The life of Ni
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About Nickel

Nickel is a naturally occurring metallic element with a silvery-white, shiny appearance. It is the fifth most common element on earth and occurs extensively in the earth’s crust and core. Nickel, along with iron, is also a common element in meteorites, and can even be found in small quantities in plants, animals and seawater.

Nickel has been found in metallic artefacts dating back more than 2000 years. It was first identified and isolated as an element by the Swedish chemist, Axel Cronstedt, in 1751. Mine production of nickel began in Norway in 1848, followed by New Caledonia in 1875 and Canada in 1886. During this period in the 19th century, nickel came to prominence in plating and in alloys such as “nickel silver” in which it is alloyed with copper and zinc (it does not actually contain any silver).

Nickel’s name comes from the German term ‘Kupfernickel’ or Devil’s Copper, as the miners in the 15th century thought the ore looked red-brown like copper – but it was too difficult to mine.
Nickel is widely used in hundreds of thousands of products for consumer, industrial, military, transport, aerospace, marine and architectural applications. Its outstanding physical and chemical properties make nickel essential in many end-use products.
MAGNETIC AT ROOM TEMPERATURE

CAN BE DEPOSITED BY ELECTROPLATING

HAS CATALYTIC PROPERTIES

CAN BE FULLY RECYCLED

PRODUCTS CONTAINING NICKEL ARE:
- EFFICIENT IN TERMS OF ENERGY AND RESOURCE USE
- DURABLE WITH LOW MAINTENANCE
- RECYCLABLE
The World’s nickel resources are currently estimated at almost 300 million tons.

Known nickel resources have significantly increased over the past 30 years, as has nickel mine production.

### Laterite World Resource
- 178 million metric tons
- Countries: Australia 17.7%, Indonesia 18.7%, Russia 2.2%

### Sulphide World Resource
- 118 million metric tons
- Countries: Australia 10.1%, South Africa 28.1%, Russia 17.3%

The world’s nickel resources are currently estimated at almost 300 million tons. Australia, Indonesia, South Africa, Russia and Canada account for more than 50% of the global nickel resources. Economic concentrations of nickel occur in sulphide and in laterite-type ore deposits.

Despite the fact that nickel mining has significantly increased over the past three decades, known nickel reserves and resources have also steadily grown. Various parameters play a role in this evolution, including better knowledge and increased exploration activities in remote areas, driven by attractive commodity prices. Improved technologies in mining, smelting and refining, as well as increased capacities, also allow for lower-grade nickel ore to be processed.

There are also reckoned to be significant nickel deposits in the sea. Manganese nodules, which are found on the deep-sea floor, contain significant amounts of various metals, including nickel. According to recent estimates, there are more than 290 million tons of nickel contained in such deposits. The development of deep-sea mining technologies is expected to facilitate access to these resources in the future.

* Reserves and resources are defined terms in mineral deposits classification and are based on their geologic certainty and economic value. Reserves are defined as being valuable and economically, legally and technically feasible to be extracted. Resources are potentially valuable and for which reasonable prospects exist for eventual extraction.

NINE COUNTRIES ACCOUNT FOR 75% OF GLOBAL NICKEL RESERVES. LATERITE-TYPE (OR OXIDE-TYPE) RESOURCES ARE FOUND IN INDONESIA, THE PHILIPPINES, BRAZIL, CUBA AND NEW CALEDONIA. SULPHIDE-TYPE DEPOSITS ARE FOUND IN SOUTH AFRICA, RUSSIA AND CANADA. AUSTRALIA HAS THE BIGGEST NICKEL RESOURCES WITH BOTH SULPHIDE- AND LATERITE-TYPE ORE DEPOSITS.
Cradle-to-gate

Unlike most other metals, nickel ores are found in diverse geological formations, in different mineralogical forms, at different depths, with varying percentages of nickel content, and often with other metals present. The processing techniques used depend on these variables which yield different rates of metal recovery.
Nickel mining

Nickel-containing ores are currently mined in more than 25 countries worldwide. The Asia Pacific region accounts for more than 70% of global nickel mine production. Indonesia, the Philippines, Russia, Australia and Canada are the biggest nickel producers.

While mine production in Canada and Russia is mainly linked to the mining of sulphide-type ore deposits, Indonesia and the Philippines predominantly mine laterites. In Australia, both laterite and sulphide mine production take place. Due to their geological formation, laterite-type ore deposits and mines are principally found in equatorial regions and production from this type of deposits has steadily increased in recent decades.

The main nickel mining companies include Ambatovy, Anglo American, BHP Billiton, Glencore, JFE Mineral Company Ltd., Lundin Mining Corporation, MMC Norilsk Nickel, Pacific Metals Co. Ltd., Sherritt International Corporation, Eramet, South32, Sumitomo Metals Mining Co. Ltd., Vale, and Western Areas Ltd.

Source: INSG Yearbook 2015. Data from 2014
In just 10 years, China has become the global leader in nickel production. In 2013, more than a third of global nickel production originated from China. Annual growth rates over recent years have been as high as 46%.
Nickel production

Over the past ten years, global nickel output has increased by more than 65%, while that of China has shot up by a factor of 13.

