NICKEL MAGAZINE

THE MAGAZINE DEVOTED TO NICKEL AND ITS APPLICATIONS

NICKEL, VOL. 40, Nº 1, 2025

NICKEL AND ESG

Sustainability considerations for nickel production

Dr. Veronique Steukers Nickel Institute President

Nickel in stainless steel – a balanced approach

CASE STUDY 33 **THE KUHBERG DRINKING WATER STORAGE FACILITY**

HYDRO-ELEKTRIK GMBH

- *Three stainless steel pillars support the roof in each tank constructed from 12.5 mm thick DN250 pipes (10″ SCH80S) using 1.4404/316L stainless steel*
- *Tank bottoms and lower 6.4 metres of the shell used 1.4162/UNS S32101 lean duplex stainless steel for high strength and corrosion resistance. 3 mm thickness for bottom plates and 4 mm for lower shell*
- *Upper shell and roof comprise duplex 1.4462/S32205 stainless steel*

The Kuhberg project is now Europe's largest stainless steel drinking water storage facility at 12,000 m³. Located in Ulm, Germany, this massive water reservoir was built by Hydro-Elektrik GmbH. Mainly constructed of 316L (UNS S31603) stainless steel, lean duplex, and standard duplex, it is designed to improve efficiency, maintain water quality, and reduce long-term maintenance.

The water storage industry has evolved significantly over the past five decades, transitioning from concrete tanks lined with stainless steel to fully stainless steel tanks with integrated cleaning systems. Three tank shells were produced using Hydro-Elektrik GmbH's spiral winding process, which unwinds sheet metal from 10-tonne coils into spiral shapes. Each tank comprises approximately 21 tonnes of lean duplex, 30 tonnes of standard duplex and 0.3 tonnes of 316L for the pillars.

The result is large-diameter tanks with fewer welds that enhance structural integrity and allow for precise control over thickness and diameter. Strategic material selection addresses challenges such as chlorine dioxide in incoming drinking water, necessitating resistant grades.

Hydro-Elektrik GmbH set new standards for design, sustainability, and longevity in the Kuhberg drinking water storage facility by leveraging the properties of stainless steel and innovative engineering.

The facility began operations in late 2023.

Adapted from an article published in Stainless Steel World.

EDITORIAL:
ENVIRONMENTAL, SOCIAL AND GOVERNANCE (ESG)

The nickel industry is at a pivotal moment. Geopolitical tensions and the shift of production to Indonesia have put the spotlight on nickel, while nations scramble to secure critical metals. At the same time, the industry must produce nickel sustainably.

In this edition of *Nickel Magazine*, we examine nickel through the lens of Environmental, Social, and Governance (ESG) principles. While some parts of the industry face criticism, there is also significant progress. The impact of nickel mining and production on workers, communities, and the environment can be mitigated. The Nickel Institute is among those providing numerous tools and studies to help the industry achieve high ESG standards.

Sustainability extends beyond nickel miners and producers, considering impacts throughout nickel's life cycle. Nickel Institute members take this responsibility seriously, promoting a greater understanding of nickel's benefits and responsible use. By pooling resources and expertise, they advance scientific research, peer-reviewed studies, and international best practices.

Nickel plays a vital role in supporting communities, economic growth, and the energy transition. The Nickel Institute's mission is to advocate for the sustainable supply of nickel and sustainable development of the nickel industry. But we can't do it alone. We urge all industry players to uphold the highest sustainability and governance standards and for downstream users of nickel to apply standards to their suppliers – towards a 'win-win' for communities, industry, and the environment.

Clare Richardson
Editor, *Nickel*

The front cover and image above show the planting of tree seedlings at a former nickel mining site in South Sulawesi, Indonesia, highlighting essential efforts to restore and rehabilitate the land.

The Nickel Institute's Sustainability Guiding Principles *provide a roadmap for companies on their journey to achieve high ESG standards, inspiring action throughout the sector and the value chain.*

