t)  | Value<br>(` '000) |
| <b>All Countries</b> | <b>41</b>   | <b>1452</b>       | <b>125</b>  | <b>11511</b>      |
| Germany              | -           | -                 | 84          | 9835              |
| China                | 41          | 1452              | 40          | 1225              |
| Nepal                | -           | -                 | 1           | 451               |
| Japan                | -           | -                 | ++          | ++                |

**Table – 5: Exports of Nickel and Alloys Including Scrap  
(By Countries)**

| Country               | 2015-16 (R)  |                   | 2016-17 (P) |                   |
|-----------------------|--------------|-------------------|-------------|-------------------|
|                       | Qty<br>(t)   | Value<br>(` '000) | Qty<br>(t)  | Value<br>(` '000) |
| <b>All Countries</b>  | <b>37512</b> | <b>32072432</b>   | <b>8708</b> | <b>6115822</b>    |
| China                 | 2683         | 2319093           | 3436        | 2523827           |
| UAE                   | 4023         | 3356555           | 809         | 529932            |
| Malaysia              | 12741        | 11105217          | 1350        | 515350            |
| Korea, Rep. of        | 7331         | 6106512           | 726         | 481390            |
| Chinese Taipei/Taiwan | 5            | 8568              | 616         | 438786            |
| Japan                 | 133          | 82993             | 346         | 209780            |
| USA                   | 214          | 275367            | 165         | 199677            |
| Saudi Arabia          | 84           | 154808            | 56          | 138586            |
| UK                    | 171          | 91267             | 179         | 110865            |
| Iran                  | 319          | 303554            | 78          | 90188             |
| Other countries       | 9808         | 8268498           | 947         | 877441            |

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

| Country               | 2015-16 (R)  |                   | 2016-17 (P) |                   |
|-----------------------|--------------|-------------------|-------------|-------------------|
|                       | Qty<br>(t)   | Value<br>(` '000) | Qty<br>(t)  | Value<br>(` '000) |
| <b>All Countries</b>  | <b>37197</b> | <b>31951710</b>   | <b>8301</b> | <b>5973202</b>    |
| China                 | 2683         | 2319093           | 3436        | 2523827           |
| UAE                   | 4023         | 3356555           | 809         | 529932            |
| Malaysia              | 12741        | 11105217          | 1350        | 515350            |
| Korea, Rep. of        | 7331         | 6106512           | 726         | 481390            |
| Chinese Taipei/Taiwan | 5            | 8568              | 616         | 438786            |
| USA                   | 191          | 264215            | 147         | 190047            |
| Japan                 | 69           | 60357             | 248         | 173425            |
| Saudi Arabia          | 84           | 153772            | 56          | 138586            |
| Iran                  | 319          | 303554            | 78          | 90188             |
| Thailand              | 77           | 110018            | 76          | 85274             |
| Other countries       | 9674         | 8163849           | 759         | 806397            |

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

| Country              | 2015-16 (R) |                   | 2016-17 (P) |                   |
|----------------------|-------------|-------------------|-------------|-------------------|
|                      | Qty<br>(t)  | Value<br>(` '000) | Qty<br>(t)  | Value<br>(` '000) |
| <b>All Countries</b> | <b>315</b>  | <b>120722</b>     | <b>407</b>  | <b>142620</b>     |
| UK                   | 146         | 57226             | 139         | 60049             |
| Germany              | 81          | 28190             | 152         | 36586             |
| Japan                | 64          | 22636             | 98          | 36355             |
| USA                  | 23          | 11152             | 18          | 9630              |
| Saudi Arabia         | ++          | 1036              | -           | -                 |
| Uganda               | 1           | 474               | -           | -                 |
| Netherlands          | ++          | 8                 | -           | -                 |

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**Table –8: Imports of Nickel Ores & Conc.  
(By Countries)**

| Country              | 2015-16 (R) |                  | 2016-17 (P) |                  |
|----------------------|-------------|------------------|-------------|------------------|
|                      | Qty<br>(t)  | Value<br>(`'000) | Qty<br>(t)  | Value<br>(`'000) |
| <b>All Countries</b> | <b>3295</b> | <b>2453862</b>   | <b>1062</b> | <b>818094</b>    |
| Guinea               | 835         | 652159           | 796         | 621980           |
| Australia            | 2414        | 1796401          | 264         | 195333           |
| Belgium              | -           | -                | 2           | 759              |
| Finland              | ++          | 5                | ++          | 22               |
| Japan                | 15          | 3636             | -           | -                |
| Singapore            | 21          | 1251             | -           | -                |
| Philippines          | 10          | 385              | -           | -                |
| USA                  | ++          | 25               | -           | -                |

