NICKEL MAGAZINE

THE MAGAZINE DEVOTED TO NICKEL AND ITS APPLICATIONS

NICKEL, VOL. 33, NO. 1, 2018

Energy transition:
Nickel helping to combat climate change

The electric vehicle revolution

Iceland's advanced geothermal deep drilling project

Carbon capture storage: an underground solution

CASE STUDY 12
AURORA WASTE-TO-ENERGY PLANT

Stainless steel tanks ensure long life in the corrosive environment caused by the decaying organic matter.

Stainless steel – easier to digest

When the Millennium drought and Melbourne Australia's growing population put a greater strain on finite resources like water and energy, Weltec Biopower, a bioenergy producer, and engineers, Aquatec Maxcon, brought their expertise to Yarra Valley Water to build a waste-to-energy facility. The Aurora waste-to-energy plant processes commercial food waste into clean, renewable energy. This in turn generates enough biogas to run the existing Aurora sewage treatment plant and the new recycled water facility, with the surplus energy being sold or exported to the electrical grid.

Rubbish to renewable energy

Operating since May 2017, nearby markets and food manufacturers deliver the equivalent of 33,000 tonnes of commercial food waste to the facility annually. The first stand-alone food waste processing facility constructed by a water utility in Australia, the ReWaste plant is based on the process of anaerobic digestion.

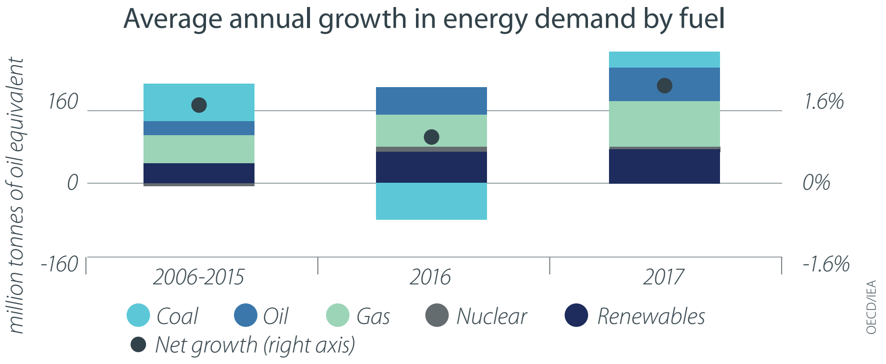
Eight stainless steel tanks including five pre-storage tanks, two digesters and a large storage tank were put together on site. Stainless steel was an ideal material to withstand the corrosive environments created by decaying organic matter which contains hydrogen sulphide, chlorides and organic acids.

Austenitic stainless steel grade Type 304 (UNS S30400) was used for the tanks. The upper part of the digesters, which are partly in the splash zone and partly in the gas phase, were made from the more highly alloyed grade of austenitic stainless steel Type 316Ti (S31635). Ni

Download the full case study from www.nickelinstitute.org

EDITORIAL:
ENERGY TRANSITION NICKEL'S UNSEEN BUT VITAL ROLE

At the Paris COP21 climate conference in 2015, 195 countries agreed to the goal of limiting the global average temperature increase to less than 2 °C above pre-industrial levels. However, with the demand for energy increasing, related carbon emissions are still on the rise. According to the International Energy Agency's Global Energy and CO_2 Status Report, *global energy demand rose by 2.1% in 2017 and more than 70% of the growth came from fossil fuels.*



More optimistically, the report noted, "renewables saw the highest growth rate of any energy source in 2017, meeting a quarter of the global energy demand growth". This increase in renewable energy is driven by China and the US, followed by the EU, India and Japan. In fact, China added as much solar power during 2017 as the total solar capacity of France and Germany combined.

Nickel plays a part in a range of applications designed to lead to energy transition and tackle global warming. In this issue, we look at a massive battery storing wind energy in South Australia; a large-scale carbon capture initiative in Canada; the potential of geothermal energy in Iceland; how nickel-containing stainless steel is helping reduce CO_2 emissions in India, and more. Each of these approaches represent steps towards achieving the Paris targets. To meet the goal of energy transition and to achieve lower greenhouse gas emissions plus increased energy efficiency, nickel is a vital part of the equation.

Clare Richardson
Editor, Nickel Magazine

Geothermal energy solutions in Iceland

We hope you like the new look of Nickel *magazine. Now in its 33rd year of publication, we felt it was time for a revamp. Let us know what you think!*
communications@nickelinstitute.org

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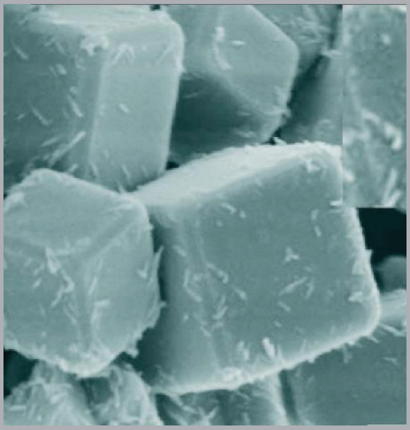
NICKEL NOTABLES

Converting methane more sustainably

Bubbling methane gas through a molten bismuth-nickel alloy, a process developed at the University of California, Santa Barbara, is showing promise as a method to make hydrogen. Traditional steam reforming of methane produces carbon dioxide as a by-product, whereas in this new method the carbon in the methane comes out as graphite. The research team is collaborating with Shell to see if they can develop this technology further.