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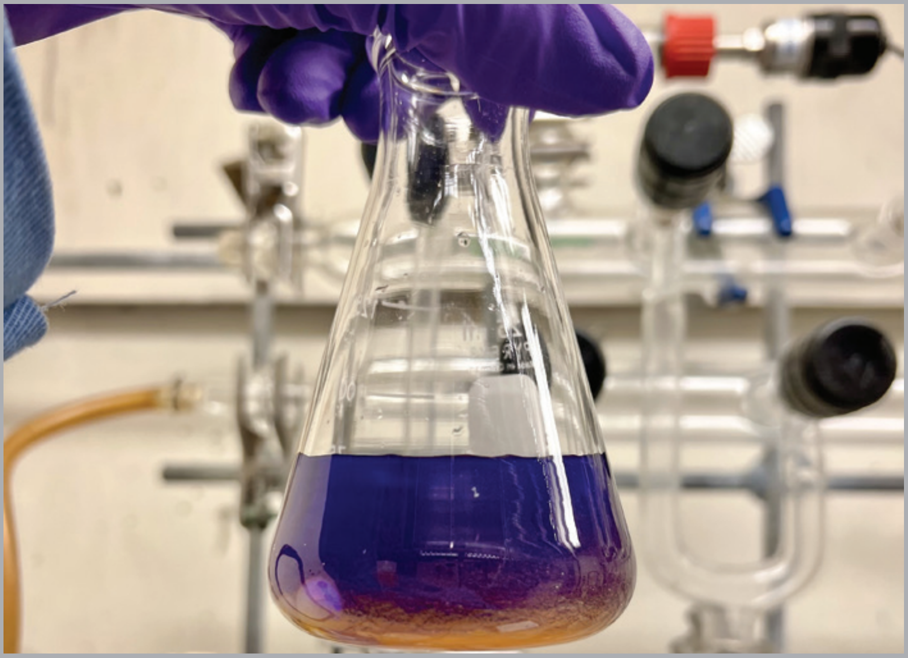
NICKEL NOTABLES



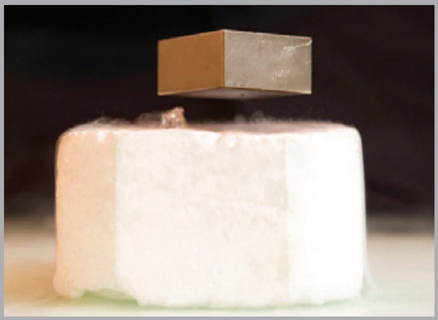
BOYANG (BOBBY) ZHANG

Greener and cleaner

Researchers supported by the US National Science Foundation Centers for Chemical Innovation program have pioneered a new way to separate cobalt and nickel from ore or recycled materials using ammonia and carbonate. Yielding both metals at 99% purity level, this more efficient extraction method could improve sustainable use of e-waste and help mitigate potential shortages. Cobalt and nickel are critical elements in battery-powered technology. “This approach addresses the harshness of traditional purification chemicals, creating better value for discarded batteries,” says Eric Schelter, the chemist who led the research team at the University of Pennsylvania along with collaborators at Northwestern University.

Super discovery

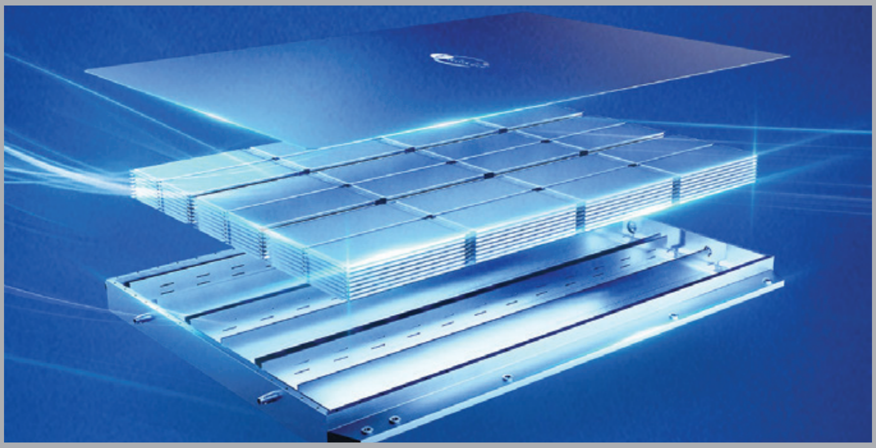
Physicists at the Southern University of Science and Technology (SUSTech) in Shenzhen, China, have created a new nickel-based high-temperature superconductor at room pressure. The breakthrough, using a nickel oxide thin film that they had grown in the laboratory, achieved superconductivity above -233°C (-387°F) at 'normal pressure.' Only cuprates and iron-based materials have previously demonstrated this achievement. "There's a huge hope that we could eventually raise the critical temperature and make [such materials] more useful for applications," says researcher Danfeng Li. This discovery would make technologies, such as magnetic resonance imaging, cheaper and more efficient. The findings were reported in the journal *Nature*.



PATRICK GAILLARDIN/LOOK AT SCIENCES/SPL

Solid progress

Chinese company Farasis Energy announced that its all-solid-state battery (ASSB) with an energy density of more than 400 Wh/kg has entered the real-world testing phase with stable cell cycling. Built on a sulfide-based system with a high-nickel ternary cathode and a high-silicon anode, these cells with all-solid-state electrolytes have passed pinprick, shear, and hot box tests, with thermal runaway self-shutdown capability at the cell levels. Farasis Energy has also made progress in building solid-state batteries based on oxide and polymer systems, using lithium metal anode and high nickel cathode with an energy density of up to 500Wh/kg. All in all, targeted benefits of these lighter ASSBs include improved safety, higher energy density and faster charging. It's another step forward in the EV world!



