Met-Info

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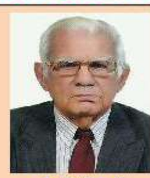
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Non-Ferrous Metals: Definition, Properties, Use and Types

Non-ferrous metals are a *very* generalized classification of metallic elements that are not iron or alloys that contain iron as their *primary* constituent. This encompasses a massively diverse range of metals with distinct and overlapping properties.

These metals are exploited across all industries and product areas, valued variously for their conductivity, malleability, aesthetics, chemical stability, resilience, and recyclability, contributing to their widespread use in modern technology and infrastructure.

This article will delve into non-ferrous metals, including their properties, uses, and types.

What is a Non-ferrous metal?

Non-ferrous metals are a class of elemental metals and alloys that lack iron as a major constituent in their composition. Non-ferrous metals exhibit a variety of divergent physical and chemical properties. They are highly versatile and valuable in a wide range of applications—from bearings to scaffolding, from food utensils to aircraft structures and engine parts.

Different Properties of Non-Ferrous Metals

Non-ferrous metals offer a startlingly diverse range of properties. These properties are discussed below:

1. Light Weight

Lower density is a prominent (but far from universal) property among non-ferrous metals, facilitating their exploitation in weight-critical roles. Lower densities result in reduced weight for the same part (in which strength is not a primary concern).

This is particularly advantageous in aerospace, handheld/carried equipment, and automotive. Non-ferrous metals like aluminium and titanium are renowned for their elevated strength-to-weight ratios. They enable the production of light/strong components without compromising serviceability or durability. This greatly enhances fuel efficiency in transportation and facilitates easier handling and installation.

2. Conductivity

The most commonly exploited non-ferrous metals encompass excellent electrical and thermal conductivities combined with relatively low cost. They are irreplaceable in electrical power, electronics, and heat transfer/management applications.

Various non-ferrous metals possess the highest levels of thermal conductivity. They enable effective heat transfer in applications such as: heat exchangers, spacecraft radiant coolers, and cooking utensils.

3. Biocompatibility

Some non-ferrous metals demonstrate excellent levels of biocompatibility, making them suitable for medical and healthcare applications. Titanium and certain of its alloys, gold, platinum, and others exhibit biocompatible properties. They are well-tolerated by living tissues and can be safely implanted within the body without causing adverse reactions. Others, such as beryllium and lead, are highly toxic.

Biocompatibility is an absolute necessity for implanted medical devices for orthopedics, dental implants, and cardiovascular devices such as stents, in which materials must interact minimally with living tissues.

4. Corrosion Resistance

Non-ferrous metals commonly offer good to outstanding corrosion resistance. They are highly desirable for applications in which exposure to moisture, chemicals, or harsh environments is a concern. Aluminium, copper, and titanium, as significant components in alloys or their pure state, naturally form impermeable protective oxide layers. These act as self-healing barriers against progressive corrosion.

Corrosion-resistant non-ferrous metals are widely applied in industries requiring high-performance materials that can withstand corrosive agents without compromising structural integrity. Sensitivities vary considerably, so the material selection is a delicate and, in many cases, difficult balance.

5. Recyclability

Non-ferrous metals are typically highly recyclable, offering significant environmental and economic benefits. In particular, they can be relatively easy to identify and sort, to avoid contamination of material streams with inappropriate materials.

Unlike ferrous metals, which degrade during recycling by oxidation, non-ferrous metals can be recycled indefinitely without losing significant mass or performance. Recycling requires less energy than purification from ores and reduces the demand for damaging, primary extraction, reducing greenhouse-gas emissions and conserving natural resources. As a result, recycling initiatives for non-ferrous metals are actively promoted and supported by governments, industries, and environmental organizations worldwide.

6. Heat Conductivity

Some non-ferrous metals exhibit good to excellent thermal conductivity, making them valuable for various applications in which heat transfer is a core function. Copper, aluminium, and their alloys are particularly renowned for their high thermal conductivity compared to ferrous metals. This enhances efficient heat dissipation and distribution, making them suitable for: heat exchangers, cooking utensils, radiant elements, and thermal-management systems. Their superior heat conductivity enhances energy efficiency, reduces operational costs, and improves overall performance in diverse industrial and domestic settings.

7. Malleability and Ductility

Non-ferrous metals are typically malleable and ductile apart from some notable exceptions like tungsten and cobalt, allowing many others to be easily shaped and formed without excessive costs. A few non-ferrous metals exhibit the highest levels of malleability and ductility of all metals—particularly gold and silver. This allows for the fabrication of complex parts through processes such as: forging, rolling, and extrusion. Additionally, the malleability and ductility of non-ferrous metals contribute to their use in: jewellery making, general metalworking, and construction sectors.

8. Non-Magnetic

Non-ferrous metals are typically non-magnetic. They are not attracted to magnets (para-magnetism) or do not retain magnetic properties (ferromagnetism) after exposure to a magnetic field. These properties arise from the absence or minimal presence of iron in their composition. Various non-ferrous metals are suitable for applications in which magnetic interference must be minimized, such as in electrical and electronic devices. The non-magnetic nature of these metals also allows for their use in sensitive equipment like MRI machines and aerospace components, in which magnetic interference could disrupt operation or accuracy.

Various non-ferrous metals do however experience powerful diamagnetism, in which eddy currents are formed in moving or forming/collapsing magnetic fields. This property is key to the AC transformer process, in which primary current and induced current coils alter voltage in proportion to the count of exposed windings. Additionally, this feature is used in electrical braking, well demonstrated by the slow fall of a magnet through a copper tube.

