

# NICKEL

THE MAGAZINE DEVOTED TO NICKEL AND ITS APPLICATIONS

Ponte Malizia, Siena:  
Harmony and Durability

Water Bottles:  
For Health and Environment

The Big Bang:  
Particle Accelerator

July 2009 Vol. 24, N° 2



The Nickel Advantage  
in Stainless Steel:  
**It's what's inside**

**Ethanol's Evolution**  
and what it means to the  
nickel industry



# The Nickel Advantage

## With nickel you get...



... a wide range of **versatile stainless steels** in different families: the austenitic 300 and 200 series, duplex, PH grades

... stainless steels with proven **reliability** in tens of thousands of applications

... stainless steels combining **resistance to corrosion**, a wide range of mechanical properties from cryogenic to elevated temperatures and ease of fabrication

... stainless steels for **hygienic** equipment in the food, beverage and pharmaceutical industry, which can be cleaned with aggressive chemicals and ensure product purity

... stainless steels of the 18/8, 18/10 or 18/12 type associated with **high quality** in consumer goods

... stainless steels that meet the need for extreme **formability**

... stainless steels with very good **weldability** over a wide range of thicknesses

... stainless steels that are widely **available** in numerous product forms and sizes

... stainless steels that come in a wide variety of surface finishes and even colours for **impressive** results

... stainless steels that can have **low magnetic permeability** necessary for electronic applications and even medical implants

... stainless steels that provide **long-lasting value** and at end of use they have a **high intrinsic value** as scrap



... a wide range of other nickel alloys with **valuable engineering properties and uses**:

- nickel alloys for resistance to extreme corrosion and high temperature requirements
- copper-nickel alloys for anti-fouling resistance
- nickel-titanium alloys for shape memory
- iron-nickel alloys for low thermal expansion
- nickel plating
- nickel catalysts

**Together, the above attributes mean that with nickel you get a highly versatile material**



*Photography from top to bottom: Petronas Towers sourced by B-M, Cleanup Corporation, Johnsen Ultravac, Ron Arad Associates, Carl Pott*

# NICKEL

The Magazine Devoted to Nickel and its Applications

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Constructive Communications, Design

Circulation, 27,000 in 95 countries

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To receive e-mail notices for Nickel Magazine Online, please go to: [www.nickelonline.org/subscribe](http://www.nickelonline.org/subscribe)

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ISSN 0829-8351

Printed on recycled paper in Canada.

Cover:

Frank Gehry's Neuer Zollhof buildings, Dusseldorf  
Photo: iStockPhoto © eyewave

The next issue of Nickel Magazine will be available online Dec. 2009.



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## DEFENDING MARKET ACCESS AND PROMOTING USE

**THE NICKEL INSTITUTE HAS A NEW MISSION: TO ENSURE MARKET ACCESS FOR NICKEL THROUGH DEFENDING MARKETS AND PROMOTING USE OF NICKEL-CONTAINING MATERIALS.**

The Nickel Institute is being restructured in response to increasing legislation restricting the use of nickel and its compounds, and to enable the industry to weather current global economic conditions.

The activities of the Nickel Institute will be spearheaded from its main office in Brussels, Belgium, with additional locations in the USA, Canada and Asia to serve the needs of members and markets. The new structure of some 23 people will consist of three main divisions: Hazard Quantification and Classification headed by Dr. Hudson Bates; Regulatory Defence run by Hugo Waeterschoot; and Promotion managed by Dr. Peter Cutler, all reporting to myself as President of the Nickel Institute.

The reorganisation will enable the Nickel Institute to focus its activities on regulatory compliance, particularly with REACH and GHS (Globally Harmonised System of Classification and Labelling of Chemicals), while ensuring that nickel and its compounds are appropriately classified by these Regulations based on sound science. The new structure will be completed by the end of 2009.

The Nickel Institute will continue to support the users of nickel in meeting the requirements of health and environmental regulations as well as the technical standards needed to ensure that the product can be used to the most exacting of requirements.

Stephen Barnett

President, Nickel Institute

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### Please Note:

This will be the final print edition of Nickel magazine.

All future issues will be available online only.

Please register at [www.nickelonline.org/subscribe](http://www.nickelonline.org/subscribe) to receive email notification of future issues.

# Innovative nickel-based technologies contribute to the reduction of greenhouse gases

The Nickel Institute co-hosts a public debate in Brussels.

Timing is everything, as the saying goes. The Nickel Institute recently co-hosted a public debate on climate change with Friends of Europe, a major EU think tank, and the event's success owes a lot to its scheduling.

The debate took place December 18, 2008. Fortuitously, only days earlier, United Nation climate talks in Poznań, Poland, had come to an end and an energy-climate package was adopted by the EU Council and the Parliament.

La Bibliothèque Solvay in Brussels was filled to capacity as international experts debated the outlook for global climate policy. The event provided a perfect opportunity for the Nickel Institute to remind the regulatory community, the media and the public of the crucial role played by nickel-based technologies.

"Industry believes a life-cycle approach is the only way to get a comprehensive and accurate view of the issue," said a Nickel Institute spokesperson. "We need not only the picture but the movie. Producing nickel represents a significant investment and, from a sustainability perspective, there is a clear return on that investment."

"While we represent only a small part of the problem – about 0.1 per cent of greenhouse gas emissions – we are a significant part of the solution, both internally through the continuous improvement of our processes but primarily externally through

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"Nickel is a critical element of the five technologies recommended by the International Panel on Climate Change for meeting global greenhouse gas reduction targets."

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the contribution of nickel products to the sustainability goals of society."

Nickel is a critical element of the five technologies recommended by the International Panel on Climate Change for meeting global greenhouse gas reduction targets. These include gas-fired plants, nuclear energy, fuel-efficient cars, ethanol production, and carbon capture and sequestration.

The Nickel Institute argued for a level regulatory playing field in order to preserve the competitiveness of global industries. All the speakers, including Stuart Eizenstat, the U.S. ambassador to the European Union from 1993 to 1996, and Jim Currie, former Director General at the European Commission with responsibility for the EU's environmental policy, were in agreement that reducing carbon dioxide emissions requires a global solution.

