NICKEL MAGAZINE

THE MAGAZINE DEVOTED TO NICKEL AND ITS APPLICATIONS

NICKEL, VOL. 37, Nº 3, 2022

Nickel and the carbon footprint

Carbon capture and storage nickel plays many roles

The life cycle of nickel and calculating CO_2 emissions

Carbon capture, naturally ultramafic rock absorbs CO_2

CASE STUDY 26
CHRISTOPHER CASSANITI BRIDGE

ARUP

Architects: KI Studio
Lead engineers: Arup
Contractor: Arenco Daracon
Fabricator: S&L Steel
Location: Sydney, Australia

Nickel-containing components:
- *Duplex 2205 plates for the primary deck structure*
- *Duplex 2205 compression struts supported the bridge deck*
- *Alloy 718 (N07718) for the pins*
- *Austenitic 316L for the balustrades*

Dimensions:
- *178 m long*
- *Double-helix diameter 7.8 m (widest) – 5.5 m (narrowest)*

With a span of 178 metres, the Christopher Cassaniti Bridge is Australia's first double-helix bridge. The pedestrian and cycleway crossing, completed in 2020, spans two busy roads.

Given the limited available space for the entry/exit points, the bridge was designed following a sinusoidal shape. It was constructed using 200 tonnes of carbon steel and 80 tonnes of bead blasted duplex stainless steel plates. Because of its excellent corrosion resistance, strength and impact toughness, duplex 2205 (UNS S32205) stainless steel (containing about 5 % nickel) was used for the primary deck structure to minimise maintenance over the 100 year lifespan of the bridge. The bridge is supported by duplex stainless steel struts connected with pins and spherical bearings made from special Alloy 718, a superalloy containing about 50 % nickel with superior corrosion resistance. The balustrades were made from austenitic 316L (S31603) stainless steel, typically containing 10 % nickel.

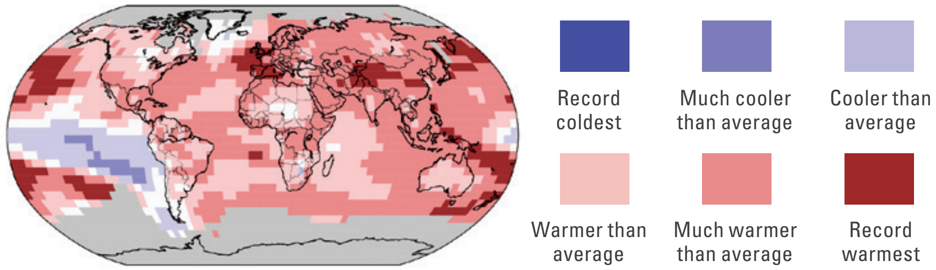
The duplex stainless steel deck rests completely within the double carbon steel helix tubular structure and does not contribute to the load-bearing function of the bridge. Over 3,600 carbon steel plates were used to form the double-helix. Laser-cut, then rolled into a particular shape and welded together to create the twisted, curved box sections, they were assembled off-site, dismantled then transported. Careful welding was required for the 12 mm thick duplex stainless steel plates to control distortion, which is greater than that of the carbon steel, due mainly to the lower thermal conductivity of duplex stainless steel.

A coating of bright blue paint opens the bridge up to the sky and green surroundings. Ni

EDITORIAL:
NICKEL AND CARBON

2022 was a year of weather extremes. In Pakistan temperatures peaking at 50 °C in March were followed by devastating floods in May. In the UK the mercury passed 40°C. Spain and Portugal were ravaged by wildfires, and in the US, reservoirs hit all time lows. In China parts of the Yangtze river dried up. In Australia, Sydney has had its wettest year on record.

SURFACE TEMPERATURE PERCENTILES JUNE-AUGUST 2022



NOAA

Carbon and other greenhouse gas (GHG) emissions are the result of human activity trapping heat in the atmosphere. The global warming this causes exacerbates natural phenomena like floods and droughts. In this issue of *Nickel* we look at carbon from several viewpoints – its reduction, calculation and sequestration.

Because the first step in reducing emissions is to measure them, the Nickel Institute has produced guidance to help nickel metal producers calculate their GHG emissions. On page 8 we answer questions about the importance of reliable life cycle data for producers and users of nickel.

In parallel with nickel producers working towards reducing their carbon emissions, nickel in use also contributes to technologies that reduce the leakage of carbon into the atmosphere. Carbon capture and storage is one such technique where nickel is essential. As climate change also provokes water shortages, desalination in many parts of the world is ensuring a supply of fresh water. Nickel also plays a role here.

Mining companies are looking to become carbon neutral, and on page 12 read about a surprisingly natural way that can help them.

Are you looking to reduce your own carbon emissions? How about trading in your gas guzzler for an electric scooter; look no further than our back cover for inspiration.