9. Aesthetic Appeal

Non-ferrous metals are generally considered to possess attractive aesthetics due to their natural lustre, ability to be polished to a high shine, and the slowness of the oxidation process. Copper alloys, for example, develop a rich patina over time, adding to their visual appeal. Additionally, some non-ferrous metals can be anodized (forcibly oxide coated by electrochemistry) or otherwise surface coated/plated to enhance their appearance, providing a wide range of finishes for various applications. These aesthetic qualities make them popular choices for: architectural elements, decorative accents, jewellery, and artwork.

10. Low Melting Points

The melting points of non-ferrous metals vary widely depending on the specific metal. For example: aluminium’s melting point is around 660 °C, while copper's melting point is around 1,083 °C. Brass’s melting point, on the other hand, typically ranges from 900–940 °C.

These limited examples demonstrate the very wide range that this extensive family encompasses.

Examples of Non-Ferrous Metals

These are examples of non-ferrous elemental metals:

1. Aluminium (Al)
2. Copper (Cu)
3. Lead (Pb)
4. Zinc (Zn)
5. Titanium (Ti)
6. Nickel (Ni)
7. Tin (Sn)
8. Magnesium (Mg)
9. Beryllium (Be)
10. Tungsten (W)

The following are most commonly employed non-ferrous alloys:

1. Brass (copper-zinc alloy).
2. Bronze (copper-tin alloy).
3. Pewter (tin alloy with copper, antimony, or lead).
4. Aluminium alloy (aluminium combined with other elements such as: copper, zinc, magnesium, or silicon).
5. Duralumin (aluminium alloy with copper, magnesium, and manganese).
6. Cupronickel (copper-nickel alloy).
7. Monel® (nickel-copper alloy).
8. Titanium alloy (titanium combined with other elements such as: aluminium, vanadium, or nickel).
9. Zamak (Zinc alloy with aluminium, magnesium, and copper).
10. Alnico (aluminiium-nickel-cobalt alloy).

These alloys offer an extended range of properties and are used in a huge abundance of applications across all product sectors.

Usage of Non-Ferrous Metals

Non-ferrous metals and their alloys find diverse applications across various industries due to their unique and highly divergent properties as a family. Some common applications include:

1. **Aerospace:** Aluminium and titanium alloys are used in aircraft components due to their lightweight nature, temperature tolerance (titanium), and high strength-to-weight ratios.

2. **Automotive:** Aluminium and magnesium alloys are employed in vehicle bodies, engine components, and wheels to reduce weight and improve fuel efficiency. Copper and its alloys are used in electrical wiring due to their conductivity.

3. **Construction:** Non-ferrous metals are used in roofing, plumbing, electrical wiring, structural components, and widely in coatings for ferrous metals, exploiting their corrosion resistance and environmental durability.

4. **Electronics:** Copper, aluminium, and their alloys are used in electronic components and conductors, transmission wiring, connectors, and heat sinks due to their electrical and thermal conductivity.

5. **Marine and Offshore:** Copper-aluminium-nickel alloys are used in marine applications such as: shipbuilding, offshore platforms, and seawater piping due to their resistance to corrosion in marine environments.

6. **Medical:** Titanium and its alloys are used in medical implants and instruments due to their biocompatibility and corrosion resistance.

7. **Single-use product packaging:** Aluminium and tin alloys are used in beverage cans, food packaging, and aerosol containers due to their light weight, corrosion resistance, and recyclability. They are also used as coatings on ferrous metal products for similar purposes.

Industrial Use Non-ferrous Metals

Industry utilizes non-ferrous metals across a wide range of applications due to their unique properties. These metals are valued for their corrosion resistance, conductivity, lightweight nature, and other advantageous characteristics. In various sectors, non-ferrous metals find applications in: mining, waste disposal, electrical generation, electricity utilization, submarine, and aerospace.

Different Types of Non-Ferrous Metals

Non-ferrous metals form a diverse family of metallic elements and alloys. The most commonly employed non-ferrous metals include:

1. Magnesium

Magnesium is a lightweight non-ferrous metal known for its high strength-to-weight ratio, excellent machinability, and corrosion resilience. It is widely used in: aerospace, automotive, electronics, sporting goods, and medical implants.

2. Aluminium

Aluminium is an alloy-versatile non-ferrous metal characterized by its low density, corrosion resistance, and high thermal conductivity. It is extensively used in all industries, including: aerospace, automotive, construction, packaging, and electronics. Aluminium alloys offer exceptional strength-to-weight ratios, making them ideal for lightweight structural components in: aircraft, spacecraft, light vehicles, sporting goods, and most engineering applications.

3. Zinc

Zinc is a non-ferrous metal of particularly high corrosion resistance in open environments due to its facility in forming protective oxide coatings. It finds applications in galvanizing steel to prevent corrosion, in pure form as roofing and die casting, batteries, alloys with other non-ferrous metals, and in various industrial and domestic chemical compounds.

4. Lead

Lead, a heavy metal, is extensively utilized in various industries despite well-understood and widely regulated health and environmental concerns. Applications range from batteries, ammunition, and radiation shielding to construction materials like pipes and roofing. Despite its toxicity, lead's highly valued malleability, corrosion resistance, and low melting point make it valuable for a wide spectrum of industrial purposes.

5. Titanium

Titanium is a lightweight and corrosion-resistant metal with wide-ranging applications in: the aerospace, automotive, medical, and chemical industry sectors. Its exceptional strength-to-weight ratio makes it ideal for structural components, while its biocompatibility renders it invaluable in medical implants. Additionally, titanium's resistance to elevated temperature and corrosion makes it suitable for use in: marine environments, jet/rocket components, and chemical-processing plants.