BRIAN LONG



XIANMEI XIANG/LANZHOU INSTITUTE OF CHEMICAL PHYSICS

Exciton news!

For the first time, Russian scientists from Ural Federal University (UrFU), together with their colleagues from Institute of Metal Physics of the Ural Department of Russian Academy of Sciences, have studied fundamental characteristics of nickel oxide nanocrystals and found excitons on the light absorption edge. This may be useful for the development of next-generation optoelectronic devices. An exciton is an electron-hole pair bound with electrostatic coupling that migrates in a crystal and transmits energy within it. The results of the study were published in *Physica B: Physics of Condensed Matter journal*.

Recycled batteries come to a boil

A new and simpler recycling process for spent lithium-ion batteries has been developed at the University of California in San Diego. For NMC batteries containing valuable nickel, manganese and cobalt as well as lithium, the process involves removing the cathode particles and treating them in a hot, alkaline solution, and then baking them at 800 °C. When reused in new batteries, charge storage capacity, charging time and battery lifetime were all restored to their original levels.

DAVID BAILLOT/UC SAN DIEGO JACOBS SCHOOL OF ENGINEERING

Reinventing the wheel

Designing tires for worlds other than Earth? Forget elongation and rebound and think “stoichiometric” and “shape memory alloys.”

Scientists at NASA’s Glenn Research Center near Cleveland have developed a non-pneumatic, compliant tire made of a stoichiometric nickel-titanium mesh, envisioning use on a future mission to Mars.

The innovation, called the Superelastic Tire, is the latest evolution of the Spring Tire that NASA Glenn and Goodyear developed a few years back, inspired by the Apollo program’s lunar-rover tires.

“The latest version uses shape memory alloys capable of undergoing high strain as load-bearing components, instead of typical elastic materials”, NASA Glenn said.

“The nickel-titanium alloy undergoes an atomic rearrangement to accommodate deformation”, according to Santo Padula, a materials scientists at NASA Glenn. “This allows a tire made of the alloy to deform up to 30 times more than one made of a more conventional material and recover its original shape without irreversible plastic deformation.”

© IMAGING TECHNOLOGY CENTER, NASA GLENN

THE LONG NOW FOUNDATION

What makes 10,000-year clock tick?

The Long Now Foundation (longnow.org) has begun installing a mechanical clock in a West Texas mountain that will keep time for 10,000 years. The mechanism is made primarily from Type 316 (UNS S31600) stainless steel, titanium and dry running ceramic ball bearings. The clock will tick just once a year, with a century hand marking every 100 years, and a cuckoo making an appearance every millennium. With a specially designed gear system that has precision equal to one day in 20,000 years, it self-corrects by “phase-locking” to the noon sun. Conceived by US engineer and entrepreneur Danny Hillis, the clock aims to shift humanity’s thinking away from the immediate, inspiring people to take a more long-term view of the world.

NICKEL GROWING INCREASINGLY IMPORTANT IN THE COMING ELECTRIC VEHICLE REVOLUTION

Within less than five years, EVs are expected to cost less than internal combustion-driven cars and sales are set to explode to the tens of millions. Some estimates place the number of EVs on the road by 2035 at as high as 350 million.

A critical part of the strategy to address climate change is to change the way we move ourselves from point A to point B. The transportation industry is responsible for an estimated 14% of global greenhouse gas (GHG) emissions. While the solution may take many forms, electric vehicles (EVs) are expected to play a big role in reducing pollution.

Clearly, since EVs are reliant on electricity, associated emissions are not zero, unless the grid itself is carbon-free. However, a recent study from the National Renewable Energy Laboratory indicates that even in a carbon-intensive power grid, EV use results in fewer emissions than conventional alternatives.

Until recently, though, EVs were not meaningful in the scheme of things. 2017 was the first year in which more than one million EVs were sold, compared with over 88 million conventional cars and light commercial vehicles sold globally in 2016, but that's just the start.

Nickel use in EVs set to accelerate

By 2040, some analysts expect that EV sales will eclipse those of internal combustion engines, displacing eight million barrels of oil per day. Those millions of cars, trucks and buses will require nickel-containing lithium-ion batteries. Today, according to market analysts Roskill, batteries use an estimated 3% of the world's nickel supply, but this number is estimated to rise rapidly.

New chemistries

Nickel-manganese-cobalt (NMC) batteries, currently deployed by many automakers, use ratios of 33% nickel, 33% cobalt, and 33% manganese (referred to as 1:1:1). Others are already using 6:2:2 formulas (60% nickel, 20% manganese, and 20% cobalt). An effort is now underway to further tweak the NMC chemistry and create an 8:1:1 cathode using 80% nickel, 10% manganese, and 10% cobalt. Two Korean manufacturers, including LG Chem, have announced plans to bring these new chemistries to market in 2018. And other companies such as Tesla (which uses an NCA – nickel-cobalt-aluminum technology) are also anticipated to be moving to more nickel.