Clare Richardson
Editor, *Nickel*

***The ten warmest Septembers on record have all occurred since 2012** — September 2022 Global Climate Report | National Centers for Environmental Information (NCEI) (noaa.gov)*

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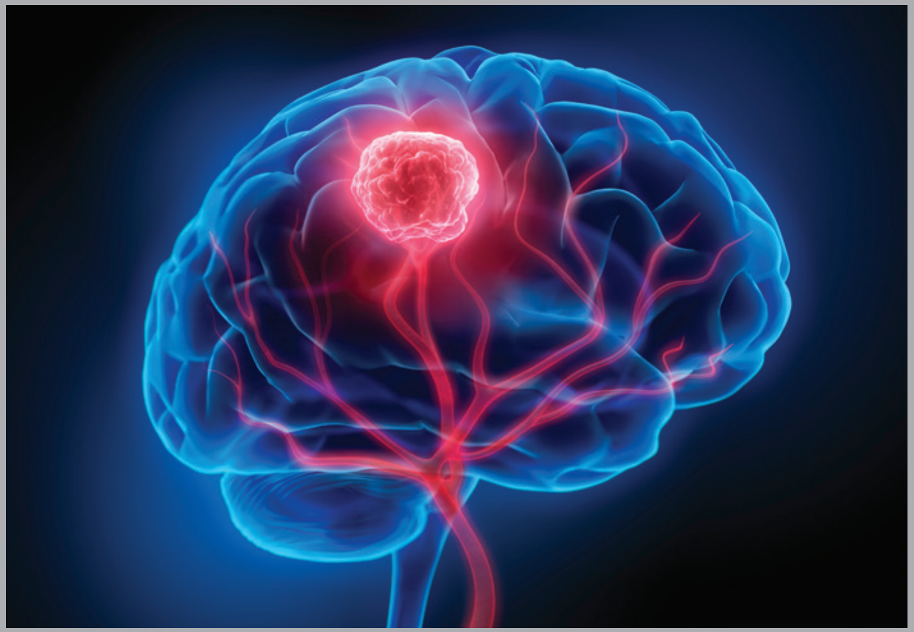
NICKEL NOTABLES

Tiny drop, big brainwave



In the pursuit of an accurate and minimally invasive way to diagnose brain cancers, a team of Canadian scientists has created an ultra-sensitive nickel-containing biosensor that can detect materials shed by tumours from a tiny blood sample. Using high-intensity laser beams, they formed 3D nickel-nickel oxide nanolayers on a nickel chip which enabled them to pinpoint minute amounts of tumour-derived materials such as nucleic acids, proteins, and lipids. The researchers were able to distinguish brain cancer from breast, lung and colorectal cancer with 100 % specificity and discern primary brain tumors from secondary ones with a similar degree of success. Published in the journal ACS Nano, it could lead to earlier diagnosis and better treatment options.

© CO-ADD

Fighting fungal infections

Researchers have made strides in fighting dangerous fungal infections, demonstrating that chemical compounds containing special metals including nickel are highly effective. With the help of the crowdsourcing Community for Open Antimicrobial Drug Discovery (CO-ADD), founded by the University of Queensland in Australia, Dr. Angelo Frei and his team at the University of Bern tested 21 highly-active metal compounds against various resistant fungal strains. "Many demonstrated a good activity against all fungal strains and were up to 30,000 times more active against fungi than against human cells," explains Frei. "If we exploit the full potential of the periodic table, we may be able to prevent a future where we don't have any effective antibiotics and active agents to prevent and treat fungal infections."

A quick stop solution

Imagine going another 400 km in your EV after a 10 minute pit stop. Researchers at Pennsylvania State University have a promising solution, after experimenting with nickel foil to warm lithium-ion batteries and boost their performance. Working with a battery that had roughly 560 km range when fully charged, senior author and battery engineer, Chao-Yang Wang and team demonstrated that by adding an ultrathin nickel foil to its interior, they could recharge the EV battery to 70 % in 11 minutes for a roughly 400 km range, and 75 % in 12 minutes for a roughly 440 km range. "Our technology enables smaller, faster-charging batteries to be deployed for mass adoption of affordable electric cars," says Wang.

EC POWER

© GREATCOLLECTIONS AUCTIONS

Famous nickel find

A USD $4.2 million five cent piece? That's what GreatCollections Coin Auctions paid this year for the Walton 1913 Liberty Head Nickel, saying the coin "has one of the greatest stories to ever be told in U.S. numismatics". One of only five known examples of the ultra-rare 1913 Liberty Head Nickel which stopped production in 1912, it is said that the five rare pieces were either struck by mistake or struck and taken by U.S. Mint employee Samuel Brown. Sold by Brown in 1924, the five copies have been owned by some of the biggest names in numismatics. GreatCollections said it acquired the Eliasberg example of the 1913 nickel last year in a historic USD $13.35 million three-coin transaction.

CARBON CAPTURE AND STORAGE

WHY NICKEL ALLOYS ARE CAPTURING ATTENTION

CNW GROUP/SHELL CANADA LIMITED

The Quest carbon capture and storage (CCS) facility, near Edmonton, Alberta, Canada. Since opening in late 2015, the facility has captured and stored over 6.8 million tonnes of CO_2 and stored it safely 2 km underground.

