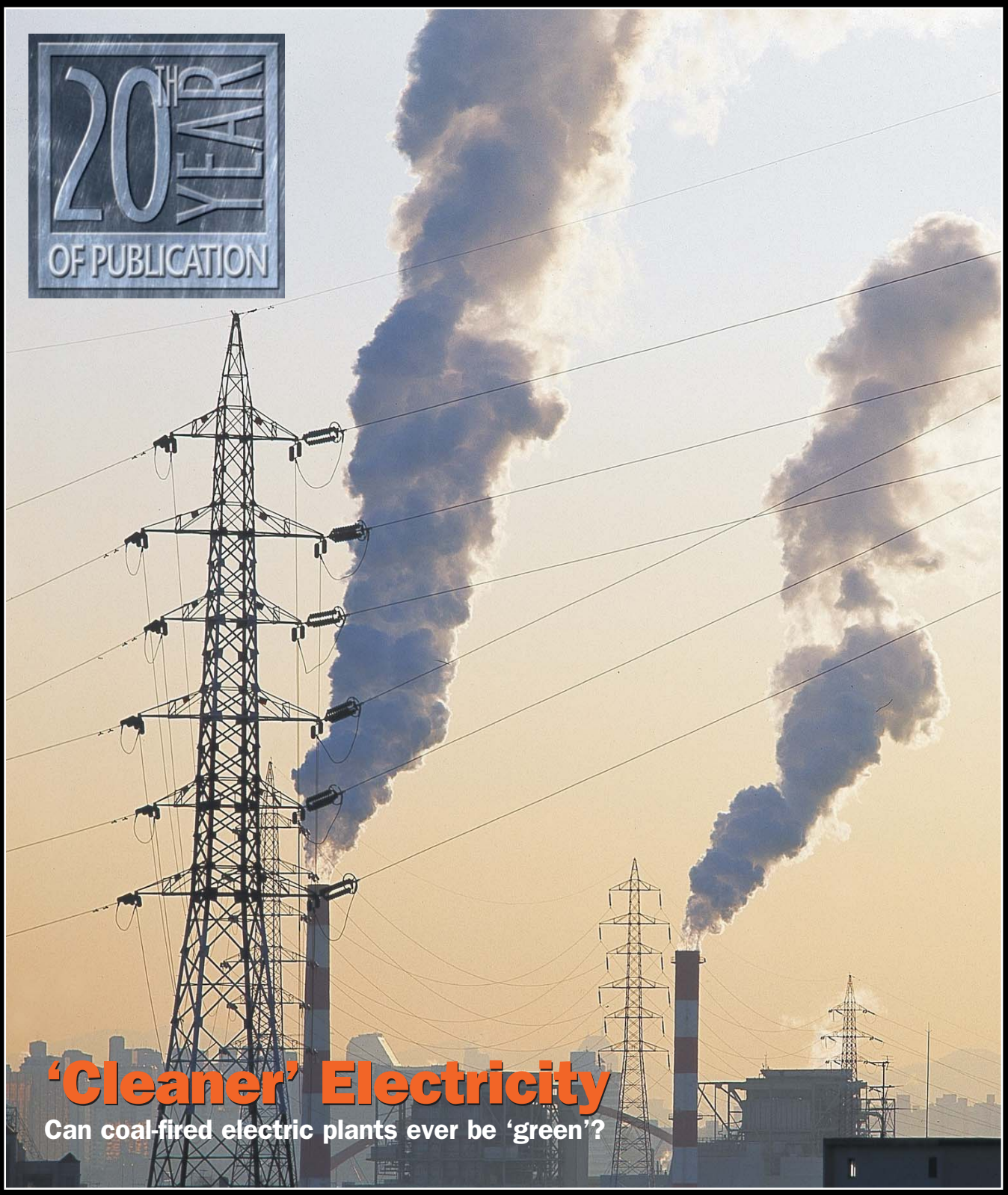
NICKEL

Nano-technology's substitute for silicon

Singapore's rivet problem, solved

NOVEMBER 2004 VOLUME 20, NUMBER 1 THE MAGAZINE DEVOTED TO NICKEL AND ITS APPLICATIONS



'Cleaner' Electricity

Can coal-fired electric plants ever be 'green'?