While non-nickel lithium-ion chemistries also exist, nobody has yet developed a technology that matches nickel for its density – the power to weight ratio – that is critical in cost-effectively moving these vehicles down the road. Nickel thus will be a major – and growing – player in the massive global deployment of electric vehicles in our race to save the planet. Ni

© TESLA

WORLD'S LARGEST LITHIUM-ION BATTERY – SOUTH AUSTRALIA

In 2016, when 1.7 million residents in the state of South Australia were left without electricity following storm damage to critical infrastructure, nickel inadvertently became the quiet achiever in tackling climate change and addressing political energy policies.

Immediately following the crisis, which left some residents without power for up to two weeks, the Hornsdale Power Reserve project was born off the back of a promise by Tesla's CEO Elon Musk to build the world's largest lithium-ion battery in South Australia in 100 days.

Tesla has constructed the 129 MWh battery in partnership with the state government and Neoen, the French renewable energy company that owns the adjacent Hornsdale Wind Farm. It's designed to load balance the state's renewable energy generation and allow for emergency back-up power during predicted short falls. Essentially, the battery stores the energy already being generated by wind and solar.

Whilst the exact chemistry of the lithium-ion batteries used at the reserve has not been communicated, Musk has previously said that for its grid battery, Tesla would use a lithium-ion chemistry with a nickel, manganese, cobalt oxide cathode.

Traditional NMC battery configurations, as they are known, used one third equal parts nickel, manganese and cobalt. However, battery manufacturers are starting to play with the relative proportions of nickel, cobalt and manganese, with latest reports showing up to 80% nickel use. As the nickel goes up, the ability of the battery to absorb lithium increases so they get higher in capacity, and cheaper to make. Nickel, cobalt, graphite and lithium serve as the biggest drivers for the overall battery cost, which Telsa has managed to reduce by 35%. Ni

The scale and use of nickel in this application shouldn't be underestimated. The battery covers approximately one hectare of land and is capable of providing additional peak power for around 50,000 homes.

NICKEL **ENERGIZING BATTERIES**

Concern over climate change, the drive towards energy efficiency and the adoption of carbon dioxide emissions targets by governments are all helping to increase interest in renewable energy technologies involving batteries and energy storage. While nickel is not always in the name, its presence in many battery technologies is helping to reduce greenhouse gas emissions - enabling clean energy solutions to be a central part of our effort to tackle global warming.

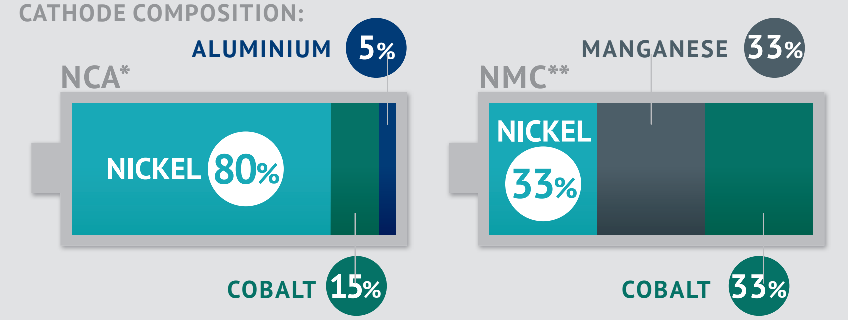
LI-ION BATTERIES

Nickel plays a crucial role in lithium-ion battery chemistries used to power electric vehicles, medical devices and cordless power tools as well as store renewable energy.

TODAY'S BATTERY OPTIONS

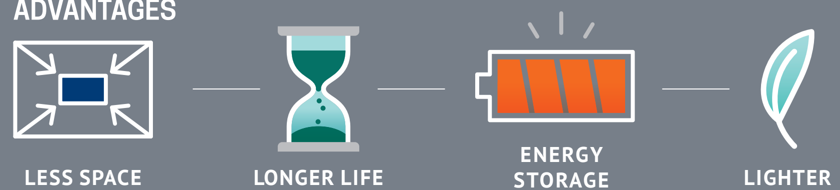
Lithium compounds are combined with other materials in order to create Li-ion batteries. Two of the commonly used Li-ion battery chemistries contain nickel.