As industries around the globe work to reduce emissions of carbon dioxide (CO_2), there is also effort to prevent its escape into the atmosphere by sequestering it. These technologies are known as carbon, capture and storage (CCS).

To help achieve the ambition of net zero anthropogenic greenhouse gas emissions, the Nickel Institute continues to explore what kind of contribution and criticality nickel will play in the successful deployment of CCS. This is an endeavour that includes the entire CCS value chain from mature carbon capture, transportation to sub-surface storage.

Going for higher grades

Corrosion and correct material selection are key concerns in the development of safe, reliable, and economical operation of CCS infrastructure.

Many CCS processes involve low temperatures with free water present, resulting in acidic conditions and risk of corrosion. As such, carbon steel is not suitable and therefore higher-grade nickel-containing stainless steels and nickel alloys are often required.

Carbon capture from gases often contain water, typically originating from combustion processes. Processes either operate in wet acidic conditions, or require prior drying to capture CO_2. Some operate at high temperatures and in harsh conditions, which are also unsuitable for carbon steel.

Getting there

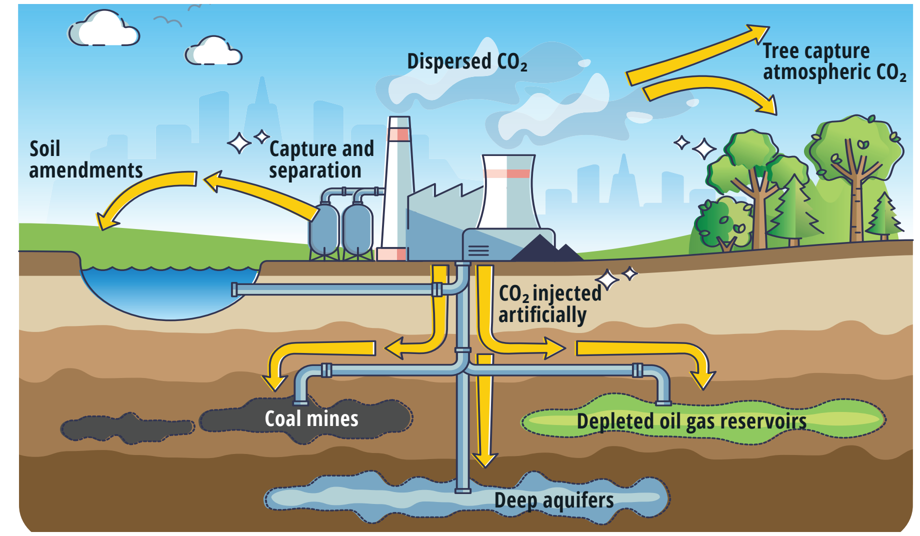
CO_2 transportation from carbon capture to sub-surface storage will primarily be through pipelines, shipping, trucking and rail.

Carbon dioxide is liquefied to enable it to be shipped to a sequestration location. Equipment to transport CO_2 from carbon capture to sub-surface storage also requires nickel-containing low alloy steel, stainless steel or nickel alloys.

Going below

CO_2 injected into sub-surface storage is typically dry and non-corrosive. However, a well must be designed to account for the risk of acidic conditions being present, leading to corrosion during its lifetime.

Data from well design in the US and EU show that nickel-containing stainless steel and nickel alloys are typically selected for critical well infrastructure at risk of corrosion. The US has set out clear guidelines for CO_2 injection well design and construction that emphasise selection of materials, supporting the criticality nickel will play in CO_2 sub-surface storage.



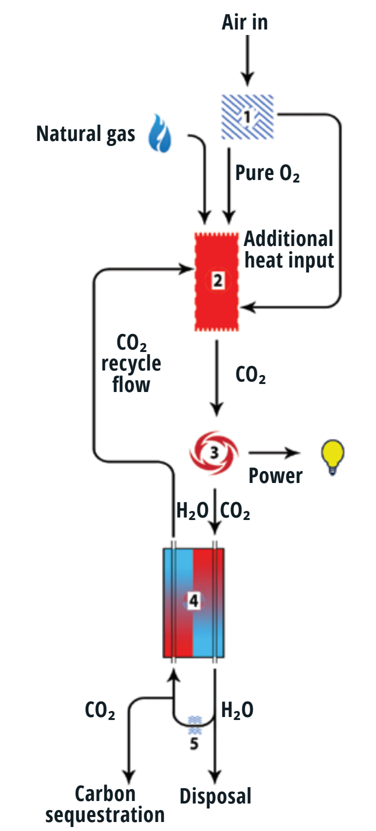
To assist in material selection for CCS processes, The Association for Materials Protection and Performance (AMPP) is developing *Guidelines for Materials Selection and Corrosion Control for CO_2 Transport and Injection*, identifying where nickel-containing materials are preferred.