NICKEL

Volume 20, Number 1, November 2004

The Magazine Devoted to Nickel and its Applications

Nickel is published three times per year by
The Nickel Institute
55 University Avenue, Suite 1801
Toronto, Canada M5J 2H7
Tel. +1 416 591 7999
Website: www.nickelinstitute.org
E-mail: ni_toronto@nickelinstitute.org

Ivor Kirman, President
Patrick Whiteway, Editor

Circulation, 27,000 in 95 countries

Other Nickel Institute offices:

Europe
42 Weymouth St.
London, England W1G 6NP
Tel. 44 20 7258 9830
E-mail: ni_london_uk@nickelinstitute.org

European Technical Information Centre
The Holloway, Alvechurch
Birmingham, England B48 7QB
Tel. 44 1527 584777
E-mail: ni_birmingham_uk@nickelinstitute.org

Japan
11-3, 5-chome, Shimbashi,
Minato-ku, Tokyo, Japan
Tel. 81 3 3436 7953
E-mail: ni_japan@nickelinstitute.org

Central & South America
Nucleo Inox
Av. Pedroso de Moraes, 240 – Conj. 22
São Paulo 05420-000 – SP, Brazil
Tel. 55 11 38130969
E-mail: nucleoinox@nucleoinox.org.br

India
K-36, 1st Floor
Hauz Khas Enclave,
New Delhi 110 016, India
Tel. 91 11 2686 5631, 2686 3389
E-mail: ni_india@nickelinstitute.org

Australasia
150 Drummond St., Suite 3
Carlton, Victoria, Australia 3053
Tel. 61 3 9650 9547
E-mail: ni_australia@nickelinstitute.org

South Korea
Olympia Building - Room 811
196-7 Jamsilbon-Dong, Songpa-Ku,
Seoul 138 229, South Korea
Tel. 82 2 419 6465
E-mail: ni_korea@nickelinstitute.org
Website: www.nidikorea.org

China
Room 677, Poly Plaza Office Building
14 Dongzhimen Nandajie
Beijing, China 100027
Tel. 86 10 6500 1188 (ext. 3677)
E-mail: ni_china@nickelinstitute.org

United States
NiPERA
2605 Meridian Parkway, Suite 200
Durham, North Carolina, U.S.A.
(Health and environment inquires only.)
Tel. +1 919 544 7722
E-mail: nipera@nipera.org

For a free print subscription, please go to: www.nickelmagazine.org. To receive e-mail notices for Nickel Magazine Online, please go to: www.nickelonline.org/subscribe

ISSN 0829-8351

Printed on recycled paper in Canada.

Cover photo courtesy of Photos.com.

The next issue of Nickel Magazine will be published in March 2005.

Inform and Communicate

In the mid-1980s, few people had heard of nano devices, hybrids (as in gasoline/electric vehicles), robotic laser welding, LNG tankers, "green" buildings, fuel cells, or the Internet, among other technologies that rely on nickel. That is why the first editions of *Nickel Magazine* were concerned instead with new applications of nickel-containing materials in architectural, electroplating, marine, pulp and paper, and oil and gas, most of which are commonplace today.

Today's designers, architects and engineers are living in a different world from that of 1984, when this magazine was launched. As these professionals and innovators strive to provide society with cleaner air, water and food, and a better, sustainable way of life, they find themselves distracted by a wide range of issues and concerns, such as life-cycle analysis, "rouging," metal dusting and risk assessment, to name just a few.

The founders of this magazine were clear in stating that "*Nickel* will regularly feature new and existing applications of nickel and nickel steels, alloys and compounds from around the world. It will contain news of developments in nickel technology and references to salient technical reports and publications. It will review new nickel-containing products from time to time as they are made known to us and judged to be appropriate."

We have striven to realize that objective by publishing timely, international articles on the use of nickel in architecture, the automotive sector, chemical processes, water, energy, and food & beverage industry.

As we continue to improve *Nickel Magazine*, our purpose remains "to inform in a way that is most useful to the reader. The format and content of "*Nickel*" will therefore vary as necessary to fulfill this purpose."

Increasingly, the most useful way to inform a global audience is to make information available on-line in languages other than just English and to provide mechanisms for readers to respond. In this way, the role of informing shifts to one of inter-communicating. That is why, in addition to a print edition, *Nickel Magazine* is published on-line, and not just in English but in French, German and Spanish as well. And that is why subscribers are informed by e-mail as soon as an issue has been posted. Most of the response we receive from readers arrives by e-mail.

We look forward to communicating the benefits of nickel and nickel-containing materials to you for the next 20 years and appreciate any comments you have to offer.