FARASIS ENERGY

KAROLINE HEALY

Gem of an idea

It is the first known object made using metals extracted through phytomining, a process where hyperaccumulator plants absorb metals from the earth. The ring, by materials researcher and designer Karoline Healy of H_2ERǴ, features mixed metallic dust encapsulated in a transparent sphere, including nickel, silver, copper, and zinc. The metals used in the ring were obtained with assistance from the biomining start-up Phyona, which focuses on developing low-carbon, fully bio-based methods to extract metals. The metals for the ring came from a heritage coal mining site in northern England. The plants aid in removing contaminants from the soil, a process known as bioremediation.

NICKEL INDUSTRY PART 4
SUSTAINABILITY CONSIDERATIONS FOR NICKEL PRODUCTION

In Part 4 of this series we review the impacts of nickel production and how to mitigate them.

In the mining industry, there are three broad categories of sustainability issues: environmental impacts, social impacts, and governance issues. So let's look at these a bit deeper, while noting that the nickel industry is evolving: the practices of the 1950s are not the practices of today.

The major environmental issues for nickel are similar to most base metals' operations: impacts to land, air, water, and ecosystems arising from the activities undertaken and waste produced.

Land

Tropical surface deposits (laterites) can significantly impact land and biodiversity, particularly in island locations with unique, localised species, posing extinction risks. In temperate continental zones, surface mining risks are lower due to widespread species distribution. High-grade underground sulfide deposits minimise surface disruption.

Restoring landscapes to true pre-mining conditions is often impossible due to landform changes. Nickel-rich soils influence plant types, and removing nickel may support different vegetation – neither better nor worse, just different. Restoration should aim for ecological or economic usefulness, planned in consultation with communities and regulators. Plans should remain flexible to adapt to evolving community goals and climate change impacts.

Workers plant trees in former mining areas that have been reclaimed by PT Vale Indonesia in Soroako, East Luwu, Indonesia.

Air and water

Air pollution is a larger issue for processing than mining. Mining fleet emissions (from fuel combustion in mobile equipment) are relatively small. Beneficiation of sulfide ores can be energy-intensive, with emissions tied to captive fossil power plants. Remote mine locations reduce some pollutant impacts on people.

Smelting laterite ores requires high energy, emitting CO_2 and pollutants, while sulfide smelting generates sulfur dioxide – often captured as sulfuric acid unless distribution from remote sites is impractical. Acid leaching offers a cleaner processing alternative.

Water pollution arises from erosion and heavy metals in tropical mining, while sulfide mines may cause acid mine drainage. Process effluents may also contain metals. Proper treatment of drainage and effluents is essential.

Solid wastes

Like all mining activities, there are solid waste issues to consider with nickel mining and processing, whether it is nickel sulfide mine tailings (often silicate gangue with some remnant iron sulfides), slag from nickel laterite or sulfide smelting, or chemical precipitate residues from nickel laterite acid leaching or concentrate or matte refining. Adherence to leading practices like the ICMM industry standard on tailings is key to reducing risks related to these waste solids.

Social and governance issues

Social issues involve treating workers and local communities responsibly. Skilled labour is essential in mining and processing, so leading companies prioritise training, proper tools, and workplace safety.

The ongoing global conversation around FPIC (Free, Prior, and Informed Consent) highlights the need for social license to operate. Communities impacted by activities – positively or negatively – must be informed and give their consent. The maturity of this discussion varies by country, but failure to secure and maintain consent can be catastrophic for producers.

Governance in nickel mining mirrors other resource industries. Internally, decision-making processes must be transparent, inclusive, and well-informed. Externally, companies should foster constructive engagement with governments, regulators, and society while ensuring diverse voices shape policies and practices without exerting undue influence over civil society.

Making progress

There are many management systems in use around the world that address a range of the issues above. The Consolidated Mining Standards Initiative, a collaboration between The Copper Mark (which includes the Nickel Mark), International Council on Mining and Metals, Mining Association of Canada and the World Gold Council aims to consolidate their four different responsible mining standards into one global standard that includes environmental, social, and governance issues. The use of techniques such as life cycle analysis can pinpoint individual facility and industry-wide hotspots for many environmental attributes, to help companies target their sustainability efforts. But care in interpretation is always required. Future articles in this series will examine how novel approaches can help reduce the impacts of nickel production. Ni

Good regulation of ecological impacts requires good information. The members of the Nickel Institute support the work of NiPERA, leading critical science studies to gain credible data.