As industries continue to evaluate the value chain of CCS, it is evident there are very few steps that will not need nickel-containing low alloy steel, stainless steel or nickel alloys. This demonstrates nickel's vital role in deploying CCS to help achieve net zero anthropogenic greenhouse gas emissions in the years and decades to come. Ni

Where is nickel 'mission-critical'

- CO_2 recovery from the flue gas of coal-fired power plants, where the flue gas is contaminated with SO_2 and water, creating an acidic condensate that would corrode carbon steel.
- Liquid solvents, such as amine, absorb CO_2 from the gas stream. This can result in acidic corrosive conditions in the CO_2 absorber vessel, in the liquid amine handling system, and in the stripper vessel where cleaned CO_2 is released.
- Solid absorbent recovery systems, such as temperature swing adsorption (TSA), also remove CO_2 from a gas stream by interaction with the sorbent. This process involves humid conditions with temperatures swinging from 40 °C to 100 °C producing acidic corrosive environments. Due to the potential formation of carbonic acid, key areas of risk are: the drying process, where austenitic nickel-containing stainless ssteel is used; and, the pre-capture blower, where nickel-containing duplex stainless steel is used.
- Innovative processes to utilise and capture CO_2, such as the Allam-Fetvedt power generation cycle, which will require nickel-containing alloys for the CO_2 turbine and combustor, the heat exchanger and the high-temperature piping connecting these two components.

SIMPLIFIED ALLAM-FETVEDT CYCLE



1. Air separation unit (ASU)
2. Oxyfuel combustor
3. Turbine
4. Heat exchanger
5. Cooling

CREATIVE COMMONS JOY OF ALL THINGS

The Allam-Fetvedt process converts carbon fuels into thermal energy while capturing the generated CO_2 and water.

MEASURING NICKEL'S CARBON FOOTPRINT Q & A WITH NICKEL INSTITUTE'S SUSTAINABILITY EXPERT, DR. MARK MISTRY

__Dr. Mark Mistry__ specialises in regulatory developments likely to impact the nickel industry and contributes to the academic and scientific debate on life cycle assessment and the benefits of using and recycling nickel. He also contributes to the development of global sustainability standards.

With climate change at the forefront of global concerns, a wide range of stakeholders require carbon footprint data from nickel producers.

Why? Customers need to assess the GHG profile of their own nickel-containing products; regulators want to know if products and processes are compliant, and trade platforms such as the London Metal Exchange need data for transparency. In addition, nickel producers themselves need the data to target process improvements. All this requires the nickel sector to produce reliable life cycle data.

What is the link between carbon footprint and nickel life cycle data?

Life cycle data describe process inputs (such as energy, process chemicals or water) and outputs (such as emissions to water, air or waste). They are collected for each step in the production of nickel products. Life cycle data are the basis for a life cycle impact assessment (LCIA). LCIAs convert in- and outputs into 15 "environmental impact categories", the most important being GHG emissions – or the carbon footprint. An LCIA identifies the process stage where the highest or most harmful environmental impacts occur.

How are they used in practice?

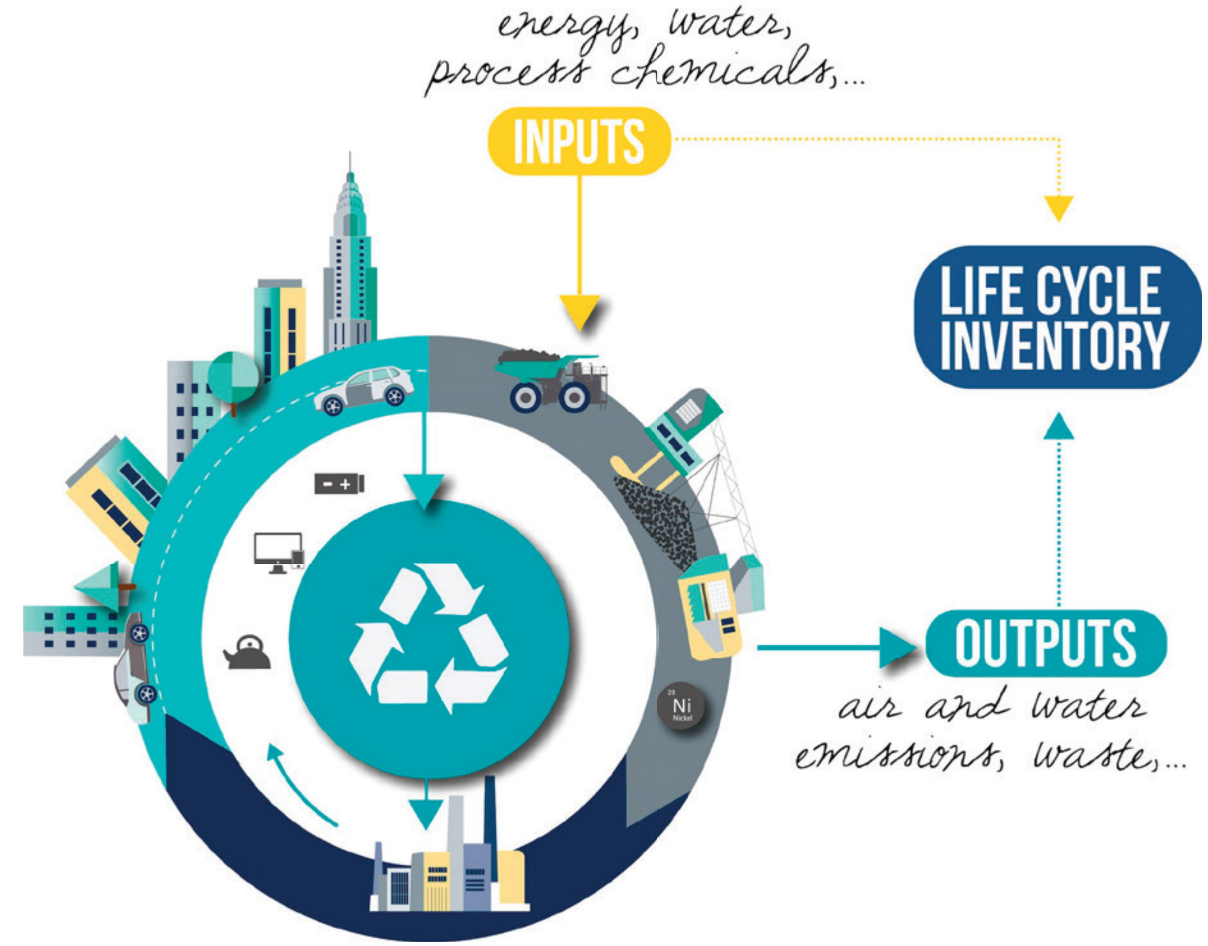
Life cycle data are used by end users to assess the environmental performance of a product. The in- and outputs of two products fulfilling the same function can be compared. For example, nickel-containing EV battery technologies can be assessed against a classical combustion engine car to understand the environmental performance of both throughout the entire life cycle. Life cycle data are also used by nickel producers to target process improvements.