The world is waiting to see what comes of the next round of climate talks. One thing is certain: industry needs to be a part of the debate as well as a part of the solution. As for nickel, it is clear it plays an important role in advancing clean power and energy efficiency, which are central goals in the global effort to tackle climate change.

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For more information please go to:  
[www.nickelmagazine.org/climate](http://www.nickelmagazine.org/climate)

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## Combining Aesthetics, Function and Sustainability

Stainless steel bridges add beauty to Italian locations

Utilitarian design has its own aesthetic, though often engineers grapple with the tension between economics and the desire to build structures that are compatible with the surrounding environment.

When the environment is as historic and beautiful as Italy's, aesthetic choices assume new importance. If the existing harmony is not to be disrupted, consideration must be given to modern engineering requirements as well as to the preservation of historical buildings and the surrounding environment.

### Siena and Padova

Stainless steel bridges recently built in the Italian provinces of Siena and Padova offer a beautiful illustration of how structures can be made to blend in with their surroundings. Crossing rivers and railways, the fluid arcs of these bridges create a refined and delicate impression.

The Chianti region, situated midway between Florence and Siena and famous for its wine, has some of the most beautiful countryside in Italy. Siena's provincial capital, which goes by the same name, is surrounded by olive groves and the vineyards of Chianti. Perched on three hills with winding alleyways, steep steps, and historic landmarks, it is one of the most beautiful cities in Tuscany. Few towns rival its beauty. In addition to vineyards and olive trees, Siena is noted for its harsh rock formations, captivating coastline, and nature reserves.

It is largely for aesthetic reasons that the municipality of Siena chooses to use stainless steel in many of its infrastructure projects. City planners have taken advantage of the unique properties offered by lean duplex stainless steels.

Although duplex grades are mainly associated with industrial applications, duplex Uranus® 35N (S32304), produced by ArcelorMittal-Industeel in France, was recently used to build a bridge in Siena.

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**The bridge's stainless steel tubular arcs, which consist of some 110 tons of S32304 will require minimal maintenance.**

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Consisting of 23% chromium and 4% nickel, this lean duplex grade has excellent atmospheric corrosion resistance – equivalent to that of 316L (S31603). S32304 is about twice as strong as S31603, is easily fabricated and is highly resistant to fatigue. The bridge's stainless steel tubular arcs, which consist of some 110 tons of S32304 will require minimal maintenance.

Duplex S32304 was also used in the recent construction of a bridge in the province of Padova. Other parts of this bridge have an external sheathing of AISI 304 (S30400) stainless steel which again, translates into minimal maintenance.

### Designing for the environment

Metallic bridges are typically designed and built to last 100-200 years, so durability is essential. Decision-makers are well aware that choosing the right materials can ensure long-term cost-efficiency. The use

of stainless steel in construction guarantees corrosion resistance and durability while satisfying sustainability criteria.

Using duplex stainless steel, in particular, helps ensure environmental sustainability. It is 100% recyclable and does not degrade. Stainless steel in infrastructure construction not only offers life-cycle cost advantages over other materials, it enables the design of sophisticated creations that please even the most demanding eye.

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**For more information please go to: [www.nickelmagazine.org/pontemaliza](http://www.nickelmagazine.org/pontemaliza)**

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*Ponte Malizia in Siena is built with an ecological sustainability approach.*



# The Nickel Advantage

Chromium provides the basic corrosion resistance that makes stainless steel “stainless.” Yet about two thirds of the stainless steel produced today contains nickel. In the following pages we present examples which illustrate the benefits offered by nickel-containing stainless steel.

When choosing a material, corrosion resistance is only part of the picture. You must be able to make the article easily and it may need other properties. It is the nickel in the familiar 18/8 grade (Type 304) of stainless steel (18% chromium, 8% nickel) which gives an austenitic structure which allows the alloy to be easily formed into complex shapes, easily welded in thin and thick sections, and to be used from very low to high temperatures without becoming brittle. The 18/8 alloy is also easily produced, familiar to users and widely available. For these reasons it is probably the most widely used grade around the world.

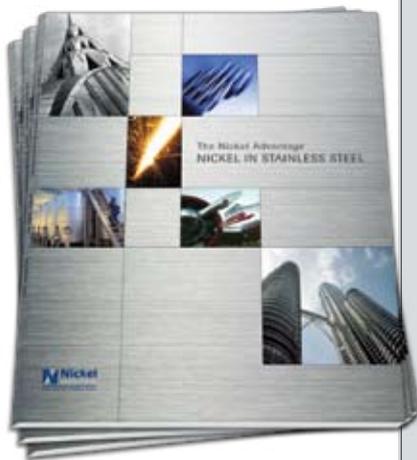
Other aspects may need to be considered. Austenitic grades become stronger when deformed. That means that cold-worked material can be used to make lighter structures. A lot of energy is absorbed when it is deformed, which can be useful in designing vehicle structures that provide protection in the event of crashes.

Aesthetics are important too. Look around any modern city. The appearance of nickel-containing austenitic stainless steels has made them popular in a variety of surface finishes for architectural applications as well as in the home.

There are other types of stainless steel. With low or very low nickel – and in the absence of other elements like manganese or nitrogen that stabilise the austenite structure – stainless steel has a ferrite structure. Intermediate nickel contents then give a mixed austenitic plus ferritic – or duplex – structure. Nickel has an important role in determining the structure and properties of most of these grades.

Their corrosion resistance also ensures that,

*continued on page 15*



## In the beginning . . .

Probing the origins of the Universe

Late in 2009 scientists hope to recreate conditions nearer to the “Big Bang” than ever before achieved. The implications for our understanding of elemental physics are enormous . . . as are all the innovations that could flow from such understanding.

In their experiments, scientists and engineers will be depending on special nickel-containing grades of stainless steel to help keep the fast-moving particle beams from straying off course.

Two high-alloy stainless steels supplied by ThyssenKrupp Nirosta GmbH of Krefeld, Germany, are able to withstand the extreme conditions that will occur in the 27-kilometre circular tunnel of the US\$2-billion Large Hadron Collider (LHC), the world’s largest particle accelerator, as scientists seek to understand the origin of the universe.