6. Copper

Copper is valued for its high electrical conductivity and malleability. It serves diverse roles in: electrical wiring, water (and other) plumbing, and electronics. It's also utilized as cladding/roofing in architecture, due to its corrosion resistance and aesthetic appeal. Copper's antimicrobial properties make it applicable in healthcare settings for surfaces and fixtures, enhancing infection control.

7. Brass

Brass is an alloy of copper and zinc. It offers excellent machinability, good corrosion resistance, and acoustic properties for musical instruments. Widely used in music, plumbing fixtures, and decorative applications, brass offers a balance of durability, price, and aesthetics. Its versatility extends to engineering components, in which its strength and workability find utility in various contexts.

8. Cobalt

Cobalt, a hard, lustrous transition metal, is essential in the production of high-strength alloys, lithium-based batteries, and magnets. Its unique properties, including corrosion resistance and high melting point, make it valuable in: aerospace, electronics, and medical applications. Cobalt-based alloys are prominent in gas turbines, while their magnetic properties find use in data storage.

9. Bronze

Bronze is an alloy of copper and tin that possesses excellent corrosion resistance. It has a golden color when unoxidized and deep brown when the oxide film is fully developed. Widely used in sculpture, architectural accents, marine components, and musical instruments, bronze is valued for its malleability, durability, and aesthetic appeal. Its (historical) significance as an industrial and weapons-grade metal is now greatly reduced, but it is a preferred material for artistic purposes, and an extensive range of functional applications remains significant.

10. Chromium

Chromium is often used as a plating material for ferrous and other non-ferrous metals as well as plastics, with a substrate of copper applied first. This coating method enhances the corrosion resistance, cosmetics, and durability of surfaces it is applied to.

Its shiny, reflective surface and resistance to tarnishing make it ideal for decorative applications, such as: automotive trim, kitchen fixtures, and bathroom fittings. Additionally, chromium's hardness and wear resistance contribute to its use in industrial applications like tools and machinery parts to make surfaces resistant to galling and abrasion.

11. Nickel

Nickel is valued for its corrosion resistance, toughness, and durability, across virtually all industries and product sectors. It's a commonly used alloy component in stainless steel production for its ability to enhance strength and resistance to oxidation and corrosion. It is also a key component of specialist bronzes. Additionally, nickel is utilized in electroplating processes to provide a decorative finish and improve resistance to wear and corrosion in various products.

12. Tin

Tin is appreciated for its malleability, low melting point, and low toxicity. It is applied as a protective coating for other (often ferrous) metals to prevent corrosion, particularly in tin-plated steel used for food packaging.

Additionally, its low melting point and high electrical conductivity mean tin is utilized in soldering alloys, providing easily melted material for joining electronic components and plumbing fixtures.

13. Tungsten

Tungsten is valued for its exceptional hardness and high melting point. It's extensively used in various industries, including: aerospace, automotive, and electrical, for its robustness and resistance to heat and wear. Additionally, tungsten alloys are utilized in military armor-piercing ammunition, exploiting its exceptional density. Decreasingly relevant now, it was universally used for filaments in incandescent light bulbs, exploiting its high melting point.

14. Beryllium

Beryllium is characterized by its low density and exceptional stiffness. It is crucial in aerospace, defense, and electronics industries, often alloyed with copper. Its unique properties make it ideal for applications requiring high strength-to-weight ratios, such as aerospace components and precision instruments. However, beryllium is toxic, posing health risks during its mining, processing, and handling, necessitating strict safety measures.

15. Platinum

Platinum is appreciated for its rarity, durability, and corrosion resistance. It is used extensively in catalytic converters, jewelry, and electronic components. Its exceptional catalytic properties make it indispensable in various industrial-chemical processes. However, its high cost and limited presence in the earth's crust restrict its widespread use, reserving it for high-value, specialized, and low-material-use applications in which its cost can be justified by its unique properties.

How To Choose Which Type of Non-Ferrous Metals To Use

When choosing a type of non-ferrous metal for a specific application, many factors should be considered. The process follows:

1. Assess the mechanical, thermal, and chemical properties required for the application. Strength, conductivity, and corrosion resistance vary widely across this large grouping.
2. Evaluate the properties of the various candidates to these requirements. Carefully consider cost, availability, ease of fabrication, and particular sensitivities.
3. Analyze the environmental conditions the material will be exposed to, as well as any regulatory compliances that may be applicable.
4. Conduct thorough research on the performance of different non-ferrous metals in similar applications and consult with materials experts, whenever any uncertainty applies.

The optimal choice will balance the desired properties with practical considerations to ensure appropriate performance and cost-effectiveness.

What Is the Advantage of Using Non-Ferrous Metals?

Non-ferrous metals offer several advantages over ferrous metals, including:

1. Corrosion resistance
2. Light weight
3. Electrical conductivity
4. Thermal conductivity
5. Service-temperature range
6. Recyclability
7. Aesthetics

What Is the Disadvantage of Using Non-Ferrous Metals?

While non-ferrous metals offer numerous advantages, they also come with some burdens that must be considered and accommodated, such as:

1. Non-ferrous metals tend to be more expensive than ferrous metals due to their scarcity and more-convoluted extraction processes.

2. In general, non-ferrous metals have lower tensile and yield strengths compared to typical ferrous metals, limiting their use in high-stress applications. Titanium is an exception to this, as is aluminum under optimized alloy/processing conditions.

3. Some non-ferrous metals, such as titanium and nickel, can be challenging to machine due to their hardness, work-hardening properties, and toughness.

4. Certain non-ferrous metals, such as platinum group metals, are relatively rare and may face supply-chain issues. Others such as aluminum and magnesium are massively abundant in the earth's crust.

5. Some non-ferrous metals, like beryllium and lead, can pose serious and insidious health hazards if mishandled, requiring special precautions during processing and use.