Why are life cycle assessment standards important?

Any GHG calculations must be sound and based on the globally agreed LCA standard (ISO 14044). A coherent approach is necessary to ensure that the data requirements and the life cycle data for nickel producers are compiled on the same basis and therefore comparable.

Are these data updated regularly?

Several parameters impact life cycle data, such as ore grades and presence of by-products, changes in the mining process, the specific process technology applied, energy supply and technology updates or



investments in emission reduction or prevention. These factors may change in a relatively short time frame and affect the results of a life cycle assessment significantly. Life cycle data must therefore be updated regularly. An update every five years is common but often customers and downstream users require the data to be updated even more frequently.

How does nickel compare with other metals?

In the life cycle community, there is a broad consensus that a comparison should be made on a "functional unit", rather than a material basis. Nickel is often used as an alloying element. A meaningful comparison with other materials would have to be made on an agreed functional unit, for example, a window frame of a specified size; or a defined tube transporting a specific substance over a certain distance.

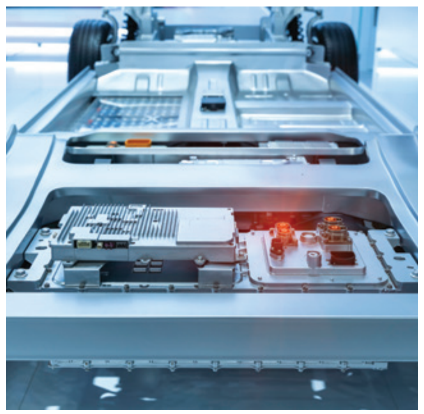
Does the quality of nickel life cycle data vary?

Data consultancies offer carbon footprint data models which are based on assumptions and frequently rough estimates due to the absence of data. The results of these models often differ significantly from the Nickel Institute's carbon footprint data which are based on hard numbers provided by companies, calculated to a globally agreed standard and independently verified.

Why are stakeholders interested in the carbon footprint of EV batteries?

Electric vehicles are critical to achieve green and sustainable,

__How to determine GHG emissions from nickel metal Class 1 production__ The Nickel Institute has published guidance for nickel producers to help them calculate their greenhouse gas emissions. This guidance considers the complexity of nickel production and contributes to robust and scientifically reliable data, comparable throughout the nickel industry.



Life cycle assessments allow the GHG emissions from electric vehicles and classical combustion engine cars to be compared throughout the entire life cycle.

decarbonised mobility. There are, however, studies claiming that EVs emit similar or even more GHG emissions than classical combustion engine cars. The carbon footprint of batteries is a significant contributor to the overall GHG emissions of EVs and are under scrutiny from various stakeholders. Life cycle assessments allow the GHG emissions from electric vehicles and classical combustion engine cars to be compared throughout the entire life cycle. Batteries are a major contributor to the EV carbon footprint and all raw materials and processes to produce an EV battery have to be assessed. Life cycle data provides the basis for the calculation of the EV battery footprint.

How relevant is nickel in the EV carbon footprint?

Nickel contributes around 9 % of the overall carbon footprint of an NMC 111 EV battery. The contribution of the electricity used in battery manufacturing and the aluminium for the casing is far more significant.

Are stainless steel producers interested in nickel life cycle data?