The experiment will attempt to recreate conditions moments after the Big Bang by accelerating protons to a whisker below the speed of light in opposite directions in two separate vacuum pipes 100 metres beneath the Jura Mountains which straddle Switzerland and France. There are 4 separate areas where the protons can collide and the experiments can be closely observed by scientists.

**In their experiments, scientists and engineers will be depending on special nickel-containing grades of stainless steel to help keep the fast-moving particle beams from straying off course.**

### Extreme operating conditions

About 500 magnets fabricated using 860 tons of Nirosta® 4375 (EN No.1.4375), a manganese-containing austenitic stainless steel will produce fields to accelerate and guide the particles. This alloy can withstand the near absolute zero (minus 271° Celsius) temperatures and the strong forces within the magnet coil, while its low magnetic permeability ensures the steel itself does not become magnetized.

“This special high quality material was essential for the smooth production and outstanding properties of the magnets,” says Detlef Krischel, senior manager of ACCEL Instruments, responsible for the magnets.

*continued on page 15*

## Enter the Dragon

Sculptor Kevin Stone uses stainless steel to turn fantasy into reality

One of Canada's most promising new artists, Kevin Stone, is attracting international attention for the massive, visionary sculptures of fantasy figures he forges out of nickel-containing stainless steel.

A metallurgy graduate, Stone honed his craft as a specialty metal fabricator over 18 years. In 2005, at the age of 35, he decided to combine his years of welding experience with a lifelong passion for fantasy art by devoting himself entirely to sculpture.

Stone constructs his pieces from hundreds of highly reflective stainless steel components which he has patiently designed and fabricated. His works are formidable in scale and produce a striking interplay of reflected light wherever they are placed.

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**"I need to know that my pieces can handle the elements, and they can. They'll last for a hundred or more years – that's how corrosion-resistant stainless steel is."**

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Stone's newest creation, the Chinese Imperial Water Dragon, came to life in his Metal Animation studio in southern British Columbia. It stands 3.6-4.2 metres tall with a width and length of 5.7 metres and 10.5 metres, respectively. The sculpture is comprised of roughly 324 sq. metres of 1.5 millimetre 304 (S30400) stainless steel.

### Why stainless steel?

Stone prefers to work with a durable material such as stainless as it allows him to

produce pieces of timeless quality while still capturing fine details and realism.

"A lot of my work as a professional welder was with stainless steel – polishing welds, grinding welds, bending, and so on. . . . The corrosion-resistance of stainless is important to me. I need to know that my pieces can handle the elements, and they can. They'll last for a hundred or more years – that's how corrosion-resistant stainless steel is."

Stone capitalizes on the reflective qualities of stainless steel by mirror-polishing all his pieces by hand.

"The polishing is crucial because ideally my pieces will be displayed over water with different-coloured lights dancing off of them. They look especially striking at night in a fountain environment. I tend to envision them either indoors or outdoors in a Las Vegas-type setting."

### Labour intensive and requiring skill

All of the pieces in Stone's sculptures are cut by hand using a power shear or a grinder with a cut-off wheel, then carefully fit and tack-welded into place using a gas tungsten arc welding machine. After all the welding is completed, he grinds down the welds and starts the multi-step process of polishing the metal with finer and finer grit polishing pads, ultimately resulting in a gorgeous mirror finish.



"Thin stainless is tricky to weld. You have to take care to avoid overheating and burning through it," Stone says. "It also requires polishing to bring out its beauty, which is labour-intensive. But the effort is worthwhile because, once polished, the pieces are ready for the elements: they won't corrode, rust or lose their mirror-like quality."

He adds that since stainless steel is a better insulator than carbon steel used by most welders, maintaining a low heat input when welding is critical.

Stone has no intention of slowing down. In fact he hopes to build a bigger studio to house his creations – one large enough for an overhead crane.

"I'm just a new artist on the scene trying to make a name for himself. Doing the largest stainless steel pieces in the world – and doing them on a highly detailed level – is something I hope to be known for."

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**For more information please go to:  
[www.nickelmagazine.org/dragon](http://www.nickelmagazine.org/dragon)**

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PHOTO: KEVIN STONE, METAL ANIMATION

PHOTO: KEVIN STONE, METAL ANIMATION

# Ethanol's Evolution

Expansion of the ethanol industry means higher demand for nickel-containing stainless steel

The rise in the production of fuel ethanol has been both extraordinary and controversial. Seen as an important part of the solution for climate change and domestic energy security, fuel ethanol has also been blamed for the spike in food prices that took place in 2008. New policy developments have led to new technology developments. Whatever balance of fuels emerges in the long term, there will be a continuing contribution from nickel-containing stainless steels.

Ethanol is an increasingly common bio-fuel alternative to gasoline in many parts of the world. While fuel ethanol production in the United States is almost exclusively derived from corn, Brazil produces almost as much ethanol using sugar cane, and in the EU wheat is an important part of the feedstock mix.

Ethanol is an attractive fuel because it comes from renewable sources. The use of ethanol as an additive to petroleum-based fuels can also result in cleaner burning with less emission of carbon monoxide and particulates. For the United States, ethanol production has also been encouraged as a way to decrease dependence on oil, and thereby improve national security.

### Construction Boom

As a result of the U.S. Energy Policy Act of 2005, which called for increasing volumes of ethanol to be blended with the U.S. fuel supply, a construction boom took place in the U.S. in 2004 to mid-2008 which generated considerable demand for stainless steel. It is estimated that the ethanol industry in the U.S. used about 227,000 tonnes of stainless steel in this same period. Some 60% of this tonnage was in stainless plate; 27% went

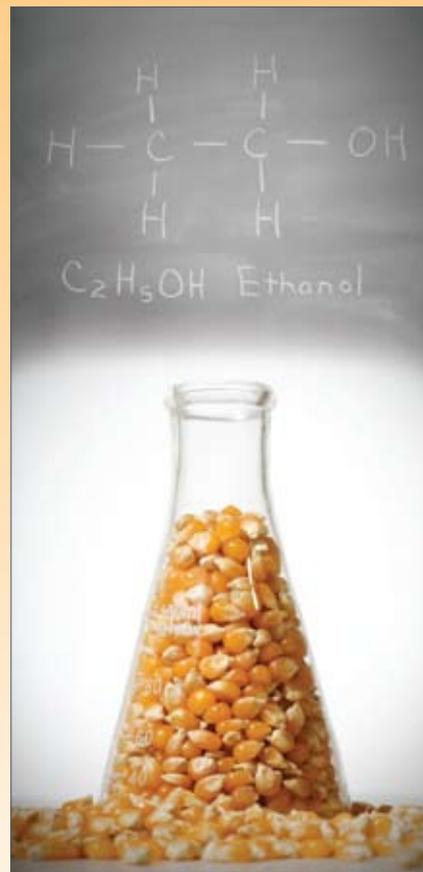
into pipe; and the remainder took the form of tubes and fittings and the like.