THE NICKEL INSTITUTE'S NEW PRESIDENT **DR. VERONIQUE STEUKERS**

NICKEL INSTITUTE

Veronique Steukers
President, Nickel Institute

Belgian citizen

PhD Organic Chemistry from University of Exeter, UK

25+ years experience of regulatory and government affairs

16+ years in the private sector with Umicore and Albemarle

Joined the Nickel Institute in 2012 as Director, Public Policy & Sustainability

Appointed President, 1 January 2025

In January 2025, Dr. Veronique Steukers stepped into her role as President of the Nickel Institute, bringing a wealth of experience and a keen enthusiasm for metals. With a strong background in chemistry, corporate leadership, and advocacy, she is committed to driving sustainability, innovation, and responsible sourcing in the nickel industry.

Leading the Nickel Institute
Recognising nickel's critical role in modern technology and sustainable development, Steukers is focused on ensuring that companies can continue to benefit from the Nickel Institute as an indispensable resource in the industry. "Nickel is a strategic mineral with immense societal benefits, but also challenges that need to be managed responsibly," she explains. "The Nickel Institute provides unique expertise and advocacy to support industry, regulators, and stakeholders in making informed decisions."

Her top priority is reinforcing the Institute's structure, funding, and membership to effectively address industry-wide challenges. She emphasises that collective action through the Institute allows members to tackle challenges that individual companies acting alone cannot and which could negatively impact the future of nickel. The Institute allows responsible industry players to pool expertise, share risks, and drive progress towards a sustainable nickel industry.

Nickel's role in global sustainability
"Nickel is indispensable for the low-carbon economy," asserts Steukers. "It is used in all renewable energy technologies, batteries and energy storage and is an essential part of our response to climate change." It also contributes to safe water distribution and food supply chains, hygienic medical equipment as well as durable infrastructure and even beautiful public art. These applications support healthy and sustainable communities.

"But sustainability starts at the source. It's our collective responsibility to ensure that nickel remains available for future generations," she insists.

To this end, the Institute has established *Sustainability Guiding Principles* to help companies develop their roadmap towards integrating environmental, social, and governance (ESG) considerations into their operations.

Advancing responsible sourcing
Veronique Steukers sees responsible sourcing as a fundamental step for companies in their ESG journey. "A responsible sourcing standard helps businesses identify hot spots, address data gaps, and build trust with investors and

NICKEL INSTITUTE

stakeholders," she says. The Nickel Institute has co-developed the Ni Mark with the established Cu Mark, a responsible sourcing framework based on OECD guidelines, offering flexibility that enables both large corporations and emerging producers to go through the process and audit.

Innovation

As a thought leader, the Nickel Institute drives innovation in regulatory science, market development, and new applications. Dr. Steukers highlights its market development work in pioneering stainless steel applications, such as earthquake-resistant water distribution systems that prevent massive water loss. Nickel's durability and recyclability make it a game-changer in sustainable infrastructure.

Looking ahead, she sees high-nickel alloys playing a growing role in space technology, thanks to their strength and extreme temperature resistance. While batteries garner much attention, nickel's potential extends far beyond energy storage.

Advocacy and education

With a reputation as a trusted global partner, the Nickel Institute plays a crucial role in educating policymakers, manufacturers, and consumers. "Our experts bring unmatched knowledge in fields ranging from human health and environmental science to regulation, market applications and sustainability," she notes. "We ensure that accurate, science-based information informs decision-making at all levels."

A passion for metals, music and leadership

Steukers' career began in organic chemistry before transitioning into metals advocacy. After roles at Umicore and Albemarle Corporation, she joined the Nickel Institute 13 years ago, eventually leading its Brussels office. "Once you're bitten by metals, it's hard to stay away," she says with a smile.

But metals are not her only passion. In her spare time, Veronique is a keen musician. She's an accomplished pianist and brings her teamwork ethos as a clarinettist in a successful wind ensemble in her native Belgium. She also sits on the Board of the Belgian orchestra Casco Phil.

And as the new *chef d'orchestre* of the Nickel Institute, she is very clear on what sets the organisation apart. "Passion, expertise, professionalism, teamwork, and fun," she affirms. "We foster respect, collaboration and trust – both within our team and with our members – ensuring a strong, sustainable future for nickel." Ni

"Nickel is a strategic mineral with immense societal benefits, but also challenges that need to be managed responsibly."

SUSTAINABILITY AND NICKEL IN STAINLESS STEEL
A BALANCED APPROACH

Nickel-containing stainless steel may have a higher production footprint but offers longevity, efficiency, and recyclability. Sustainability is assessed by full life cycle assessments, including social and economic factors.

In today's world, sustainability is more than a buzzword – it's a guiding principle shaping industries, policies, and consumer choices. In the stainless steel sector, nickel plays an important role in enhancing material performance, longevity, and supporting long-term sustainability goals. But what does sustainability truly mean in this context, and how can we effectively measure it?