Company-specific life cycle data is becoming increasingly mandatory. For example, the EU Carbon Border Adjustment Mechanism requires the carbon footprint of stainless steel to be calculated when being imported into the EU to determine the amount of carbon certificates that need to be purchased. Also, for stainless steel producers declaring their carbon footprint, the data is incorporated into Environmental Product Declarations (EPDs).

Does carbon footprint vary for different nickel products used in stainless steel production?

Nickel pig iron, ferronickel and nickel metal are the major nickel-containing input materials for stainless steel production. Their carbon footprint can vary by a factor of more than 30 between the producers with the lowest and highest GHG emissions. The choice of nickel product used in stainless steel production therefore impacts the carbon footprint of stainless steel significantly.

Is stainless steel from scrap more sustainable as it has a lower carbon footprint?

Generally, recycling is important to achieve sustainability as it prevents landfill, reduces the demand for primary raw materials, increases resource efficiency and creates jobs for small and medium sized enterprises active in collection and recycling. In life cycle modeling, a “cutoff” approach is commonly applied for the inclusion of secondary materials. In this approach, scrap as an input material comes free of environmental impacts. “End of life” approaches distribute the environmental impacts from primary production over the several life cycles that a material experiences. Applying end of life approaches would better align the carbon footprints of primary and recycled metal.

The Nickel Institute has produced guidance to help nickel producers calculate their greenhouse gas emissions. *How to determine GHG emissions from nickel metal class 1 production* is available for download from the Nickel Insititute website. *www.nickelinstitute.org* Ni

FRESH IDEAS ADVANCE WATER DESALINATION

By 2025, the UN has estimated that 1.8 billion people will be living in countries or regions with absolute water scarcity, and two-thirds of the world population could be under stress conditions.

With the pressure to secure potable water continuing to increase, the number of desalination plants are on the rise. Nickel-containing materials are critical to ensure trouble-free and long-term operation, as processes to convert seawater and brackish water are subject to corrosion unless suitable materials are used.

Key to viable solutions that satisfy demand, is the need for sustainable desalination options. There are two main types of technologies; membrane (reverse osmosis), and thermal (multiple effect desalination and multi-stage flash).

Thermal desalination techniques involve evaporation and they can be more energy-intensive and expensive with more significant environmental impacts than reverse osmosis. First developed in the late 1950s, reverse osmosis desalination uses the principle of osmosis by selectively removing chloride by forcing water at high pressure through semi-permeable membranes. Reverse osmosis has become the preferred choice because it is highly scalable, servicing individual hotels to cities.

In reverse osmosis plants, several components can be made from super duplex S32750 or S32760, such as seawater inlets, screens, discs for butterfly valves and piping in the high-pressure section. Pumps casings in the low- and high-pressure parts of the system can be cast from super duplex J93380 and J93404. Instrumentation tubing to monitor the process can also be made from super duplex, 6 % Mo stainless steels, such as S31254, N08367 or N08926, and 90/10 Cu/Ni (C70600).

The Nickel Institute publication *Materials selection for desalination plants – 11029* is available for free download from the Nickel Institute website *www.nickelinstitute.org*. Ni

SEQWATER

High pressure, super duplex stainless steel pipework at the seawater reverse osmosis (SWRO) desalination plant in Queensland, Australia. Duplex and super duplex stainless steels are default materials for the high pressure pipework in most RO plants worldwide due to their combination of high strength and excellent corrosion resistance.

The Victorian Desalination Plant, in the state of Victoria, Australia was completed in 2012 with an estimated output of 410 megalitres of water per day.

CARBON CAPTURE, **NATURALLY**

Most companies have publicly announced that they plan to be carbon neutral either by or before 2050. This will be a significant challenge for many of them. One way to help achieve carbon neutrality is by capturing carbon dioxide that has either been generated in a process such as fuel combustion or that occurs in the atmosphere. The captured CO_2 can be used in another process or be permanently stored so that it will not be released. There are many different proposed and operating processes to capture carbon dioxide and then sequester it, and most of them are expensive to build and operate.

But what if there was a plentiful and naturally occurring substance that reacted with CO_2 in the air to form matter that could be easily and safely stored for many thousands of years? Some mining companies have that option.

Ultramafic rock absorbs CO_2

In mining, the target minerals are mixed with other minerals, called gangue. A mine will grind rock to separate out the target minerals, with the rest being disposed of as tailings.

BHP NICKEL WEST

Research at BHP's Nickel West Mount Keith nickel mine shows that one year's worth of tailings currently captures about 40,000 tonnes of CO_2, with the potential to capture 4 million tonnes.

But if the tailings are composed of ultramafic rock – the general term for different minerals that contain a relatively high magnesium content along with low silica content – they will slowly absorb CO_2 from the atmosphere, converting it to a stable and solid carbonate compound. In other CO_2 storage technologies, gaseous carbon dioxide is pumped into the earth and remains as a gas, whereas here the CO_2 transforms into a solid chemical which will remain in that form for thousands of years. For example, serpentine, a magnesium silicate hydroxide, is one such ultramafic rock commonly found in tailings. It will naturally react with carbon dioxide in the air to form magnesium carbonate.