The operating conditions of an ethanol from corn plant are not particularly corrosive to most stainless steels: pH ranges from 5.8 to 2 in most areas and, with a few exceptions, temperatures are relatively low. Therefore 304L (S30403) is by far the most commonly used grade of stainless steel, accounting for some 90% of total stainless usage in an ethanol plant. The remaining 10% is mainly 316L (S31603). There are also small

### More than two hundred ethanol plants exist in the United States.

applications for Alloy 20 (N08020), various duplex grades, and some ferritic grades. Pure ethanol is quite non-corrosive, but it is very hygroscopic, i.e. absorbs water. Certain impurities from the bioethanol process, such as organic acids, sulphuric acid and chloride-containing salt, will concentrate in the water phase, making it quite corrosive to carbon steel.

A 400-million-litre-per-year ethanol plant would typically require about 1,600-2,300 tonnes of stainless steel. Applications for stainless steel include equipment such as corn steepers, centrifuges, filters, mixers, dryers and evaporators. Stainless steel tanks at various stages of production include liquefaction, fermentation, yeast slurry, beer well, washing, stillage, centrate surge and syrup tanks. Heavy walled tanks are candidates for lean duplex stainless steel, which has higher strength than the standard 300 series alloys. Most piping systems, including pumps and



PHOTOS: ISTOCK PHOTO © ROBERT KYLLO © DAVID FREUND COMPOSITION: CONSTRUCTIVE COMMUNICATIONS

valves, are stainless steel.

### Ongoing development and trends

Criticism of grain ethanol production grew in 2007-2008 as industry critics linked rising world food prices to the diversion of corn to ethanol production. Industry critics linked increased grain consumption and higher grain prices to the production of ethanol. Corn-based ethanol was also criticized for its life cycle environmental impacts. It was disputed whether corn-based ethanol as an automotive fuel increases rather than reduces greenhouse gas emissions, particularly when forests are converted into farm land.

Although it is now suggested by some that high and rising grain prices were driven more by strong global economic growth and oil and gas prices than by the demand for ethanol, governments have been forced to examine the full life cycle impacts of the bio-fuels that are produced.

In 2007, the Energy Independence and Security Act (EISA) was passed in the U.S. The legislation increased the renewable fuel

# Feature: The Nickel Advantage

standard to 163 billion litres (36 billion gallons) by 2022. In response to the criticism facing the ethanol industry, EISA capped corn-based ethanol consumption in the U.S. at 68 billion litres (15 billion gallons) per year by 2015. This revised legislation continued to create the conditions for the U.S. bio-fuels industry to expand, while encouraging research and development into producing ethanol from alternative sources such as cellulose.

Producing ethanol from cellulose is a new approach which may alleviate concerns about using forest land or food to produce fuel. Cellulosic ethanol can be produced from any plant material – including waste agricultural material such as corn stalks – potentially doubling yields and reducing its impact on climate change.

## Evolution of material demands

Cellulosic biomass requires pretreatment before it can be converted into fermentable sugars. There is an array of pretreatment processes, many of them involving corrosive environments. Regardless of the technology used to break down the bio-mass in order to release the sugars, whether it's acid hydrolysis or enzymatic hydrolysis, pretreatment tanks will be required as part of the production process. In the case of acid hydrolysis, the operating conditions will be quite corrosive as a result of high temperatures and sulphuric acid present in the operating media (2% sulphuric acid). Acid hydrolysis tanks for small-scale pilot and demonstration plants have been constructed from Alloy C-276 (N10276) and super-duplex grades. Other acids are being considered which may result in other grades of stainless being used. The pretreatment tanks for enzymatic hydrolyses are expected to be made from 316 stainless, though other grades such as duplex 2205 (S32205) may also be considered.

Process technologies for the production

of cellulosic ethanol are still at the development stage. Although the first commercial cellulosic plants are being built, large scale, cost-competitive, commercial production of cellulosic ethanol is not expected to get under way until 2-5 years from now.

## Enter the Obama Administration

As part of the American Recovery and Reinvestment Act of 2009, passed in February, U.S. President Barack Obama included US\$58 billion to be devoted to energy investments in the coming years. Of that amount, at least \$800 million is to be directed specifically at biomass-driven energy projects. President Obama has also declared that the government will invest US\$15 billion annually to develop renewable energy technologies, including advanced bio-fuels and fuel-efficient vehicles.

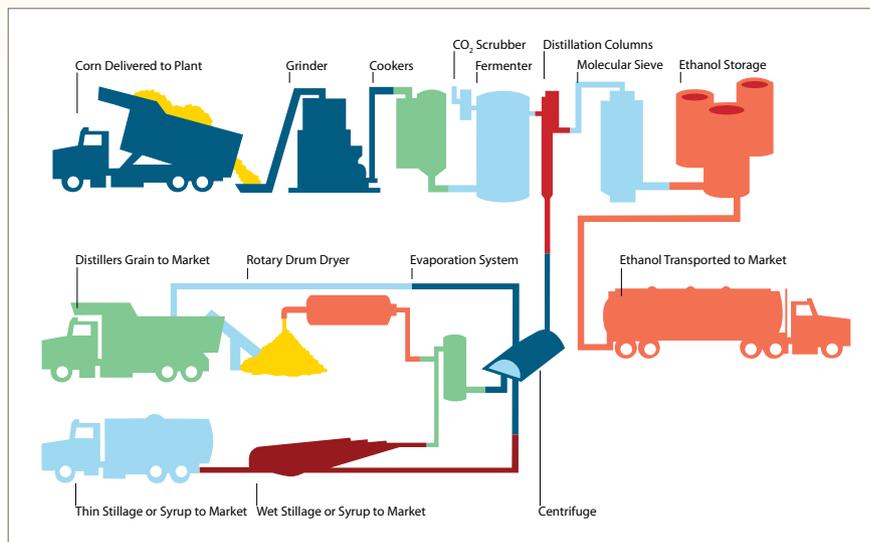
## More change to come

The ethanol industry, both in the U.S. and internationally, will require considerable quantities of stainless steel over the next 10-