How Do Industries Leverage the Conductivity of Non-Ferrous Metals in Electrical Applications?

Industries leverage the high *electrical* conductivity of non-ferrous metals in electrical applications by utilizing them in the production of electrical wiring, conductors, and components. Copper and aluminium (among several others) are known for their excellent electrical conductivity and are extensively used in power transmission lines, electrical cables, and electronic circuitry. They offer efficient transmission of electrical currents with minimal voltage drop. Additionally, non-ferrous metals' conductivity makes them suitable for applications requiring high-speed data transmissions, such as telecoms and computer networking.

Source: Xometry, April 12, 2024

e-Waste is Full of Metals that could be Recycled

To build all of the solar panels, wind turbines, electric vehicle batteries, and other technologies necessary to fight climate change, world is going to need a lot more metals. Mining those metals from the earth creates damage and pollution that threaten ecosystems and communities. But there's another potential source of the copper, nickel, aluminium, and rare-earth minerals needed to stabilize the climate: the mountain of electronic waste discarded each year.

Exactly how much of each clean energy metal is there in the laptops, printers, and smart fridges the world discards? Until recently, no one really knew. Data on more obscure metals like neodymium and palladium, which play small but critical roles in established and emerging green energy technologies, has been especially hard to come by.

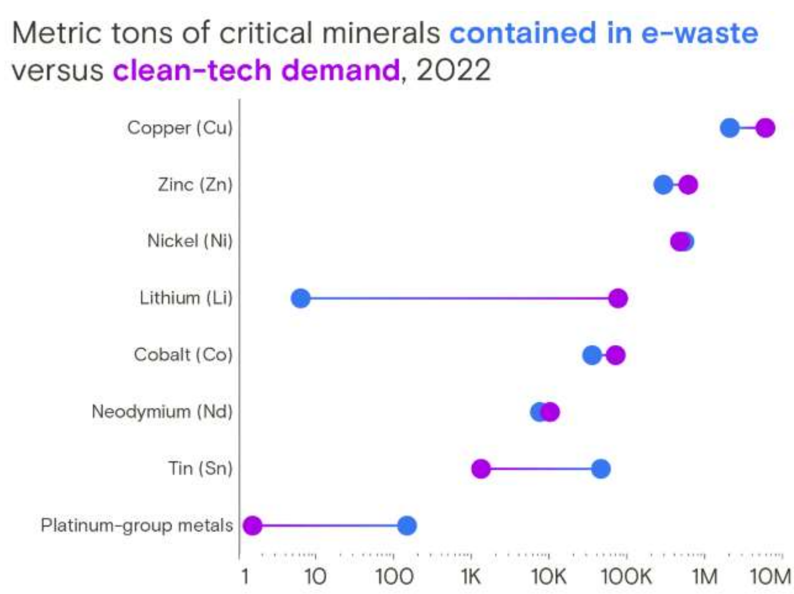
Now, the United Nations has taken a first step toward filling in these data gaps, with the latest instalment of its periodic report on e-waste around the world. Released last month, the new "Global E-waste Monitor" shows the staggering scale of the e-waste crisis, which reached a new record in 2022, when the world threw out 62 million metric tons of electronics. Report also includes a detailed breakdown of the metals present in the electronic garbage and how often they are being recycled.

There is very little reporting on the recovery of metals from e-waste globally.

One of those facts is that some huge quantities of energy transition metals are winding up in the garbage bin.

Two of the most recyclable metals found abundantly in e-waste are aluminium and copper. Both are slated to play essential roles in the energy transition: Copper wiring is prevalent in a range of low- and zero-carbon technologies, from wind turbines to the power transmission lines that carry renewable energy. Aluminium is also used in some power lines and as a lightweight structural support metal in electric vehicles, solar panels, and more. Yet only 60 percent of the estimated 4 million metric tons of aluminium and 2 million metric tons of copper present in e-waste in 2022 got recycled. Millions of tons more wound up in waste dumps around the world.

The world could have used those discarded metals. In 2022, the climate tech sector's copper demand stood at nearly 6 million metric tons, according to the International Energy Agency (IEA). In a scenario where the world aggressively reduces emissions in order to limit global warming to 1.5 degrees Celsius, copper demand for low-carbon technologies could nearly triple by 2030.



Source: UN E-Waste Monitor 2024; IEA Critical Minerals Market Review 2023
Copper is classified as near-critical by DOE. The UN does not include lithium ion batteries in its accounting.

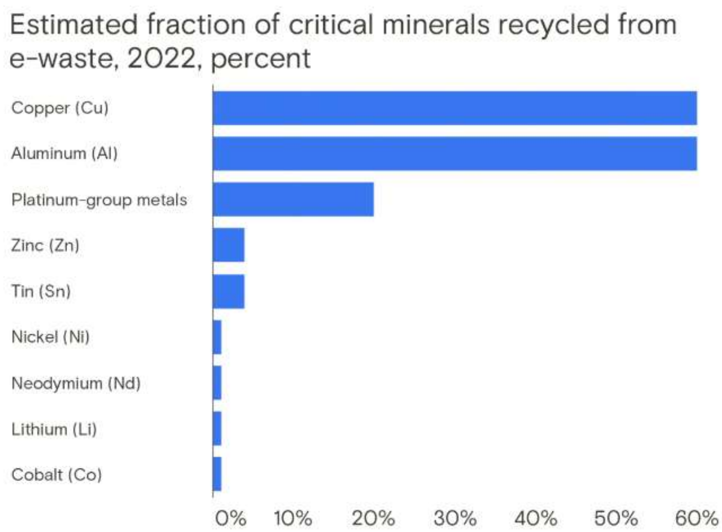
Aluminium demand, meanwhile, is expected to grow by up to 80 percent by 2050 due the pressures of the energy transition. With virgin aluminium production creating over 10 times more carbon emissions than aluminium recycling on average, increased recycling is a key strategy for reining in aluminium's carbon footprint as demand for the metal rises.