CATHODE COMPOSITION:

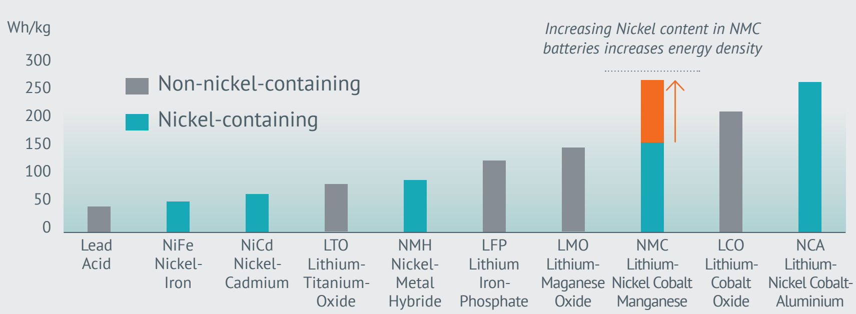


*NCA: Nickel Cobalt Aluminium **NMC: Nickel Manganese Cobalt

ADVANTAGES

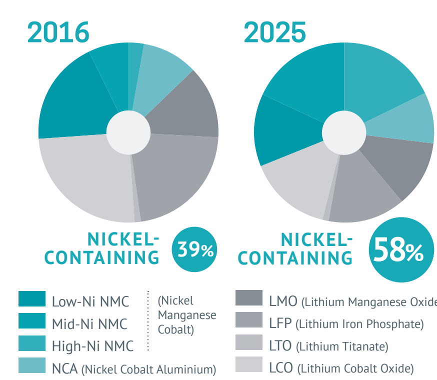


NICKEL- CONTAINING BATTERIES COME IN MANY CHEMISTRIES AND OFFER THE HIGHEST ENERGY DENSITY ON THE MARKET



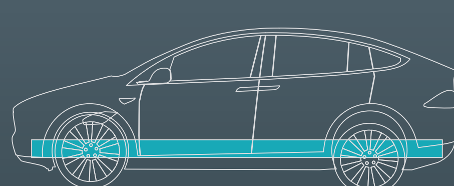
GROWING SHARE OF NICKEL-CONTAINING LITHIUM-ION BATTERIES

The lithium-ion battery sector will continue to grow in response to the strong demand for battery powered products. In particular, demand for energy-dense nickel-containing batteries will increase for applications such as electric vehicles and renewable energy storage. Currently 39% of Li-ion batteries contain nickel. This is expected to rise to around 58% by 2025.



POWERING THE FUTURE OF TRANSPORT

Companies and governments around the world are asking for increased capacity and energy at lower cost to achieve greenhouse gas reductions. This is leading to major investment in R&D and new production facilities in the lithium battery sector, directly linked to the development of electric vehicles (EVs). Nickel-containing cathodes make batteries lighter, smaller and provide higher energy density, resulting in a more efficient EV. It's clear that future EV batteries will employ more nickel.



"Our cells should be called Nickel-Graphite, because primarily the cathode is nickel and the anode side is graphite with silicon oxide... [there's] a little bit of lithium in there, but it's like the salt on the salad" - Elon Musk, CEO Tesla

NICKEL IS PART OF THE SOLUTION FOR A MORE SUSTAINABLE SOCIETY

Nickel in the battery provides higher energy density and storage at lower cost. And crucially it contributes to a longer drive range. New battery developments are helping to make each kWh of battery storage more cost competitive so that intermittent renewable energy sources such as wind and solar can replace fossil fuels for energy production.

Sources: Roskill • International Nickel Study Group, Nickel in batteries, 2015 • http://batteryuniversity.com/ • Nickel Institute Member companies

NICKEL-CONTAINING STAINLESS STEEL COOK STOVE PROVIDING CLEAN COOKING TECHNOLOGY IN RURAL INDIA

According to estimates from the World Health Organization, exposure to smoke from traditional cook stoves burning biomass (wood, animal dung, crop waste) and coal – the primary means of cooking and heating for nearly three billion people in the developing world – causes more than four million premature deaths per year (2012).

India alone accounts for more than 1.2 million such deaths annually. Traditional cooking practices are also thermally inefficient and contribute to climate change through emissions of greenhouse gases such as carbon dioxide and methane, and aerosols such as carbon black.

Fuel efficient ICS lowers emissions

To counter these effects, a New Delhi based non-profit research organisation, The Energy Research Institute (TERI), designed an energy efficient, improved cook stove (ICS), TERI SPT 0610. The ICS can operate with a range of traditional biomass fuels. Made from stainless steel, the inner core is fabricated from Type 304 (UNS S30400) where the combustion takes place, with Type 202 (S20200) for the outer structure and base as well as nuts and bolts.

Recent laboratory tests by the Indian Institute of Technology in Delhi showed that the nickel-containing stainless steel stove performed significantly better than traditional cook stoves. Emissions are lower and it is more fuel efficient. The ICS demonstrated a combustion efficiency of 37%. When compared to a traditional mud stove, the tested model showed a reduction of 72% in particulate matters emission (PM 2.5), 80% in carbon monoxide emission, and 54% in fuel consumption.

Cooking up cleaner air

The deployment of 20,869 ICS between 2009 and 2015 has resulted in 43.6% reduction in cooking time and an estimated annual fuel wood saving of nearly 24,000 tonnes. Research conducted by University of California at San Diego, TERI and Nexleaf Analytics, suggests that switching to a clean biomass stove could reduce approximately five tonnes of carbon dioxide equivalent emissions per household per year and will also reduce air pollution by 60-70%.