Passive carbon mineralisation

Research at BHP's Nickel West Mount Keith nickel mine in Western Australia shows that one year's worth of tailings currently captures, without any special processing, about 40,000 tonnes of CO_2. This is called passive carbon mineralisation. However, those tailings have the capacity to capture 4 million tonnes of CO_2, but the natural reaction rate is very slow. Similarly, a report for the Dumont nickel-cobalt mine in northern Quebec, Canada has suggested that 21,000 tonnes of CO_2 per year could be captured passively over the projected 33 year life of the mine.

Laboratory work is being done to establish how the reaction can be accelerated. Such technology could allow many mines to not only be carbon neutral, but to be carbon negative. This is of special interest to mines that produce metals for electric vehicle (EV) batteries – EV purchasers want to know that the battery components have been produced in a socially and environmentally responsible way.

Operationalising the process

One company working towards being carbon negative is Canada Nickel, based on their proposed Crawford Project, a nickel-cobalt sulphide mine located near Timmins in Ontario, Canada. They have developed a novel process they call *In Process Tailings Carbonation* which would fix the CO_2 in the processing circuit. It would use a concentrated source of CO_2, for example from natural gas power generation. Mark Selby, Chair and CEO of Canada Nickel, commented "These lab scale tests advance our understanding of how to operationalise this process to turn a nickel mine into a net generator of carbon credits rather than a generator of carbon emissions."

Similarly, other nickel projects are working on increasing the reaction speed. FPX Nickel has performed tests on tailings from their proposed Baptiste Project in central British Columbia, Canada. "FPX is very proud to be playing a leading role in applying fundamental science to evaluate the potential for large-scale permanent carbon capture and storage in the mining industry," said Martin Turenne, FPX's President and CEO. And, Giga Metals is funding research to determine how to use the tailings from their proposed Turnagain mine in British Columbia, for carbon capture.

The Earth's mantle is composed of ultramafic rocks, and the potential CO_2 capture is huge. While nickel mines have been featured in this story, the natural carbon capture nature of the ultramafic rocks can be utilised by many types of mining enterprises around the world. NI

JEAN-MICHEL HAROUY CREATIVE COMMONS

The Earth's mantle is composed of ultramafic rocks and the potential for CO_2 capture is huge.

ASK AN EXPERT FAQ FROM THE NICKEL INSTITUTE TECHNICAL ADVICE LINE

Geir Moe P.Eng. is the Technical Inquiry Service Coordinator at the Nickel Institute. Along with other material specialists situated around the world, Geir helps end-users and specifiers of nickel-containing materials seeking technical support. The team is on hand to provide technical advice free of charge on a wide range of applications such as stainless steel, nickel alloys and nickel plating to enable nickel to be used with confidence.
https://inquiries.nickelinstitute.org/

Q: I have received complaints from a customer who is doing deep drawing of pots, pans and sinks with Type 304L (UNS S30403). During forming the material is fine, but cracks appear after a certain period of time.

A: Nickel-containing stainless steel Type 304L, which has an austenitic microstructure, is metastable, meaning that it forms some martensite as a result of plastic deformation (also known as strain-induced martensite). This alternate microstructure, which is less ductile, will form in those areas that have been cold worked and is susceptible to cracking by hydrogen present in the stainless steel. Due to this cold working, hydrogen diffuses to the martensite and eventually causes the cracking. This diffusion takes time and that is why the cracking is delayed. Susceptibility of the stainless steel to cracking is highly dependent on its composition.

Higher nickel contents and lower carbon and nitrogen contents will help to prevent cracking. Stainless steels with higher nickel contents such as 305 (S30500) and 316L (S31603) possess microstructures which are more stable and thus resist the formation of strain-induced martensite and would be resistant to delayed cracking.

This phenomenon is also seen in 200 series stainless steels which contain higher manganese contents. Manganese is also an austenite stabiliser which is used in combination with lower nickel contents; however, manganese is not as effective in stabilising the austenite phase in the presence of chromium which is a very strong ferrite stabiliser. Therefore, the chromium content in these low-Ni austenitic stainless steels must be reduced, which has a negative effect on corrosion resistance, and they are still prone to martensite formation due to plastic deformation. Reduced corrosion resistance and potential for delayed cracking are factors limiting the utilisation of low-Ni 200 series austenitic stainless steels. Ni

NICKEL ONLINE

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NEW PUBLICATIONS, NEW VIDEO

Materials selection for desalination plants (11029) is a new publication discussing the application of various metallic materials, in particular nickel-containing materials for desalination. The three processes are examined – multi-stage flash (MSF), multiple effect desalination (MED) and the newer seawater reverse osmosis (SWRO). SWRO has gained favour because it can be modularised for easy expansion, water production can easily be controlled based on demand, it can be powered by renewable energy (solar and wind) and the cost to produce water is generally lower.

Magazine articles refreshed
The Nickel Institute has refreshed more than 90 magazine article reprints that describe significant applications of nickel-containing materials.