**Table – 9: Imports of Nickel and Alloys Including Scrap  
(By Countries)**

| Country              | 2015-16 (R)  |                  | 2016-17 (P)  |                  |
|----------------------|--------------|------------------|--------------|------------------|
|                      | Qty<br>(t)   | Value<br>(`'000) | Qty<br>(t)   | Value<br>(`'000) |
| <b>All Countries</b> | <b>71080</b> | <b>58556855</b>  | <b>49539</b> | <b>37077252</b>  |
| Russia               | 6201         | 4567978          | 7165         | 4699826          |
| Norway               | 5317         | 3998395          | 6088         | 4204345          |
| Australia            | 8173         | 6471498          | 5920         | 3984985          |
| Canada               | 5616         | 4169383          | 4708         | 3325701          |
| South Africa         | 2728         | 2058357          | 4056         | 2768142          |
| Japan                | 4568         | 3763242          | 3125         | 2436489          |
| UK                   | 1856         | 2222993          | 1984         | 2058868          |
| USA                  | 930          | 1561639          | 1567         | 1966810          |
| Netherlands          | 924          | 562467           | 2993         | 1855868          |
| Korea, Rep. of       | 481          | 347530           | 1588         | 1070295          |
| Other countries      | 34286        | 28833373         | 10345        | 8705923          |

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**Table – 10: Imports of Nickel & Alloys  
(By Countries)**

| Country              | 2015-16 (R)  |                   | 2016-17 (P)  |                   |
|----------------------|--------------|-------------------|--------------|-------------------|
|                      | Qty<br>(t)   | Value<br>(` '000) | Qty<br>(t)   | Value<br>(` '000) |
| <b>All Countries</b> | <b>69070</b> | <b>57724031</b>   | <b>46878</b> | <b>35988099</b>   |
| Russia               | 6137         | 4537559           | 7165         | 4699826           |
| Norway               | 5317         | 3998395           | 6088         | 4204345           |
| Australia            | 8171         | 6470572           | 5853         | 3961631           |
| Canada               | 5556         | 4146788           | 4708         | 3325701           |
| South Africa         | 2728         | 2058357           | 4056         | 2768142           |
| Japan                | 4568         | 3763242           | 3125         | 2436489           |
| UK                   | 1682         | 2140537           | 1884         | 2019728           |
| Netherlands          | 823          | 524331            | 2857         | 1804023           |
| USA                  | 656          | 1430908           | 1089         | 1764254           |
| Korea, Rep. of       | 470          | 342172            | 1585         | 1068842           |
| Other countries      | 32962        | 28311170          | 8468         | 7935118           |

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

| Country              | 2015-16 (R) |                   | 2016-17 (P) |                   |
|----------------------|-------------|-------------------|-------------|-------------------|
|                      | Qty<br>(t)  | Value<br>(` '000) | Qty<br>(t)  | Value<br>(` '000) |
| <b>All Countries</b> | <b>2010</b> | <b>832824</b>     | <b>2661</b> | <b>1089153</b>    |
| UAE                  | 294         | 117429            | 790         | 321749            |
| Saudi Arabia         | 156         | 62042             | 563         | 210581            |
| USA                  | 274         | 130731            | 478         | 202556            |
| Netherlands          | 101         | 38136             | 136         | 51845             |
| Kuwait               | 59          | 28243             | 101         | 49970             |
| Bangladesh           | 49          | 19630             | 117         | 48579             |
| UK                   | 174         | 82456             | 100         | 39140             |
| Malaysia             | 29          | 9425              | 59          | 27152             |
| Baharain             | -           | -                 | 77          | 25732             |
| Australia            | 2           | 926               | 67          | 23354             |
| Other countries      | 872         | 343806            | 173         | 88495             |



## **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 12<sup>th</sup> 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 data 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.