At its core, sustainability is about meeting present needs without compromising the ability of future generations to meet theirs. It requires balancing economic growth, environmental care, and social well-being. Sustainable development, meanwhile, is the roadmap to achieve this – a continuous process of improving technologies, practices, and policies.

Can materials be compared for sustainability? Yes, but it's complex. Since the 1990s, scientists and industry experts have worked to define methods for evaluating materials based on sustainability. While environmental and economic aspects are well-established through agreed methods and tools, the social dimension is evolving. Evaluating materials goes beyond carbon footprints or energy consumption – it involves understanding their full life cycle impact while considering the environment, economics and social aspects.

Tools like Life Cycle Assessment (LCA)

offer a structured approach to evaluate a material's environmental impacts from cradle-to-grave. Defined by ISO standards, LCAs help assess the environmental performance of nickel-containing stainless steel throughout its entire life cycle – from raw material extraction to end-of-life recycling.

Complementary methods like Life Cycle Costing (LCC) and Social LCA (s-LCA) expand this evaluation to economic and social impacts, providing a more comprehensive sustainability assessment. These tools highlight not only environmental benefits but also economic efficiency and social responsibility.

Context matters

No material is inherently sustainable – its impact depends on its production, use, and end-of-life management. Take, for example, stainless steel made entirely from recycled scrap using hydropower. While this seems highly sustainable, if it ends up as a decorative part in a short-lived electronic device that's improperly disposed of and not recycled, its sustainability is undermined.

Conversely, using nickel-containing stainless steel in long-lasting applications – such as infrastructure or chemical processing – maximises its value and reduces environmental impact over time.

Recycled stainless steel generally carries a lower carbon and environmental footprint than that produced from primary raw materials. However, assessing sustainability requires consideration of economic and social dimensions, alongside the product's entire life cycle.

And is recycling always more sustainable? Not necessarily. If recycled stainless steel is used in a short-lived product that neither benefits from its robust properties nor gets recycled again, its sustainability might be lower than primary stainless steel used in a long-lasting, fully recycled application.

From a social perspective, primary production in areas with limited infrastructure may create more jobs and economic benefits than highly efficient recycling processes in wealthier regions that employ fewer people.

Quantitative data from LCA, LCC, and s-LCA are therefore essential tools for evaluating materials and product systems holistically, enabling informed decisions across all sustainability dimensions.

Looking ahead: building a sustainable future with nickel

Nickel's role in stainless steel is pivotal. Nickel has a high economic value which ensures that downstream and end-users carefully assess whether to use nickel-containing products or to look for nickel-free alternatives. Nickel is used where the economics are justified by better functionality, longer life, higher efficiency – and this also creates significant environmental benefits. What's more, stainless steel recyclers benefit from the fact that nickel-containing stainless steel scrap has a higher economic value, which is a driver for far higher collection rates.

Its durability, corrosion resistance, and recyclability make it a prime material for sustainable applications. Continued investment in LCA and LCC studies allows the industry to highlight nickel's long-term value while refining practices to reduce its environmental footprint. The Nickel Institute's work helps to understand the socio-economic relevance of nickel and its value chains in various nickel producing and using regions globally, complementing the environmental and economic dimension with social aspects. Ni

As industries worldwide adopt greener practices, integrating nickel thoughtfully in stainless steel will help strike a balance between economic success, environmental protection, and social responsibility – a true reflection of sustainability.

BATTERY CHAT

INTERVIEW WITH DR. MARK MCARTHUR

NOVONIX

Dr. Mark McArthur and his team focus on discovering and developing useful materials and production methods for the energy storage ecosystem. Since 2020, Dr. McArthur has led the NOVONIX cathode team in developing and scaling up its patented all-dry, zero-waste cathode synthesis technology, which is expected to significantly reduce the costs and environmental impact of nickel-based cathode production.

Prior to his role at NOVONIX, Dr. McArthur worked at Tesla, uncovering new lithium-ion battery materials and technologies for the EV and ESS sectors. He completed his PhD in Chemical Engineering at McGill University on energy storage materials and his M.Sc. in Physics at Dalhousie University under the supervision of Prof. Jeff Dahn.

Dr. Mark McArthur is the Director of R&D at NOVONIX in Nova Scotia, Canada. The Nickel Institute's battery expert, Dr. Parvin Adeli, caught up with him to talk about NOVONIX's patented, all-dry, zero-waste, cathode synthesis technology, which is expected to significantly reduce the costs and environmental impact of nickel-based cathode production.