For other energy transition metals, recycling rates are far lower. Take the rare-earth element neodymium, which is used in the permanent magnets found in everything from iPhone speakers to electric vehicle motors to offshore wind turbine generators. Worldwide, it is estimated there were 7,248 metric tons of neodymium locked away in e-waste in 2022 — roughly three-quarters of the 9,768 metric tons of neodymium the wind and EV sectors required that year, per the IEA. Yet less than 1 percent of all rare earths in e-waste are recycled due to the immaturity of the underlying recycling technologies, as well as the cost and logistical challenges of collecting rare-earth-rich components from technology.

"It's a lot of hassle to collect and separate out" rare-earth magnets for recycling. Despite the EV and wind energy sectors' fast-growing rare-earth needs, "there is no push from the market or legislators to recover them."

The metals present in e-waste aren't necessarily useful for every climate tech application even when they are recycled. Take nickel. The lithium-ion batteries inside electric vehicles gobble up huge amounts of the stuff — over 300,000 metric tons in 2022. The amount of nickel required for EVs could rise tenfold by 2050, according to the IEA. But while the world's e-waste contained more than half a million metric tons of nickel in 2022, most of it was inside alloys like stainless steel. Rather than getting separated out, that nickel gets "recycled into other steel products. Some of that recycled steel could wind up in wind turbines and other zero-emissions technologies. But it won't directly help to fill the much larger nickel demands of the EV battery market.

In other cases, e-waste might represent a significant supply of a specialized energy transition metal. Despite being present in tiny amounts, certain platinum group metals — found on printed circuit boards and inside medical equipment — are already recycled at high rates due to their value. Some of these metals, such as palladium, are used in the production of catalysts for hydrogen fuel cell vehicles. Recycling palladium from e-waste could help meet the growing demand for these metals in fuel cell technologies and clean hydrogen production, supporting the transition to clean energy.



Source: UN E-Waste Monitor 2024; IEA Critical Minerals Market Review 2023

Copper is classified as near-critical by DOE. The UN does not include lithium ion batteries in its accounting.

For the energy transition to take full advantage of the metals present in e-waste, better recycling policies are needed. That could include policies requiring that manufacturers design their products with disassembly and recycling in mind. When a metal like copper isn't getting recycled, that's usually because it's in a smartphone or other small consumer device that isn't easy to take apart.

In addition to design-for-recycling standards, metal recovery requirements are needed to push recyclers to recover some of the non-precious metals present in small quantities in e-waste, like neodymium. To that end, the European Council approved a new regulation that sets a goal that by 2030, 25 percent of "critical raw materials," including rare-earth minerals, consumed in the European Union will come from recycled sources. While this is not a legally binding target, it could "create the legislative push" toward metal recovery requirements.

Harvesting more of the metals inside e-waste will be challenging, but there are enough reasons to do so.

Source: Canary Media, 19 April 2024

Nippon Steel's Hydrogen Reduced DRI Based Steelmaking

Nippon Steel, the largest steelmaker in Japan, is set to invest ¥38.4bn ($250m) into the development of highly efficient hydrogen-based direct iron reduction and electric arc furnaces to drastically cut emissions from steel production. Nearly 60% of the bill will be footed by the Japanese government.

In traditional blast furnace-based steelmaking, coking coal is used to “reduce” iron ore, or remove its oxygen content, while simultaneously producing high heat to melt the metal.

However, this is an emissions-intensive process, with Japanese government figures putting its domestic steel industry’s CO_2 footprint at 131 million tonnes a year, or 40% of the country’s industrial emissions.

The move by Nippon Steel may be a reaction to plans by the EU — a major steel importer — to start taxing imports according to their lifecycle greenhouse gas emissions from 2026 as part of the bloc’s Carbon Border Adjustment Mechanism, which is expected to drive steelmakers outside its borders towards greener alternatives to blast furnaces.

Nippon Steel’s research and development programme, which is scheduled to run from this year through 2028, aims to develop extremely efficient technology that uses H_2 to directly reduce low-grade iron ore and produce 100 or more tonnes of iron per hour, which can then be melted into steel in electric furnaces.

The focus on low-grade iron ore could also widen the potential supply for green steelmaking. For example, H2 Green Steel’s planned facility in Sweden has to use high-grade, pelletised iron ore, which it is set to ship from Brazil and Canada as it has been unable to sign domestic supply agreements.

Nippon Steel also aims to reduce impurities in hydrogen-processed iron, such as keeping phosphorus concentrations to 0.015% or less, in order to make high-grade steel, while also producing slag from the electric arc furnaces at a quality suitable for use in cement — e.g., 3% or lower iron oxide concentration.

A demonstration is scheduled to be held at a test electric arc furnace a fifth the scale of a conventional blast furnace in 2030.

The Japanese government's New Energy and Industrial Technology Development Organization (NEDO) will contribute ¥23bn, footing around 60% of Nippon Steel's bill.

But while similar government-backed projects in Europe to use hydrogen for direct iron reduction have committed to use green hydrogen — produced from renewables-powered electrolysis — in order to reduce emissions by up to 95%, Nippon Steel's pilot makes no such commitment. The project is set to use H_2 generated within Nippon Steel's existing works from coke oven gas, with any extra volumes purchased from external sources — likely to be grey hydrogen produced from steam methane reforming.

NEDO suggests that the technology developed will reduce CO_2 emissions by "more than 50%" by 2030.