Through innovations like ICS, nickel-containing stainless steel is contributing to cleaner air and better health in the developing world. Ni

Ensuring universal access to clean fuel and technologies is a target of the United Nations' Sustainable Development Goal on energy (SDG 7). If this target is met it could prevent millions of premature deaths and improve the health and well-being of the billions of people relying on polluting fuels and technologies for cooking, heating and lighting.

JOURNEY TO THE CENTRE OF THE EARTH: NICKEL MAY BE CRITICAL TO SUCCESS OF ICELAND'S 4.5 KM ADVANCED GEOTHERMAL DEEP DRILLING PROJECT

HANSUELI KRAPF

Finding the right alloy for the job becomes even more critical as developers eye a potential major new geothermal frontier: deep advanced geothermal projects sitting close to the edge of the earth's magma, at pressures as high as 200 atmospheres.

The typical conventional geothermal well produces energy from water or steam in contact with hot rock at 200-325 °C, with wells typically ranging in depth from 60 to 3,000 m. At this point, the industry has decades of experience and the technologies are relatively well known. Stainless steel and other nickel-containing materials are commonly and successfully employed in these projects on a global basis, with their principal role being to deal with corrosive brines and chemicals.

Different local conditions call for different alloys

Geothermal projects have been developed widely across the planet from Kenya to New Zealand, with well over 13,000 megawatts (MW) of capacity worldwide, and the possibility of reaching as much as 23,000 MW by 2021. Some countries, such as Kenya – which at the end of 2016 had about 650 MW of capacity, representing about half of its electricity production – rely heavily on the resource.

Geothermal projects are developed in widely different environments, with enormous variations in metal ions, corrosive chlorides and gases encountered. As a result, a broad range of stainless steels and nickel alloys are deployed in the piping and process equipment.

For many less corrosive wells, standard nickel stainless steels including Types 304L (UNS S30403), 316L (S31603) and 321 (S32100) are commonly utilised, but in chloride- or sulphide-rich wells, higher corrosion-resistant alloys are often needed. These may include duplex stainless steel Types 2205 (S32205), 2507 (S32750) or austenitic alloys such as 904L (N08904) or 825 (N08825). In extremely corrosive environments, more of the highest corrosion-resistant nickel alloys such as Alloy 625 (N06625) and C-276 (N10276) may be required.

This challenge of finding the right alloy for the job becomes even more critical as developers eye a potential major new geothermal frontier: deep advanced geothermal projects sitting close to the edge of the earth's magma, at pressures as high as 200 atmospheres.

A potential new approach to geothermal in Iceland: exploiting supercritical fluids

The first of these deep drilling projects is taking place in the Krafla geothermal field in northeast Iceland. The potential of a vastly greater geothermal resource is being explored

ÁSGEIR EGGERTSSON

Krafla geothermal field in northeast Iceland

here, with the goal of tapping supercritical fluids at 400-600 °C. Supercritical is the point at which, under extreme temperature and pressure, distinct phases of gas and liquid do not exist.

After 176 days of drilling, the $15 million Iceland project, using stainless steel liners to address corrosion, reached the targeted 4,659 m in January 2017 and encountered supercritical conditions (452 °C – the highest temperature ever measured in a geothermal well). The next steps have been to conduct further testing and research, particularly flow testing and fluid handling experiments. A final determination on the technology and electricity production economics will not be known until the end of 2018.

With these extreme conditions, corrosion has been a big problem

During the drilling, several key engineering challenges have arisen. One big problem is that the superheated steam contains acidic gases that are extremely corrosive, posing potential challenges to even highly corrosion-resistant nickel alloys that are typically used in conventional geothermal applications. Testing has shown that alloys such as C-276 and 625 fare relatively well at lower temperatures (180 °C), but corrosion rates were significantly higher at 350 °C. It is abundantly clear that the deep drilling environment, with its even higher 400 °C temperatures and highly corrosive environment, has created new challenges across the spectrum of alloys.

If this resource can be harnessed, the potential for additional geothermal resources could be enormous in geological areas of the world where young volcanoes occur and magma is relatively close to the surface. For this resource to be cost-effectively developed, the right nickel-containing alloys necessary for this challenging task need to be identified. Ni

If this resource can be harnessed, the potential for additional geothermal resources could be enormous in geological areas of the world where young volcanoes occur and magma is relatively close to the surface.

BATINTHERAIN

SHELL'S QUEST PROJECT

HOW NICKEL-CONTAINING STAINLESS STEEL CONTRIBUTES TO BETTER AIR QUALITY

CNW GROUP/SHELL CANADA LIMITED

The CO_2 Capture Facilities consist of amine absorption units located in each of the Hydrogen Manufacturing Units, a common amine regeneration unit, a CO_2 compression unit and a triethylene glycol dehydration unit.

The International Energy Agency (IEA) considers carbon capture and storage (CCS) to be an important climate mitigation technology in its Blue Map strategy for reducing carbon dioxide emissions. CCS is needed to successfully transition to a low-carbon economy and achieve the Paris 'below 2 degree' international climate change target.