Tell us about NOVONIX

NOVONIX is a battery materials, technology, and services company established in 2013. As a spin out of Dalhousie University, NOVONIX started with the development of ultra-high precision battery testing equipment. Since then, we have continued to expand, now offering research and development services. Our R&D team can build and test battery cells using our cell prototyping lines and provide materials development and characterisation. In 2017, we established NOVONIX Anode Materials in Chattanooga, Tennessee, USA, and developed high-performance graphite for the industry. My Cathode Materials team was established five years ago to focus on commercialising our patented, all-dry, zero-waste cathode production technology, initially developed at Dalhousie University in Dr. Mark Obrovac's battery materials lab.

What is the focus of the all-dry zero-waste process technology?

Our technology focuses on synthesising Nickel Manganese Cobalt (NMC) cathode materials in a scalable, sustainable, and cost-effective way.

What distinguishes it from other technologies?

In the standard process, NMC cathode materials are produced by first forming a Precursor Cathode Active Material (PCAM) through aqueous co-precipitation of nickel, manganese, and cobalt sulfates. This process generates wastewater and byproducts like sodium sulfate. A lithium compound is mixed with the PCAM, which, after calcination, becomes a Cathode Active Material (CAM) powder.

At NOVONIX, we focused on making the same high-quality materials, but through a better process. We've shown we can achieve competitive performance to conventionally made NMC cathode powders for a range of nickel chemistries (60-95% Ni). Our process flow is simple, but making the final product is not. We combine various metal feeds – primarily metal powders, oxides, or carbonate – together with lithium and dopants, and calcine everything.

The magic is in how we combine the raw materials in a completely dry state, without specialised reagents, and refining the crystal structure through precise heating. The result is similar to conventional NMC powder, using the same equipment in a new, different way.

What are the benefits of the all-dry, zero-waste process?

By converting to an all-dry process, the CAPEX and OPEX savings can be as much as 30% and 50%, respectively.[1] We're making quality CAM powder without generating any waste. There's no sodium sulfate waste byproduct to worry about, nor do we need any specialised waste disposal systems. And it's easy to convert a facility to use NOVONIX technology. Making the same material, lowering costs, eliminating waste, and decreasing plant footprint. This is a winning combination for CAM manufacturers.

What have been the challenges?

The problem with ternary CAMs, like NMC, is that the feeds you are combining have different oxidation states. 'Forcing all the kids at the party to play nicely together' ends up being complicated, and manganese really is the odd one out. It doesn't mix nicely with nickel and cobalt. The first challenge we had was to overcome inhomogeneous cation mixing within the particles. You would get localised islands of manganese appearing where you should have this beautiful, intermixed crystal structure. We had to develop a process beyond the lab and understand how to control the combination of different feeds. It took time. And what we learned is that every chemistry has a different strategy to overcome that inhomogeneity.

What are the next steps for expansion and large-scale production?

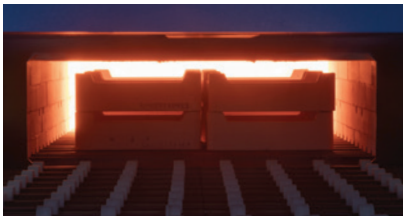
We understand the challenges of bringing battery materials to scale. While we continue to progress engineering and leverage our 10k tpa pilot facilities to define a path to deployment, we are also looking at options to scale this technology and see it in the market. We are focused on establishing partnerships with strong companies that can help in that final scaled industrialisation.

There is opportunity for partnering with a materials manufacturer to provide a facility to produce CAM the NOVONIX way or building it ourselves. For now, we're favouring the partnership and licensing route as the best path to see this technology make a positive impact on the market. Ni

Read the extended interview on Chronickels, the Nickel Institute's blog.

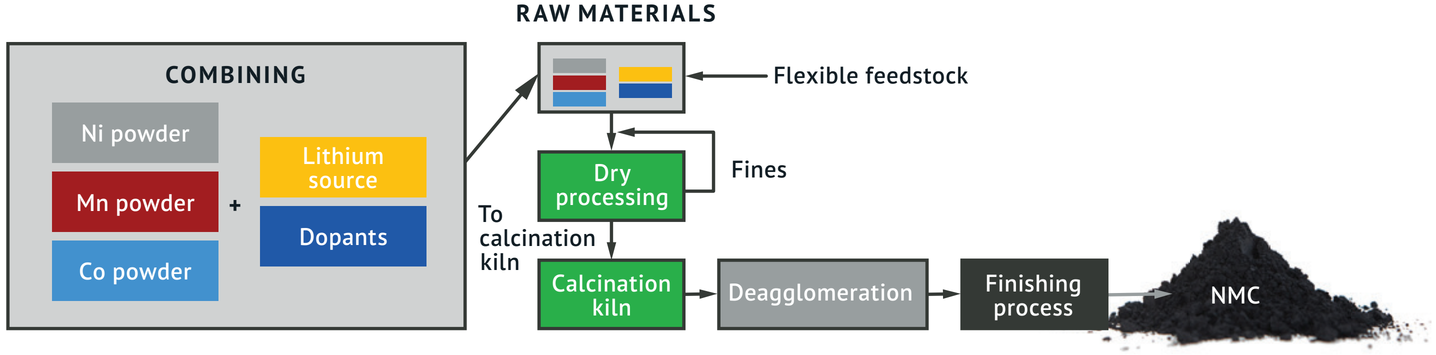
[1] Process comparison study conducted by Hatch Ltd at a Front End Loading-1 level estimate.