Nippon Steel is also running a NEDO-backed trial to inject heated hydrogen into existing blast furnaces, which in February it claimed had enabled a 33% cut in emissions at a test furnace.

Source: Accelerate Hydrogen Newsletter, 16 April 2024

Hydrogen Injection Cuts Test Blast Furnace Emissions by Third

Japan's largest steelmaker Nippon Steel plans to deploy H2-based process at Kimitsu works at beginning of 2026

Nippon Steel has announced it has reduced emissions from a small-scale test blast furnace by 33% through injecting heated hydrogen in a month-long trial.

While Nippon Steel has referred to purchasing H_2 "from outside steelworks" for the Super COURSE50 process, which aims to displace as much coking coal with hydrogen as possible, it has not disclosed what proportion of the molecule to coking coal was used in the blast furnace, nor whether it was produced from fossil gas or electrolysis.

In order to produce steel, iron ore must first have its oxygen removed in a process called "reduction". This is traditionally done through the use of coking coal in a blast furnace, which both reduces iron ore and produces vast amounts of heat that melt the metal. However, this is an emissions-intensive process.

While hydrogen can be used instead of coke as a direct reduction agent, this reaction is difficult to sustain as it is endothermic rather than exothermic, which also means no heat for melting the iron.

Some companies, such as Sweden's H2 Green Steel, plan to directly reduce iron with hydrogen and use renewables-powered electric arc furnaces for heat, which could theoretically reduce emissions by 95%.

Other large steelmakers, including Tata Steel and Thyssenkrupp, have also trialled H_2 injection in order to prolong the lifetime of existing blast furnaces, although the emissions reduction of these tests have been meagre.

For example, Tata Steel's 40% hydrogen injection into a blast furnace at its Jamshedpur steelworks in India displaced 10% of coking coal, indicating an emissions saving of just 7-10%.

Nippon Steel aims to reduce existing blast furnace emissions by 50% through hydrogen injection.

The Japanese steelmaker plans to start using its COURSE 50 technology — which recycles hydrogen generated when coking coal is fired in a blast furnace for use as a reducing agent — at its No. 2 blast furnace in its East Nippon Works in Kimitsu from January 2026, and deploy the Super COURSE50 process of injecting externally-bought H2 by 2050.

Both of the hydrogen injection techniques had been developed with funding from research and development agency NEDO, which budgeted up to ¥193.5bn ($1.3bn) for a wider Nippon Steel-run decarbonisation programme.

Source: Hydrogen Insight, 12 Feb. 2024

JSOL's New High-Capacity Hot Strip Mill Commissioned

New high-capacity hot strip mill (HSM) at Jindal Steel Odisha Ltd. (JSOL) has been successfully into operation. Erection and commissioning of the plant took place in record time, despite temporary restrictions caused by COVID-pandemic.

JSOL placed an order with SMS in 2021 for the erection of a 1,780-Millimeter HSM, to be equipped with the world's most advanced technologies in the field of hot strip production, especially when it comes to rolling of hot strip to thin final gauges.

Major equipment of the HSM

Main scope of equipment included the primary descaler, roughing stand No. 1 in 2-hi design with attached edger, roughing stand No. 2 in 4-hi design also with attached edger, transfer bar cooling system, $HI_{BOX}^{®}$ heat preservation hoods, mandrel-less coilbox, edge heating equipment, drum shear, secondary descaler, a seven stand finishing mill, laminar cooling, three downcoilers, coil conveying system, coil strapping machines, marking machine and an inspection line.

Challenging products

In the roughing mill section, slabs with twelve-meter length maximum, a thickness range from 180 to 260 milli meter and a width range from 800 to 1,680 milli meter are rolled down to transfer bar thickness. The range of hot strip thicknesses is 1.20 to 20.00 milli meter. JSOL's HSM is designed for an annual capacity of five million tons.

The range of steel grades that to be processed is very wide. These include, e.g. sophisticated grades such as HSLA, pipe grades and silicon steels. The share of harder material grades is more than 20 percent. Furthermore, very thin strips can be rolled reliably and stably. This is possible by implementation of various innovative rolling technologies.

Groundbreaking technology

Transfer bar cooling. For optimal temperature regulation in the roughing mill, SMS installed the newly developed transfer bar cooling system. The transfer bar cooling prevents uncontrolled air-cooling during oscillation and comes with favorable effects on temperature profiles. The effects on the rolling process in the finishing mill are positive. By equalizing the temperature, product homogeneity is improved.

$HI_{BOX}^{®}$ heat preservation hoods. JSOL's HSM is equipped with the latest generation heat panels of the $HI_{BOX}^{®}$ type. This simplifies the inspection and maintenance of the elements and increases the service life by factor four compared to conventional preservation hoods. Using the HI_{BOX}® heat panels makes the finishing train's rolling behavior more stable and JSOL is able to shift the product mix toward smaller final thicknesses and/or higher strength steel grades. The HI_{BOX}® system comes with resilient savings in terms of energy, CO_2 footprint and OPEX.

Mandrel-less coilbox. Arranged between the second roughing stand and the finishing mill, the coilbox forms transfer bar into coils and thereby equalizes the temperature over the transfer bar length. Coiling the transfer bar prevents the inner windings from cooling. Material and heat are accumulated, providing a positive effect on the material to be rolled and the production process. The improved transfer bar temperature allows expansion of the product range to thinner gauges.

Edge heater. The edge heater, located upstream of the finishing mill descaler, utilizes inductive heating. The primary role is to enhance strip edge quality by maintaining optimal pre-rolling temperatures. This ensures flawless production, even for advanced grades.