Nickel-containing Type 304L (UNS S30403) is a contributor to the success of CCS operations where there are concerns about corrosion from wet liquid carbon dioxide in the process streams. Carbon dioxide dissolved in water forms carbonic acid, a weak acid that can attack carbon steels under certain process conditions. However, Type 304L is typically resistant to such conditions.

Keeping CO_2 out of the atmosphere

Type 304L played a key role in Shell's Carbon Capture and Storage Quest project, launched in 2015 with the goal to capture and store up to one million tonnes of carbon dioxide per year from the expanded Scotford Upgrader at Fort Saskatchewan, Alberta. The facility was built on behalf of the Athabasca Oil Sands Project (AOSP) joint venture owners (current partners include Shell, Chevron, and Canadian Natural Resources), with support from the Canadian and Alberta Governments. Funding was part of the province's commitment to reduce emissions from large-scale industrial sites, which account for up to 70% of emissions in Alberta.

The carbon dioxide is captured from the Scotford steam methane reformer units, which produce hydrogen for upgrading bitumen to lighter oil products. Captured carbon dioxide is transported 65 kilometres from the facility via underground pipeline to several wells at a permanent underground storage site. The nominal design life of the plant is 25 years.

Reaching targets ahead of time

Since commercial operation start up almost three years ago, it reached the milestone of capturing over two million tonnes of CO_2 ahead of schedule.

Quest is the first application of this technology at an oil sands upgrader. From a global perspective, it is comparable to the emissions of approximately 250,000 motor vehicles per year.

Shell Canada stresses that a key component to this success has been the integration of the newer project with the existing process units. This facilitated the "fine-tuning" and optimisation of the operation, resulting in 99% plant reliability (unplanned downtime of less than 1%) during the first year.

Based on Shell Canada's operating and engineering experience, austenitic stainless steel is used in the capture and compression sections of the process, as well as for the injection tubing at the wells.

How it works

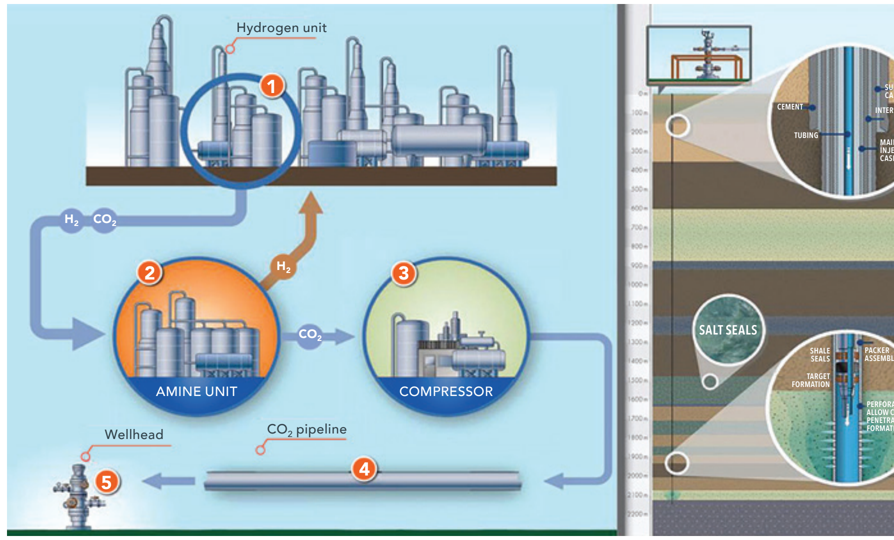
The capture facility is interconnected to various process gas streams in the three Hydrogen Manufacturing Units (HMUs) where hydrogen is produced for the conversion of AOSP bitumen to crude oil. The carbon dioxide is removed by contacting the gas stream of methane, carbon dioxide, carbon monoxide, and hydrogen with an amine solution.

The carbon dioxide is separated from the amine in a regeneration process that produces 95% carbon dioxide at a pressure slightly above atmospheric pressure. The carbon dioxide stream is then compressed to a supercritical state and dehydrated by a multi-stage compressor and transported via pipeline for off-site deposition.

The CO_2 enters the pipeline at roughly 40 °C and 10 MPa pressure. This is also sometimes known as a dense-phase state. It is injected into the wells at a slightly lower temperature in a liquid state.

A big step forward for CCS

The successful design, construction, and operation of this Alberta plant represents a significant stride forward using this technology. The Global CCS Institute's data shows that there are "currently 21 large-scale CCS facilities in operation or under construction globally; these facilities can remove 37 million tonnes per annum of CO_2 that otherwise could have entered the atmosphere. This is the equivalent to taking almost eight million passenger vehicles off our roads." Ni



CNW GROUP/SHELL CANADA LIMITED

Signs that China is serious about combatting climate change

At the World Economic Forum in Davos, Switzerland in January 2017, China's President Xi Jinping defended the Paris Climate Agreement and called for stronger international co-operation to meet today's global problems. China's role will be key, as it is currently the largest investor in sustainable infrastructure.

In 2016, China invested $88 billion in renewable energy, the highest in the world. Home to five of the top solar panel manufacturers and five of the top ten wind turbine makers, China is building capacity at an astonishing rate, installing on average one new wind turbine every hour. China has also commenced other initiatives to reduce carbon dioxide emissions. Many require nickel-containing materials.