NOVONIX 13.5 m long roller hearth kiln (RHK) with insulating covers removed showing gas handling system and roller/heater covers



NOVONIX

"At NOVONIX, we focused on making the same high-quality materials, but through a better process."



NOVONIX

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 notice that my welds in 304L (UNS S30403) and 316L (S31603) are slightly attracted to a magnet and have read that ferrite is important in welds. Please explain.

A: The microstructure of all stainless steels is determined by their chemical composition. 300 series nickel-containing stainless steels possess an austenitic microstructure. 400 series stainless steels with essentially no nickel are ferritic, while duplex stainless steels with approximately equal quantities of ferrite and austenite possess nickel contents in between those 300 series and 400 series.

Unfortunately, welds that solidify with a 100% austenitic microstructure are susceptible to hot cracking. This is due to austenite's higher coefficient of thermal expansion than a ferritic microstructure and thus as the weld cools tensile stress across the width of the weld can result in longitudinal cracks. This susceptibility to hot cracking is exacerbated by sulfur and other contaminants which have limited solubility in austenite and concentrate at the grain boundaries as the weld solidifies, further reducing the tensile strength at the grain boundary making hot cracks even more likely. To prevent hot cracking, a lower heat input and thus slower welding speed are necessary to reduce the weld's cooling rate which negatively impacts productivity.

A ferritic microstructure has a lower coefficient of expansion and has a higher solubility for sulfur and other contaminants than austenite. Therefore, the chemical composition of welding electrodes, such as those for 304L (308L) and 316L, is adjusted to introduce some ferrite in the weld metal which imparts resistance to hot cracking, enabling a higher deposition rate.

Typically, 4–10% ferrite (or FN) is preferred to avoid hot cracking of 308L and 316L welds. Either a ferrite percent or a ferrite number (FN) will usually be reported on the material certificate for the welding electrode, if the actual chemistry is being reported. FN is a calculation based on the actual composition. (Some suppliers only provide a typical chemical analysis, not the actual.) The actual amount of ferrite in a completed weld will rarely be the same as what is stated on the material certificate because welds are a mixture of the welding electrode and base metal, and during welding nitrogen, which is an austenite stabiliser, can be drawn into the weld from air, and the cooling rate will all have an influence on the final ferrite content.

Finally, ferrite is ferromagnetic and this small amount of ferrite in the weld is enough to feel a magnetic attraction. Ni

Nickel can be found in many forms from nanowires to stainless steel alloys. But what are the properties of nickel that make it an essential element in everyday objects?

Why nickel?