Finishing Mill. The seven-stand finishing mill in 4-hi design is equipped with hydraulic adjustment systems, hydraulic loopers and latest generation CVC® plus (Continuously Variable Crown) combined work roll shifting and bending systems. Also, part of the supply was the X-Pact® Profile, Contour and Flatness process model (PCFC®) being able to cope all requirements in terms of producing high sophisticated products with an exceptional wide range of properties and dimensions. PCFC® calculates the optimal set points for the actuators of the CVC® plus and bending system. This is why PCFC® ensures the stability of the rolling process, highest product quality regarding strip geometry and a flexible rolling schedule.

The high-capacity HSM is completed by the laminar cooling system and three downcoilers.

Source: SMS group #Connect update - April 2024 - Regional edition

CSP® Nexus Plant of JSW Steel Dolvi

JSW Steel (Dolvi Works) has placed an order to supply CSP® Nexus plant. The plant, the third of its kind worldwide, not only promises maximum productivity but also expands the product mix in terms of widths and thicknesses. It achieves peak values with regard to performance, efficiency and carbon reduction. The plant will be constructed at Dolvi site, and put it into operation in 2026.

CSP® Nexus: Plate and strip from the same, fully integrated casting and rolling plant

JSW has been operating a typical CSP® plant from SMS group very successfully since 1998.

For the first time, hot strip and plate for shipbuilding, wind towers, heavy pipeline grades (API) or alike with a maximum width of 2,600 millimeters can be produced on a single plant that comprises casting and direct rolling. The hot strip thickness range of 2.0 to 32.0 millimeters is exceptional and offers JSW Steel (Dolvi Works) a unique opportunity to open up new markets at a competitive cost level, particularly in the field of "green plate" production. With parameters like these, the CSP® Nexus plant for JSW Steel (Dolvi Works) is not only setting standards for thin slab casting and rolling plants, but also for conventional hot strip mills.

The scope of supply includes a single-strand caster with high throughput, a multi-stand roughing mill that can reduce the slab thickness to the optimal transfer bar thickness, and a six-stand finishing mill. A highly advanced laminar cooling system and three down coilers are completing the plant. The scope of supply also comprises all the automation technology for controlling the plant, including drive engineering and the array of technology packages, which feature sophisticated process models from the X-Pact® family of automation solutions. With an annual capacity of four million tons, this is the highest capacity for a single-strand caster of this type anywhere in the world. Provision is made for a plant extension, either a second casting strand or a lateral slab feeding facility, to further boost the productivity to more than seven million tons in future.

The bow-type casting machine is capable of casting slabs up to 160 millimeters. This ensures an appropriate reduction ratio for particularly thick products and allows for a production throughput of up to 8.5 tons per minute and, going forward, has the potential to deliver ten tons per minute.

Three roughing stands, located downstream of the first tunnel furnace, ensure the full range of transfer bar thicknesses. Even with larger slab dimensions, thin strip can be rolled. Roughing and finishing mill are decoupled by a heated roller table thus the roughing stands operate at highest rolling speed rates to meet the relevant temperature requirements and increase the overall energy efficiency of the plant.

In addition to the three roughing stands, a high-performance six-stand finishing mill ensures the desired hot strip thickness range.

The laminar cooling section comprises nine super-reinforced microzone groups, which are designed to ensure both plant productivity and the mix of product dimensions. Three extremely robust down coilers complete the CSP® Nexus line.

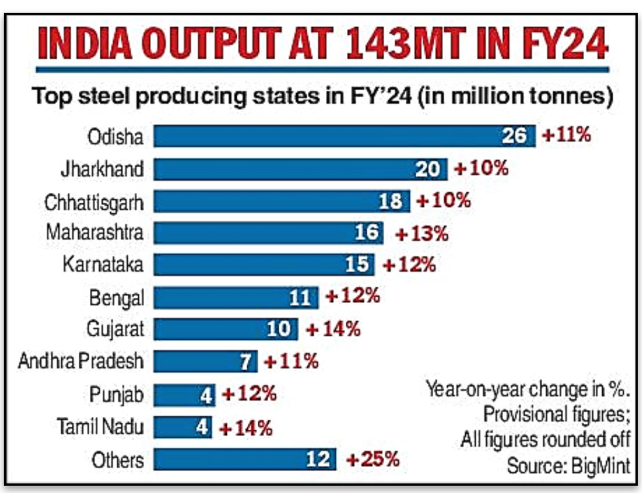
JSW will benefit from remarkable improvements in both efficiency and predictability through innovative tools that enable real-time data analysis, and data-driven decision-making, ultimately improving overall production quality and performance.

Source: SMS group #Connect update - April 2024 - Regional edition

Bengal Steel Production Up 12%

Bengal recorded a 12 per cent growth in steel production in FY2024, lagging marginally behind the national average as Indian steel output rose to 143 million tonnes in the last fiscal.

Data collected by market intelligence platform BigMint pegged India s growth at 13 per cent, mostly led by top producing states such as Odisha, Jharkhand, Chhattisgarh, Karnataka among others (See chart).



Steel production in Bengal stood at 11mt in FY24, compared with 9.83 mt in the previous fiscal. The Indian production hovered around 127mt in FY23.

Odisha, which is endowed with iron ore and coal-- two key raw materials for steel making by the blast furnace route - was the largest producer among Indian states with 26mt production. The state also boasts of multiple sea ports allowing logistic advantage to producers.

Jharkhand, which has been the cradle of steel production in India, stood second with 20mt production, followed by another mineral rich state Chhattisgarh, which produced 18mt steel.

The growth in steel production was led by the primary producers (the large integrated players such as Tata and JSW) and smaller secondary producers who usually took the sponge iron route to steel making.

However, BigMint noted that electric induction furnace (IF), which uses electricity for melting, spearheaded the production in FY24 and the share of this segment rose to 35 per cent.