The output of primary nickel production is generally divided into two main product categories.

Nickel Class I describes a group of nickel products comprising electrolytic nickel, powders and briquettes, as well as carbonyl nickel.

Nickel Class II comprises nickel pig iron and ferronickel. These nickel products commonly have a lower nickel content and are used especially in stainless steel production, where stainless steel producers take advantage of the iron content.

Roughly 55% of the total nickel mining output relates to Class I nickel products, with Class II nickel products accounting for the remaining 45%.

1.99 million metric tons total annual world production
China accounted for half of global nickel use in 2014. Asia plays a dominant role when it comes to the first use with roughly 70% global market share followed by Europe with roughly 20% and the US with around 8%.
A discrepancy between nickel mining, production and use can be observed. This is attributed to stockpiling as a result of fluctuations in demand.

Note: The numbers shown are % of global use. Source: INSG Yearbook 2015. Data from 2014.
First use of Nickel

The first use of nickel is defined as the conversion of nickel products into intermediate products, which form the basis for nickel-containing end-use products. In nearly all cases, these first-use products undergo further processing before they are ready for use.

TWO THIRDS OF GLOBAL NICKEL PRODUCTION IS USED TO PRODUCE STAINLESS STEEL. AS AN ALLOYING ELEMENT, NICKEL CONTRIBUTES TO THE LONGEVITY, CORROSION RESISTANCE AND LOW MAINTENANCE OF STAINLESS STEEL GOODS.
The conversion of first-use nickel products into final goods results in different end uses of nickel. Due to its outstanding physical and chemical properties, nickel is used in a wide range of end-use sectors.
Recycling: a new life for Ni

Similar to other metals, nickel is fully recyclable. Because nickel-containing products have value, an infrastructure for gathering and processing these materials exists. While society is more likely to see metal recycling today as an environmental activity, it has existed for thousands of years as a profitable economic activity. In most countries, the economics of gathering, sorting, preparing, transporting and using scrap metal employs more people and is of greater economic importance than the mining and refining of ores.

Nickel is one of the most valuable common non-ferrous metals, along with aluminium, copper, lead and zinc (Al, Cu, Pb, Zn). Given its value as a commodity, the commercial motivation to use nickel effectively in the first place is very strong. There is a similarly compelling incentive for recovering and recycling nickel effectively at all stages of the production and use cycle.

Recycling efficiencies are calculated based on a set of widely agreed and accepted recycling indicators, which are reviewed on a regular basis in the nickel industry. The global efficiency of recycling nickel from end-of-life products for the reference year 2005 was calculated to be at 63%. Losses that occur after use mainly relate to nickel-containing materials ending up in landfills and so called "non-functional recycling", i.e., nickel that ends up in other material streams such as carbon steel where the outstanding properties of nickel are not further exploited. Depending on the region and the specific end uses, nickel-recycling efficiencies can vary greatly. In the case of nickel-containing stainless steel, very high recycling efficiencies can be reached.

DUE TO ITS HIGH ECONOMIC VALUE AND ITS USE IN STAINLESS STEEL AND NICKEL ALLOYS, THE RECYCLING EFFICIENCIES OF NICKEL ARE AMONG THE HIGHEST IN THE METALS INDUSTRY.
Nickel is a natural resource, which cannot be consumed. It is fully recyclable again and again without loss of quality, contributing to the Circular Economy (CE) model.
Outlook

It is hard to imagine a world without nickel. It is an essential material used in many critical applications that bring widespread benefits to society, from the fundamental necessities of clean air, clean water, safe food preparation, and health care, to everyday items in the home as diverse as kitchenware and computers. One of the best-known nickel-containing materials is stainless steel, which has now been in use for over 100 years.

In industry, nickel catalysts and alloys are at the heart of an efficient and modern chemical industry, including oil refining, allowing the production of low sulphur fuels. Nickel enables clean power generation, and has a role in all renewable energy solutions.

It can be found in advanced green technology that increases energy efficiency and reduces carbon emissions. In architecture, nickel alloys combine functionality and high recyclability with aesthetics.

The best-known properties of nickel – toughness, malleability and enhanced corrosion resistance – allow superior performance in difficult environments and at extremely high temperatures. These properties are why nickel-containing materials play such an important role in providing energy, transport, food and clean water, and why they will continue to contribute to a durable and sustainable economy and society. New applications for nickel in millions of parts and processes going forward will continue to make sizeable contributions relative to the small amounts used.

Nickel-containing materials have the further advantage of being ideally suited for recycling because of their end-of-life value; they are easily identified and can be turned into new, high-quality materials in an efficient manner.

The production and use of nickel adds value in all regions of the world in the form of employment, taxes, investment and the utility of the end products themselves.

But beyond nickel’s enormous contribution to society, the nickel industry is also committed to ensuring the responsible management of nickel and nickel-containing materials throughout their life cycles.