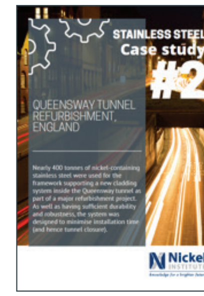
The drive for more electric vehicles (EVs) – As the largest car market in the world, China is providing incentives to buy all-electric vehicles and plug-in hybrid electric vehicles to reduce CO_2 emissions and help clean up air in cities. The goal is to reach five million EVs by 2020. These vehicles typically utilise nickel-containing lithium-ion batteries. The Chinese government took a further step in February 2018, when it ruled that EV manufacturers are to be responsible for establishing battery recycling channels and service centres.

The plan for more nuclear – To meet future energy demands while lowering GHG emissions, China planned to construct 60 nuclear reactors by 2020. The 2011 accident at the Fukushima nuclear reactor in Japan brought a pause, but China has recommitted and currently has 20 reactors under construction. The primary circuit of a nuclear plant, which contains the reactor core, is almost exclusively nickel-containing stainless steels and nickel alloys.

More environmentally responsible railway – China's Railway Network Plan (2016-2030) projects that total railway mileage will reach 175,000 km by 2025. Subway and surface rail networks will also be expanded. This will require additional rail cars, which are typically constructed from nickel-containing Type 304 (UNS S30400) stainless steel.

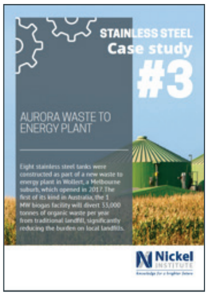
With vast low-lying cities that could be largely underwater in a century if climate change is not mitigated, China is showing that it is serious about taking action. Ni

Structural case studies



Three new structural nickel-containing stainless steel case studies to inspire architects and engineers are available for download from the Nickel Institute website. The case studies were written by Nancy Baddoo of the Steel Construction Institute, a leading, independent provider of technical expertise and disseminator of best practice to the steel construction sector. Ni

NEW PUBLICATIONS

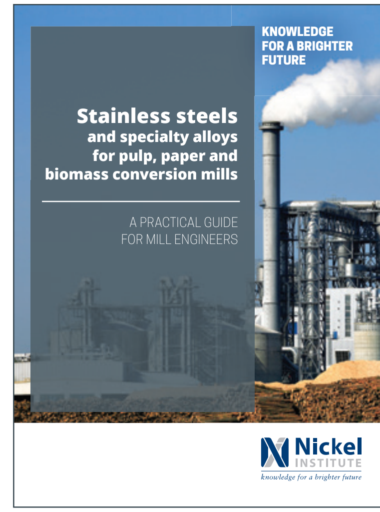


#1 Aguilas footbridge

#2 Queensway tunnel refurbishment

#3 Aurora waste-to-energy plant

Stainless steels and specialty alloys for pulp, paper and biomass conversion mills



The Nickel Institute has published a fully revised second edition of *Stainless Steels and Specialty Alloys for Pulp, Paper and Biomass Conversion Mills*, a popular and practical guide for mill and project engineers within the pulp, paper and biomass sector.

The revision team was headed by senior editor Dr. Andrew Garner together with ten other materials specialists, and advice from a task force from the TAPPI Corrosion & Materials Engineering Committee. In addition to covering technology changes for pulp and paper mills, the publication includes new chapters on biomass conversion mills, risk-based inspection techniques and a comprehensive guide to the use of corrosion-resistant fasteners. Of special interest are details about newer duplex stainless steels – their applications and why they work.

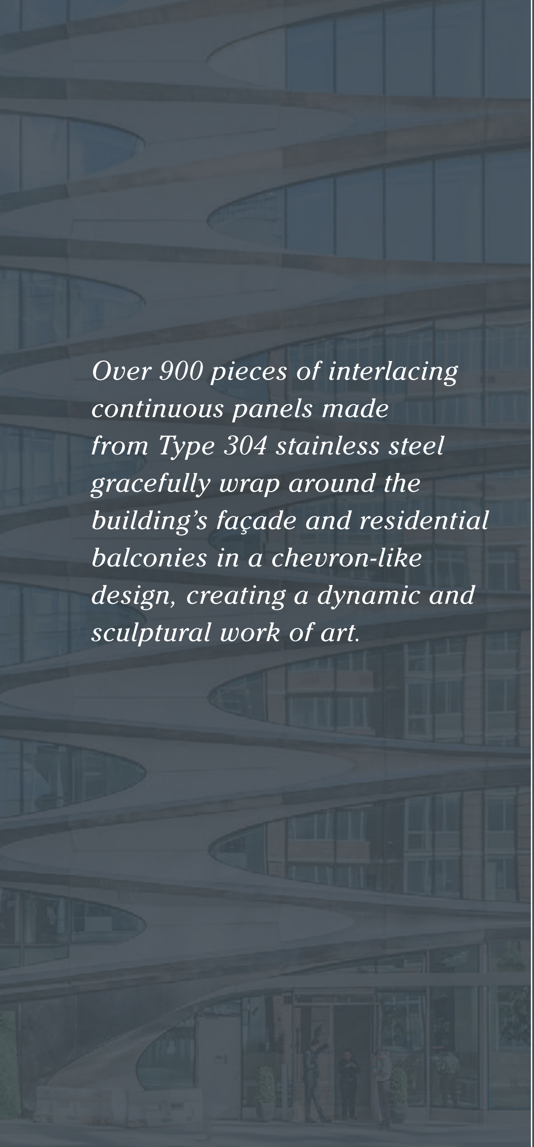
This book is available for download free of charge from the Nickel Institute website. Printed copies can be ordered from communications@nickelinstitute.org. The guide is an invaluable addition to a mill engineer's bookshelf. Ni