12 years. In the U.S. alone, the bio-fuels industry is expected to require about 500,000 tons of stainless. The bio-fuels industry in North America will remain a key end-use market for stainless steel; it is forecast to account for half of global production growth in bio-fuels over the next 20 years. Ethanol process technology companies like the way 304L performs and perceive it to be both reliable and cost-effective. With the advent of cellulosic ethanol, 316L stainless will certainly play an increasingly important role.

The fuel mix used by societies in the 21st century will not resemble those of the late 20th. While technological progress and political priorities may favour certain alternatives at different times, what remains constant is the need for nickel-containing materials to provide the performance needed to produce them.

For more information please go to:  
[www.nickelmagazine.org/ethanol](http://www.nickelmagazine.org/ethanol)



*Dry Milling*

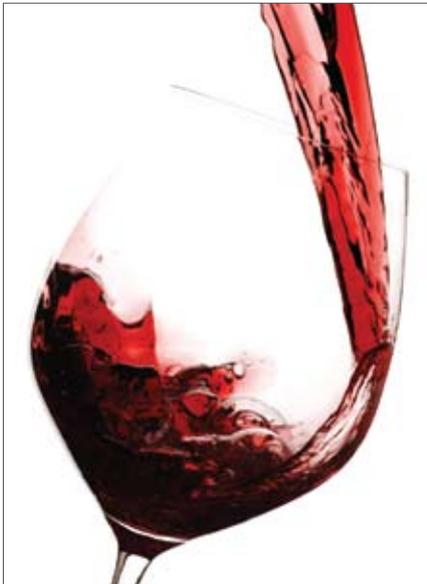
## Blending Tradition and Progress

### Winemaking with a new stainless steel surface finish

Success in winemaking does not come easily. Winemakers must not only consider the grape variety, but also the specific terroir (geographical conditions) from which the grapes came and the season in which they were picked when planning the blending and aging processes that will be used to develop the flavour of the wine.

One major concern is undesired effects from the materials that come in contact with the wine during the production process. Winemakers must carefully select the materials they use; otherwise they risk altering the wine's organoleptic characteristics (taste, smell, colour, and so on). The materials used for the wine tanks and the detergents and solutions used to clean them must undergo a range of tests to ensure that they will have no effect on the taste or aroma of the wine.

*Wine tanks fabricated with InoxWINE™ finish*



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**Stainless steel has long been the material of choice for key parts of the winemaking process, largely owing to its easy cleanability.**

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Winemakers pay careful attention to costs, but also to their environmental footprint during wine production, for example as it relates to cleaning of equipment.

#### **A better surface finish for stainless steel**

Stainless steel has long been the material of choice for key parts of the winemaking process, largely owing to its easy cleanability. What's more, it is possible to optimize surface finishes for specific applications such as wine making.

One such proprietary stainless surface finish is InoxWINE™ from ThyssenKrupp Acciai Speciali Terni. This special surface finish, which can be produced on 304 (S30400) or 316L (S31603) cold-rolled stainless sheet, was developed after carrying out laboratory simulations of conditions used in winemaking processes. One particular issue focused on the formation of potassium bitartrate on equipment walls, and its ease of removal from various surface finishes.

The cleaning and maintenance of wine tanks require the use of large amounts of water-containing cleaning chemicals, which must be handled and disposed of carefully. The washing of tanks with this new finish is claimed to require less chemical and water usage, resulting in reduced waste disposal. The shorter washing cycle means the tanks are available for re-use sooner; which increases productivity, and reduces labour requirements.

#### **Quality with efficiency**

For winemakers around the world, success requires the manipulation of the variables nature provides and the management (or exclusion) of variables that can interfere with the desired result. Stainless steels with appropriate finishes enable the winemakers to concentrate on the things that make their products so unique to their regions and so special to those who love their wines.

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**For more information please go to:**  
[www.nickelmagazine.org/inoxwine](http://www.nickelmagazine.org/inoxwine)

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# Europe Recognises Mobile Phone Dermatitis

Nickel Institute actively involved in regulatory step, making its stewardship efforts a reality

For many of us, discovering that we've left home without our mobile phone is a little like feeling only half-dressed. We at least feel as if we're missing a fundamental accessory. Although nickel comprises only 1% of the total weight of a mobile phone, it helps enable this twenty-four/seven form of communication in a number of important ways. Nickel is used in electrical connectors and capacitors, and can be a major or minor element in a phone's battery. It is also used to shield users and equipment from electro-magnetic radiation.

At the same time, there is one area where nickel should not be used: on the outside surfaces of mobile or cell phones. About 8.6% of the general population have an allergy to nickel. In some cases, and in the event of prolonged, direct contact with the skin, this allergy can cause rashes. Most commonly, it is women who experience this reaction after wearing nickel-plated jewellery.

It was in 2000 that the Nickel Institute first learned that nickel-allergic individuals were at risk of suffering a reaction due to skin contact with their mobile phones. A report from Italy in the scientific journal Contact Dermatitis described two cases of nickel dermatitis on a patient's ear.

Following the publication of that report, the Nickel Institute contacted several major manufacturers of mobile phones, provided them with copies of the article, and suggested a review of their material choices. That may seem like an unusual reaction for an industry association; however, by 2000, the Nickel Institute had a decade of experience as an active product steward and had established a clear policy to discourage inappropriate use of nickel.

The Nickel Institute's early progress in this area can be explained by its active involvement in the review of the EU Nickel Directive, a piece of European legislation designed to protect

the public from nickel allergy. The review of the Nickel Directive, completed in 1994, incorporated the Nickel Institute's scientific argument that it is the release of nickel ions when exposed to sweat, and not the nickel content, that determines the risk to the consumer.