Small-scale producers usually prefer the route where small to medium batches of metal are melted, requiring precise temperature control. These mills witnessed higher margins resulting in higher capacity utilisation from these players.

In comparison, the electric arc furnace (EAF), which is suitable for large-scale metal recycling and for melting various grades of metal scraps, is gaining currency among some of the large integrated producers as well. Both Tata Steel and JSW Steel have announced plans to set up EAF using scrap as raw material in a bid to reduce carbon footprint and promote a circular economy.

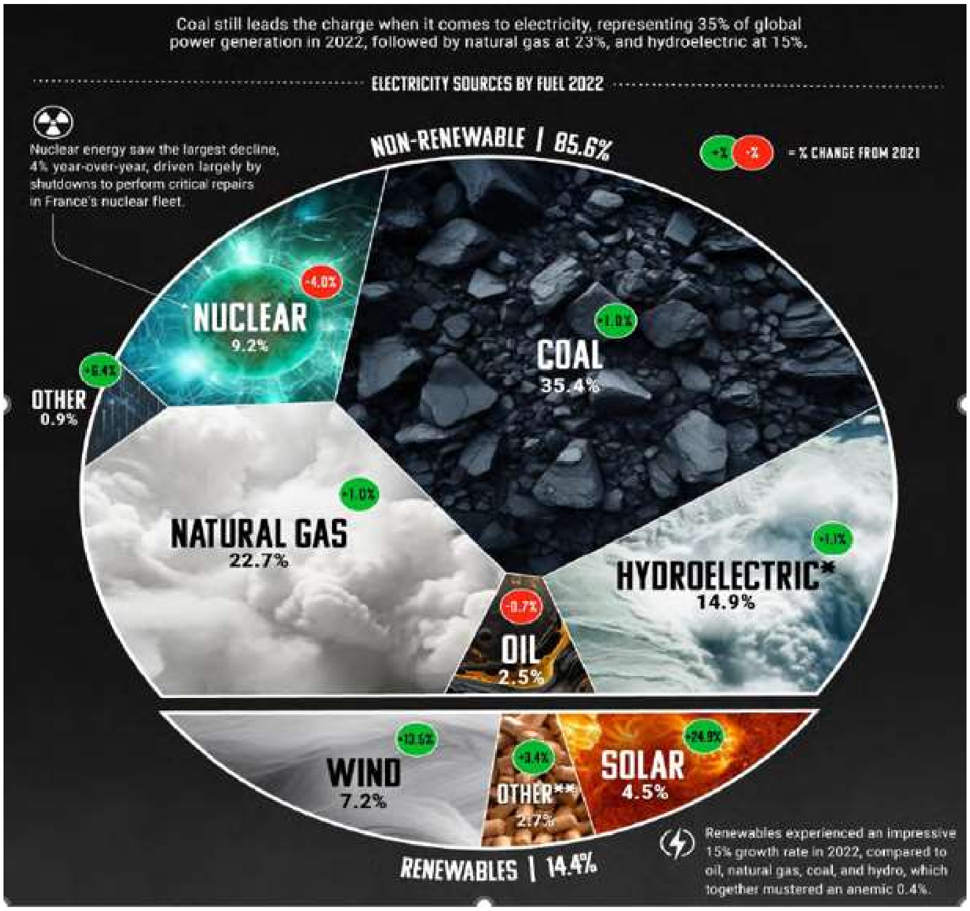
However, it is predicted that future capacities are going to take the BOF route mostly. Icra estimates 15.6mt additional steel capacity will be added in FY2025. Some of the notable additions will come from Tata, JSW and ArcelorMittal.

Bengal, which lacks the iron ore resource, depends on neighbouring states. Sponge iron and IF are preferred routes for state-based secondary steel makers and they are expected to operate and grow in that way.

SAIL is the only company to have integrated steel making operations in Durgapur (Durgapur Steel Plant) and Burnpur (IISCO). The next phase of expansion will add close to 7mt additional capacity in Bengal.

Source: The Telegraph, 22nd April, 2024

What Powered the World in 2022?



Know Your Members

K R KRISHNAKUMAR

Shri KR Krishnakumar is a Mechanical Engineer, joined Rourkela Steel Plant, Rourkela, Odisha in 1982. He has vast experience in Commissioning, Operation and Maintenance of Captive Power Plants and Steel Plants.

He is one of the pioneers in implementing Total Quality Management (TQM) Principles, Total Cost of Ownership (TCO) in Material Management Area and ISO 9000 Quality Management Systems in SAIL. He is a Chartered Engineer and Professional Valuer of Institution of Engineers of India.

In his last assignment, as Chief General Manager (Projects), at Corporate Office of SAIL, Delhi he has worked in various functions such as Business Development, SAIL Restructuring and Project Management. He has retired as CGM (Projects) in March 2019. His area of experience includes Financial and Technical Appraisal of large & complex steel plant projects including the embedded CPPs and Oxygen Plants, Commissioning and successful completion of the Modernization and Expansion Plans of Bhilai, Bokaro and Rourkela Steel Plants.

His overseas exposure includes Technical and Management Training in countries such as Poland (for Captive Power Plants), USA (for MoU studies), London, Paris and Madrid (for advanced management course), Kuwait and Oman (for business development). His hobbies include reading, research on technical developments and management strategies and listening to Music.

He is a Life Member and an Executive Committee Member of Indian Institute of Metals, Delhi Chapter. As Secretary (IIM-DC) he has played an active role in improving the functioning of the Chapter and in organising MMMM 2022 flagship event. He has vast networking experience with Board Of Directors, Government Departments and State Governments. He is currently working as Consultant, Ministry of Mines and a practicing Consultant for Steel, Power and Water Resources.

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