All publications are available for free download from *www.nickelinstitute.org.*

Securing nickel for the future
In this short video, the Nickel Institute's Dr. Mark Mistry answers frequently asked questions about nickel. Is there enough nickel to satisfy future demand? Can both laterite and sulphidic ores be used for batteries? Is nickel a critical raw material? What is the difference between nickel reserves and resources? What about recycling and future challenges for the industry? *Watch on the Nickel Institute's YouTube channel.*

UNS DETAILS

Chemical compositions (% by weight) of the alloys and stainless steels mentioned in this issue of *Nickel*.

UNS	Al	B	C	Co	Cr	Cu	Fe	Mn	Mo	N	Nb	Ni	P	S	Si	Ti	W	Other
C70600 P 11	-	-	-	-	-	bal	1.0-1.8	1.0 max		-	-	9.0-11.0	-	-	-	-	-	Pb: 0.05 max Zn:1.0 max
J93380 P 11	-	-	0.03 max	-	24.0-26.0	0.5-1.0	bal	1.00 max	3.0-4.0	0.20-0.30	-	6.5-8.5	0.030 max	0.025 max	1.00 max	-	0.5-1.0	-
J93404 P 11	-	-	0.03 max	-	24.0-26.0	-	bal	1.50 max	4.0-5.0	0.10-0.30	-	6.0-8.0	0.04 max	0.04 max	1.00 max	-	-	-
N07718 P 2	0.020-0.080	0.006 max	0.08 max	1.0 max	17.0 21.0	0.30 max	bal	0.35 max	2.80-3.30	-	4.75-5.25	50.0-55.0	0.015 max	0.015 max	0.35 max	0.65-1.15	-	-
N08367 P 11	-	-	0.030 max	-	20.0-22.0	0.75 max	bal	2.00 max	6.00-7.00	0.18-0.25	-	23.5-25.5	0.040 max	0.030 max	1.00 max	-	-	-
N08926 P 11	-	-	0.020 max	-	19.0-21.0	0.50-1.50	bal	2.00 max	6.00-7.00	0.15-0.25	-	24.0-26.0	0.030 max	0.010 max	0.50 max	-	-	-
S30100 P 16	-	-	0.15 max	-	16.0-18.0	-	bal	2.00 max	-	0.10 max	-	6.0-8.0	0.045 max	0.030 max	1.00 max	-	-	-
S30403 P 14	-	-	0.03 max	-	18.0-20.0	-	bal	2.00 max	-	-	-	8.0-12.0	0.045 max	0.030 max	1.00 max	-	-	-
S30500 P 14	-	-	0.12 max	-	17.0-19.0	-	bal	2.00 max	-	-	-	10.0-13.0	0.045 max	0.030 max	1.00 max	-	-	-
S31254 P 11	-	-	0.020 max	-	19.5-20.5	0.50-1.00	bal	1.00 max	6.0-6.5	0.18-0.22	-	17.5-18.5	0.030 max	0.010 max	0.80 max	-	-	-
S31603 P 2, 14	-	-	0.030 max	-	16.0-18.0	-	bal	2.00 max	2.00-3.00	-	-	10.0-14.0	0.045 max	0.030 max	1.00 max	-	-	-
S32205 P 2	-	-	0.030 max	-	22.0-23.0	-	bal	2.00 max	3.00-3.50	0.14-0.20	-	4.50-6.50	0.030 max	0.020 max	1.00 max	-	-	-
S32750 P 11	-	-	0.030 max	-	24.0-26.0	-	bal	1.20 max	3.0-5.0	0.24-0.32	-	6.0-8.0	0.035 max	0.020 max	0.80 max	-	-	-
S32760 P 11	-	-	0.030 max	-	24.0-26.0	0.50-1.00	bal	1.00 max	3.0-4.0	0.20-0.30	-	6.0-8.0	0.030 max	0.010 max	1.00 max	-	0.50-1.00	-

BENT ON A BETTER BIKE

JORIS LAARMAN

Made from Outokumpu's Forta 301 (UNS S30100) temper rolled stainless steel, the lightweight scooter, powered by a lithium battery, and has a third of the carbon footprint of other scooters.

It's a kind of "industrial origami" where robots fold single sheets of stainless steel into motorbikes and scooters. Sweden-based startup, STILRIDE was bent on creating a lightweight, electric scooter with the smallest carbon footprint possible. Years in the making, their first product Sport Utility Scooter One (SUS1) will be taking to the streets late 2022.

Founders, Jonas Nyvang and Tue Beijer and their team, have demonstrated a method of designing and constructing the vehicles with steel sheets as the raw material using its proprietary technology called STILFOLD. Challenging the traditional views, they use robotic industrial origami to fold structures from a flat sheet of metal true to the material's characteristics and geometric nature. Curve folding is a well-established craft but has rarely been used in manufacturing. Conventional scooters consist of a tubular frame and a plastic body while the SUS1's chassis is constructed by taking a single sheet of stainless steel and cutting and folding it. According to the company, this method can significantly reduce the environmental impact of production compared to conventional manufacturing techniques as it requires fewer raw materials and components.

The goal was to build the most attractive and sustainable electric scooter in the world. The result? Unconventional, rideable art for the modern scooterist. Ni