This is an important distinction. Prior to the review, the Nickel Direc-

"by 2000, the Nickel Institute had a decade of experience as an active product steward and had established a clear policy to discourage inappropriate use of nickel."

utive had set a limit on the percentage of nickel contained in a product. That meant that nickel-containing stainless steel, even higher corrosion resistant grades such as 316 (S31600), could not be used in skin contact applications. This hardly made any sense as wrist watch cases have been made of nickel-containing stainless steels for years. Therefore, the Nickel Institute, together with the stainless steel industry and the medical community, set out to ensure, through advocacy initiatives, that the law would be based on sound science.

But what the 1994 revision of the Nickel Directive didn't include was mention of mobile phones. Remember that, at the time, mobile phones were much larger than today's slim models. There was no colour, no memory card, and the handset had to have an extendible antenna. Many were designed for permanent installation in vehicles, hence the popular term "car phone."

Today's mobile phones are smaller and more sophisticated, and there are in excess of 4 billion of them in use worldwide. Mobile phones are used for personal and business communications, as well as for entertainment. New applications are being developed daily, further increasing the amount of time people spend on their phones.

As a result of this dramatic change in consumer habits, the Euro-

pean Commission was asked, in December 2008, to clarify whether or not the Nickel Directive covers mobile phones. After considering input from the Nickel Institute, the Commission agreed that mobile phones fulfill the condition of "direct and prolonged contact with the skin" and even went on to say that they are "used on a daily basis often for prolonged periods of time."

Mark Mistry, the Nickel Institute's EU Director of Sustainability, based in Brussels, says the recent announcement creates a welcome opportunity for the industry to work with mobile phone manufacturers. "It remains ever-important that nickel be used in appropriate applications – for the important value it brings to society, and not where it poses a risk to public health," he says.

For more information please go to:  
[www.nickelmagazine.org/mobile](http://www.nickelmagazine.org/mobile)



PHOTOS: STOCK PHOTO © LUCA DI FILIPPO

# Stainless steel water bottle market soars



## A healthy and green choice

FDA investigation. They have responded swiftly to consumer demand by taking plastic water bottles off their shelves and replacing them with metal ones.

“I think there’s a lot of room for stainless bottles in the marketplace,” says John Steed, product manager for Guyot. “More and more people are concerned about plastic in general now. The BPA scare put a lot of metal bottles on

On top of being a healthy choice, stainless steel is a better environmental alternative to plastic because the alloy lasts a long time and is readily recyclable.

shelves, and that, in and of itself, seems to reinforce people’s concerns.”

Although aluminum is another alternative to plastic in bottles, the metal has to be lined – commonly with a BPA-containing epoxy resin.

Guyot’s bottles are made from 316L (S31603) stainless steel, a grade that is highly resistant to corrosion. California-based Klean Kanteen, Guyot’s largest competitor, uses food-grade 304 (S30400) stainless steel also called 18/8. Both of these stainless steel grades are commonly used in other food-contact applications such as cutlery, cookware, commercial food processing equipment, as well as water treatment and distribution systems.

## Other benefits

On top of being a healthy choice, stainless steel is a better environmental alternative to plastic because the alloy lasts a long time and is readily recyclable. Customers have the opportunity to return old bottles so that Guyot can have them recycled, closing the life cycle loop.

“Stainless steel is durable, so it lasts longer and is fully reclaimable, thus kept out of a landfill when the bottle is at the end of its useful life,” says Steed.

Stainless steel has other advantages. It is easy to clean, sanitary, and doesn’t pick up flavours from the substances contained in the bottle. Along with the health and environmental benefits, those features should solidify stainless steel’s high standing in the water bottle market for a long time to come.

**For more information please go to:**  
[www.nickelmagazine.org/guyot](http://www.nickelmagazine.org/guyot)

## How Green is my Bottle?

The New York Times took an in-depth look at the issue of stainless steel containers versus plastic bottles. The article was authored by Daniel Goleman (author of *Ecological Intelligence: How Knowing the Hidden Impacts of What We Buy Can Change Everything*) and Gregory Norris (professor of Industrial Ecology at the University of Arkansas). The authors’ conclusion: “If your stainless steel bottle takes the place of 50 plastic bottles, the climate is better off, and if it gets used 500 times, it beats plastic in all the environment-impact categories studied in a life cycle assessment.”

When Guyot Designs started making stainless steel water bottles in 2005, the Maine, U.S.A.-based company was promoting a greener alternative to plastic, one that would last longer and be recycled more easily. Little did they know that their bottles would soon be in hot demand for health and safety reasons.

In 2007, Canada decided to reassess the safety of bisphenol A (BPA), a compound used in the manufacture of polycarbonate plastics found in household items such as baby bottles, water bottles, and food storage containers. The announcement triggered a response by retailers, and suddenly sales of Guyot’s stainless steel bottles were soaring.

As a precautionary measure, Canada added the chemical to its list of toxic substances in 2008 and, after declaring BPA safe in its current use, the Food and Drug Administration (FDA) in the U.S. is now reconsidering the issue.

## Consumer responses

Retailers, including high-profile names such as Wal-Mart and Toys “R” Us, are not waiting for the results of the

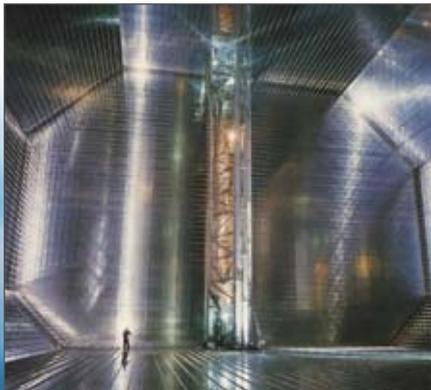
# Massive Q-Max carriers

The transportation of liquefied natural gas enters a new era.

When it comes to shipping liquefied natural gas to distant markets, bigger is better. Large-scale tankers save energy, produce less carbon emissions, and ensure that nearly 100% of the cargoes arrive at their destinations.