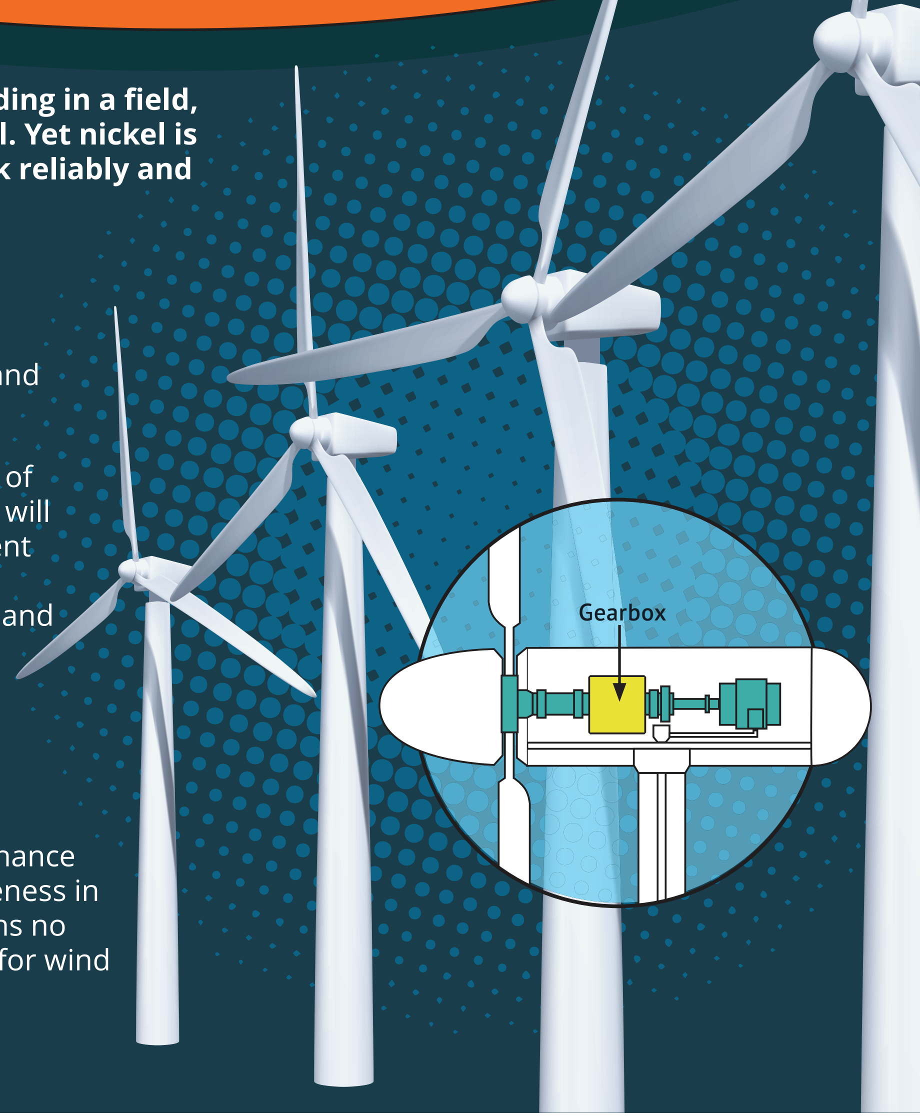
NICKEL IN WIND TURBINES

When you look at a wind turbine standing in a field, chances are you will not see any nickel. Yet nickel is critical to ensuring wind turbines work reliably and perform well for decades.

So, where's the nickel? Inside the nacelle – the box at the top of the tower – is the gearbox which turns mechanical energy into electricity and where nickel is essential.

The gearbox converts the rotation speed of the blades from 8–20 rpm to a shaft that will rotate at 1000–1800 rpm, enabling efficient electricity generation. The metals in the gearbox must withstand wear, vibration, and extreme temperatures. Gearboxes can weigh over 40 tons and are made from strong steel alloys containing about 1.5% nickel, along with chromium and molybdenum.

While all three alloying elements enhance strength, only nickel prevents brittleness in extreme cold. A failed gearbox means no electricity generation. Nickel is vital for wind turbine performance.

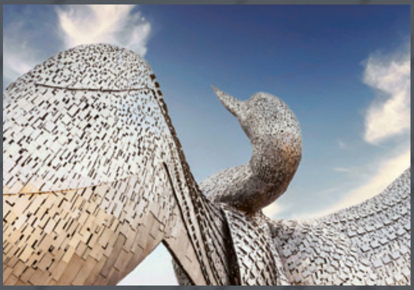


UNS DETAILS

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

UNS	C	Cr	Cu	Fe	Mn	Mo	N	Ni	P	S	Si
S30403 pg 14, 16	0.030 max	18.0-20.0	-	bal	2.00 max	-	-	8.0-12.0	0.045 max	0.030 max	1.00 max
S31603 pg 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
S32101 pg 2	0.04 max	21.0-22.0	0.10-0.80	bal	4.00-6.00	0.10-0.80	0.20-0.25	1.35-1.70	0.040 max	0.030 max	1.00 max
S32205 pg 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

SCULPTOR ANDY SCOTT LLC



To achieve a bright, long-lasting appearance, the 'feathers' were cut from plates of 304L (UNS S30403) stainless steel 6 mm (0.25 in.) thick. The attractive surface finish was created by sandblasting followed by bead blasting.

THE CALLING
STAINLESS STEEL LOON SCULPTURE

With a striking, ethereal aesthetic and its head arched back, The Calling was inspired by Minnesota's iconic state bird, the loon. Constructed from over 5,000 pieces of stainless steel, this landmark sculpture was commissioned by the McGuire Family Foundation for the United Village development at the Minnesota United Football Club's Allianz Field Stadium.

Andy Scott, renowned for his Kelpies sculpture in Scotland, UK, teamed up with the fabrication company Dyson and Womack. The project began in his workshop. Says Scott, "I built a one-third scale maquette in mild steel, which my colleagues then enlarged to the full-scale artwork. They did a superb job using techniques similar to the traditional way ships were fabricated – a steel frame clad with steel plates which were fixed and welded individually by hand."

The 65 sections were trucked in a convoy of thirteen 17 m semi-trailers, then assembled on-site over ten days. 11 m (36 ft.) tall with a wingspan of 30 m (98 ft.), the sculpture weighs approximately 25 tons.

Situated in a prominent place in the cityscape, it is part of a major regeneration of that area of St. Paul, Minnesota, USA. Ni