UNS DETAILS

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

UNS	Al	C	Co	Cr	Cu	Fe	Mn	Mo	N	Nb	Ni	P	S	Si	Ti	W
S20200 p. 9	-	0.15 max	-	17.0-19.0	-	bal	7.5-10.0	-	0.25 max	-	4.0-6.0	0.060 max	0.030 max	1.00 max	-	-
S30400 p. 2,9,12,14,16	-	0.08 max	-	18.0-20.0	-	bal	2.00 max	-	0.10 max	-	8.0-10.0	0.045 max	0.030 max	0.75 max	-	-
S30403 p. 10	-	0.03 max	-	18.0-20.0	-	bal	2.00 max	-	0.10 max	-	8.0-12.0	0.045 max	0.030 max	0.75 max	-	-
S31600 p. 5	-	0.08 max	-	16.0-18.0	-	bal	2.00 max.	2.00-3.00	0.10 max	-	10.0-14.0	0.045 max	0.030 max	0.75 max	-	-
S31603 p. 10	-	0.03 max	-	16.0-18.0	-	bal	2.00 max	2.00-3.00	0.10 max	-	10.0-14.0	0.045 max	0.030 max	0.75 max	-	-
S31635 p. 2	-	0.08 max	-	16.0-18.0	-	bal	2.00 max	2.00-3.00	-	-	10.0-14.0	0.045 max	0.030 max	0.75 max	5x(C+N) min 0.70 max	-
S32100 p. 10	-	0.08 max	-	17.0 19.0	-	bal	2.00 max	-	-	-	9.0-12.0	0.045 max	0.030 max	0.75 max	5x(C+N) min 0.70 max	-
S32205 p. 10	-	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. 10	-	0.030 max	-	24.0-26.0	0.50 max	bal	1.20 max	3.3-5.0	0.24-0.32	-	6.0-8.0	0.35 max	0.020 max	0.80 max	-	-
N08904 p. 10	-	0.020 max	-	19.0-23.0	1.00-2.00	bal	2.00 max	4.00-5.00	-	-	23.0-28.0	0.045 max	0.035 max	1.00 max	-	-
N08825 p. 10	0.2 max	0.05 max	-	19.5-23.5	1.5-3.0	22.0 min	1.0 max	2.5-3.5	-	-	38.0-46.0	0.03 max	0.03 max	0.5 max	0.6-1.2	-
N06625 p. 10	0.40 max	0.10 max	-	20.0-23.0	-	5.0 max	0.50 max	8.0-10.0	-	3.15-4.15	58.0 min	0.015 max	0.015 max	0.50 max	0.40 max	-
N10276 p. 10	-	0.01 max	2.5 max	14.5-16.5	-	4.0-7.0	1.0 max	15.0-17.0	-	-	bal	0.025 max	0.010 max	0.08 max	-	3.0-4.5

STAINLESS STEEL LEADS A STELLAR LUXURY DEVELOPMENT



Over 900 pieces of interlacing continuous panels made from Type 304 stainless steel gracefully wrap around the building's façade and residential balconies in a chevron-like design, creating a dynamic and sculptural work of art.

520 West 28th has transformed the architectural landscape in New York's West Chelsea with its striking glass and nickel-containing stainless steel façade.

The 11-storey, luxury residential building was designed by the late British-Iraqi and Pritzker Prize winning architect, Zaha Hadid, known for her abstract and circular form designs.

Located along High Line Park, the surrounding urban landscape was the main inspiration for the building's design. Unique to this L-shaped development is the split-level configuration and the façade's curves.

The Type 304 (UNS 30400) stainless steel features a blackened finish achieved by an antiquing process, light orbital brushing and hand tinting.

The panels were engineered, cut, welded and installed by Philadelphia-based fabrication group, M. Cohen and Sons. Over 350,000 man hours were invested to produce these and bring the architect's vision to life.

Stainless steel's functionality and durability provide a long-lasting solution. Its aesthetic appeal made it the material of choice to create the striking visual impact. In addition, stainless steel was specified to adapt it to its historically industrial Chelsea neighbourhood.

The building offers 39 loft-like units with amenities such as automated-valet car parking, a 23 metre sky lit swimming pool and New York city's only private IMAX theatre.

TIM FISHER PHTOTOGRAPHY