These are among the advantages of a new generation of LNG tanker known as the Q-Max, designed to carry 80% more gas than conventional carriers while reducing transport costs by as much as one-third.

The first Q-Max vessel, named Mozah, was delivered in December 2008 to Exxon Mobil Corp., which developed the giant ships in partnership with Qatar Petroleum. It will deliver the Persian Gulf state's natural gas to markets in Europe and North America. Each ship is longer than three football fields, stands 20 stories high from keel to the tip of the mast,



△The membrane is fashioned from one of two nickel alloys.

The first Q-Max carrier, Mozah▷

and boasts a storage capacity of 266,000 cubic metres – enough gas to supply the energy needs of 70,000 American homes for a year.

That's almost double the capacity of the largest LNG carriers to enter service in the past three decades. In the words of Neil Duffin, president of Exxon Mobil Development Co., the Q-Max carriers "break the LNG shipping mould in nearly every way."

## Demanding environment, impressive scale

Q-Max carriers store natural gas in the largest on-board LNG tanks ever built. For storage purposes, the natural gas is cooled to  $-163^{\circ}\text{C}$ , which transforms it into a liquid and reduces its volume to one six-hundredth of its gaseous state. Each tank is 48 metres wide, 28 metres high and 58 metres long and lined with a thin metal membrane.

The membrane is fashioned from one of two nickel-containing alloys, depending on the shipyard. One is 304L (S30403) stainless which is 1.2 millimetres thick with a corrugated surface that will allow for contraction on contact with the LNG. The stainless covers stacked foam panels. The other uses a double membrane of 0.7-mm thick nickel-iron Invar® (K93600) alloy which covers stacked plywood boxes that are filled with insulation. With 36% nickel and 64% iron, this alloy is quite special

"Each ship is longer than three football fields, stands 20 stories high from keel to the tip of the mast, and boasts a storage capacity of 266,000 cubic metres."

in that it has the property of an extremely low thermal expansion and contraction rate. About 700 tonnes of metal are needed for the tanks of a single Q-Max carrier. In both cases, the insulated tanks will have the same effect as a gigantic thermos bottle, keeping the contents cold during the voyage.

"Both these materials were chosen for their toughness and ductility at cryogenic temperatures," notes Exxon spokesperson Kimberly Johnson Brasington. "The 36 per cent nickel steel alloy has the advantage of having an extremely low coefficient of thermal expansion."

## Technological innovation

Q-Max designers have employed a number of technical innovations. Some LNG vaporizes during transit and other classes of carrier use it to power the ship, but during the long voyage from Qatar to the United States, up to 5% of the cargo could revert to gas and be

*continued on page 15*



## Invar® & Steel Alloy Game

**Q: What is an alloy?**

**Q: What kind of ingredients could a steel alloy have?**

**Q: What different kinds of steel alloys are there?**

**Q: What are the different steel alloys used for?**

This online game available at: [http://nobelprize.org/educational\\_games/physics/steel/](http://nobelprize.org/educational_games/physics/steel/) is a crash course in how to make steel alloys. Alloys are mixtures of substances in which the resulting material has

metallic properties. They are usually produced by melting the mixture of ingredients. Steel, brass and amalgam are a few examples of alloys. Invar, from the word "invariable", is a special steel alloy – used today in toasters and CRT-monitors, for example. In the game you will be given "an order" to make a special steel product – a different product each time you play. Your mission will be to find the steel alloy that suits this product best, mix the "ingredients", and finally, try to place as many molds as possible on a "steel dough". If you're quick at making alloys you could end up on the all-time high score list!



Online Invar® & Steel Alloy Game

The Invar & Steel Alloys educational game and related reading are based on the 1920 Nobel Prize in Physics awarded for discovering the steel alloy Invar.

For more information please go to: [www.nickelmagazine.org/invar](http://www.nickelmagazine.org/invar)

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WATCH nine short nickel videos on YouTube. Search for "Nickel Institute" and visit the Nickel Institute Channel. Includes our new "Climate Action" video, three BBC World commercials and three recyclable stainless steel commercials.  
[www.youtube.com/user/NickelInstitute](http://www.youtube.com/user/NickelInstitute)

## Stainless Steel in Construction Information Centre

The Steel Construction Institute (SCI) has recently launched an online Information Centre for Stainless Steel in Construction. The Information Centre, [www.stainlessconstruction.com](http://www.stainlessconstruction.com), is designed to encourage practitioners to use stainless steel by helping them find information on successful applications and technical guidance on specifying, designing, fabricating and installing stainless steel.

The Information Centre provides access to a wide range of up-to-date information for architects, engineers, fabricators, installers and academics, including technical guidance, design software, design data, case studies and research papers.



For more information please go to: [www.nickelmagazine.org/ssinfocentre](http://www.nickelmagazine.org/ssinfocentre)

## UNS details Chemical compositions (in percent by weight) of the nickel-containing alloys and stainless steels mentioned in this issue of Nickel.

Alloy	Al	B	C	Co	Cr	Cu	Fe	Mn	Mo	Nb	N	Ni	P	Pb	S	Si	Sn	Ti	V	W	Zn	Zr	Other
<b>K93600</b> p. 13	-	-	-	-	-	-	64	-	-	-	-	36	-	-	-	-	-	-	-	-	-	-	-
<b>N10276</b> p. 9	-	-	0.02 max	2.5 max	14.5- 16.5	-	4.0- 7.0	1.00 max	15.0- 17.0	-	-	rem	0.030 max	-	0.030 max	0.08 max	-	-	0.35 max	3.0- 4.5	-	-	-
<b>N08020</b> p. 8	-	-	0.07 max	-	19.00- 21.00	3.00- 4.00	bal. max	2.00 max	2.00- 3.00	min 8 x C max 1.00	-	32.00- 38.00	0.045 max	-	0.035 max	1.00 max	-	-	-	-	-	-	-
<b>S30400</b> p. 5,7,10,12	-	-	0.08 max	-	18.00- 20.00	-	-	2.00 max	-	-	-	8.00- 10.50	0.045 max	-	0.030 max	1.00 max	-	-	-	-	-	-	-
<b>S30403</b> p. 6, 8, 13	-	-	0.03 max	-	18.00- 20.00	-	-	2.00 max	-	-	-	8.00- 12.00	0.045 max	-	0.030 max	1.00 max	-	-	-	-	-	-	-
<b>S31600</b> p. 11	-	-	0.08 max	-	16.0- 18.0	-	-	2.00 max	2.00- 3.00	-	-	10.00- 14.00	0.045 max	-	0.030 max	1.00 max	-	-	-	-	-	-	-
<b>S31603</b> p. 5,8,10,12	-	-	0.030 max	-	16.0- 18.0	-	-	2.00 max	2.00- 3.00	-	-	10.00- 14.00	0.045 max	-	0.030 max	1.00 max	-	-	-	-	-	-	-
<b>S32205</b> p. 9	-	-	0.030 max	-	22.0- 23.0	-	-	2.00 max	3.00- 3.50	-	0.14- 0.20	4.50- 6.50	0.030 max	-	0.020 max	1.00 max	-	-	-	-	-	-	-
<b>S32304</b> p. 5	-	-	0.03 max	-	21.5- 24.5	0.05- 0.60	-	2.50 max	0.05- 0.60	-	0.05- 0.20	3.00- 5.50	0.040 max	-	0.040 max	1.00 max	-	-	-	-	-	-	-
<b>EN 1.4375</b> p. 6	-	-	0.040 max	-	19.00- 21.00	-	-	8.00- 10.00	-	-	0.30- 0.45	6.00- 8.00	0.045 max	-	0.015 max	1.00 max	-	-	-	-	-	-	-

## NI Consultant Jim Jenkins Receives LaQue Award



The Sea Horse Institute's Francis L. LaQue Award was presented to James F. "Jim" Jenkins at the 55th Sea Horse Marine Corrosion Conference, held in Daytona Beach, Florida, USA, October 26 – 30, 2008.

Jim was employed by the U.S. Navy for thirty years. His responsibilities included research in deep ocean corrosion and the application of corrosion engineering to a wide variety of U. S. Navy facilities. Jim has been a consultant to the Nickel Institute since 1995. He has authored or co-authored a large number of publications, including many guidelines for controlling corrosion in marine service. Jim is a NACE Certified Corrosion specialist and a registered Professional Engineer in Corrosion (California).

**For more information please go to:**  
[www.nickelmagazine.org/laque](http://www.nickelmagazine.org/laque)

### The Nickel Advantage cont'd

correctly used, stainless steel items will be in service for many years. This durability means they have a big part to play in developing a more sustainable society: improving energy efficiency, reducing pollution, reducing the use of materials. Furthermore, the value of all the alloying elements – not just the nickel – provides a strong incentive to collect the items at the end of their lives and to recycle the stainless steel. Indeed, stainless steel is one of the most recycled of all materials. The amount of stainless available for recycling is only

limited because so many stainless steel items are still in use after many years.

Nickel plays a critical role in providing the combinations of properties that make stainless steel one of the fastest growing materials in use today and an important solution to the sustainability challenges that the world is facing.

**For more information please go to:**  
[www.nickelmagazine.org/niadveditorial](http://www.nickelmagazine.org/niadveditorial)

### In the beginning... cont'd

Stainless steel is also a crucial component of the pipes that carry liquid helium to cool the magnets. To develop magnetic fields high enough to accelerate the particles to close to the speed of light, the magnet coils must be cooled to near absolute zero so that they can become superconducting and transfer almost all of their energy into magnetic fields. The distribution system of pipes that runs parallel to the magnets and supplies them with helium is made of EN No.1.4307, a chromium-nickel stainless steel similar to 304L (S30403) that also does not embrittle at these extremely low temperatures. Approximately 450 tons of the material were needed for the 120 kilometres of pipe.

Although the European Organization for Nuclear Research was forced to halt the project in September, 2008, because of a faulty electrical connection between segments of the LHC's superconducting cable, it is scheduled to resume in late September 2009 and make the first collision experiments in late October.

#### **Pure science, innovation and nickel**

The LHC is already an engineering triumph notwithstanding the start-up problem. Moreover, the insights gained from it will influence technologies and human ambitions for decades, indeed generations. It is appropriate that nickel – that is, part of the nickel formed at the nano-instant after the Big Bang – is essential to its success.

**For more information please go to:**  
[www.nickelmagazine.org/bigbang](http://www.nickelmagazine.org/bigbang)

### Massive Q-Max Carriers cont'd

burned as fuel. The solution was to install an on-board plant to re-liquefy the vapour and return it to the storage tanks. This makes long voyages more feasible while enabling engineers to replace conventional steam boilers with high-efficiency, low-speed twin diesel engines that consume an estimated 40% less energy per unit of cargo. The new ships also have improved fire-protection systems and boast twin propellers and rudders for better manoeuvrability.

Three Korean shipyards – Samsung Heavy Industries, Daewoo Shipbuilding & Marine Engineering, and Hyundai Heavy Industries – have been contracted to build a total of 45 carriers. These include not only Q-Max but the smaller, yet still massive, Q-Flex tankers, which have a capacity of 212,000 cubic metres. Exxon Mobil has ordered seven Q-Max vessels, all to be delivered by the end of 2009.

**For more information please go to:**  
[www.nickelmagazine.org/qmax](http://www.nickelmagazine.org/qmax)

# THIS IS NOT A BRIDGE.

But it does provide a path to a more sustainable future, connect important innovations to the needs of society and support millions of jobs in the EU and billions in economic development.



## *This is nickel.*

Look closely at nickel stainless steels and you'll see both their brilliance and their beauty. But nickel's role in sustaining our planet is also well worth looking at. Most importantly, nickel in all its forms is recyclable. Beyond that, nickel improves the corrosion resistance of alloys like stainless steels. This means less maintenance and less expensive rehabilitation. And nickel's strength and ductility make it ideal for creating superalloys for turbines that burn biogases—from landfills, for example—to generate electricity.

Nickel also helps to reduce greenhouse gas emissions in many ways. Hybrid cars use nickel metal hydride batteries; waste-to-energy plants use corrosion-resistant nickel alloys for a long, maintenance-free operating life; and wind turbines use nickel alloy castings because they perform so well under cold operating conditions.

Nickel. Take a closer look. You'll see so much more.

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