Patrick Whiteway
Editor

inuse

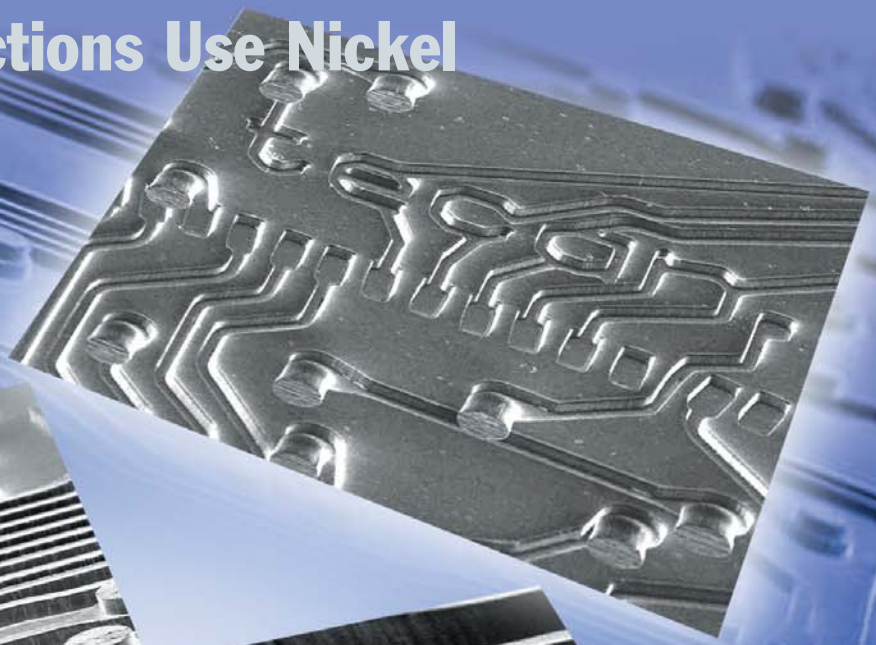
THE LATEST NICKEL APPLICATIONS WORLDWIDE

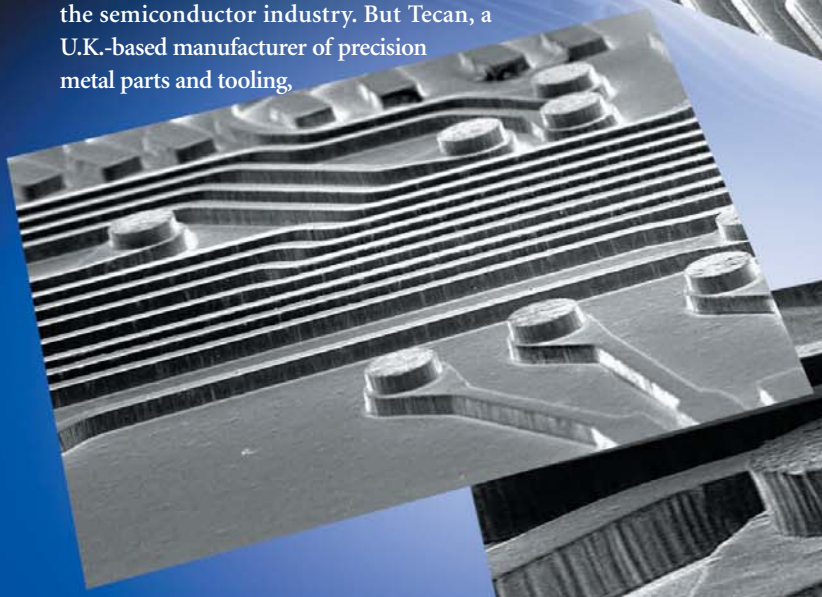
Nano-device Connections Use Nickel

Nickel winning favour as a substitute for silicon

As a low-cost alternative to silicon, nickel continues to make inroads into microstructure applications such as high-density circuit manufacturing.

Traditionally, micro-electromechanical systems (MEMs) have been manufactured in silicon using technology borrowed from the semiconductor industry. But Tecan, a U.K.-based manufacturer of precision metal parts and tooling, has opened a dedicated facility to produce both highly accurate micro parts and larger parts with ultra-fine features by electroforming in nickel and other materials.





The company is particularly enthusiastic about a technique called imprint patterning, a new approach developed for high-density circuit manufacturing.

"We've had a mini-frenzy [over the technology]," says Noel Cherowbrier, vice-president of international development for Tecan Inc. "Customers are coming to us with all sorts of different applications where they want to have an imprint tool made."

Based on the microreplication techniques used to make compact disks and reflective road signs, imprint patterning produces a high-density metal stamp or "tool foil" made of nickel. Using an ordinary laminating press, an image of the stamp can be imprinted directly on to a substrate, producing circuit traces and vias (small holes that connect the wires on different layers of a circuit board). The substrate can then be metallized to ensure accurate high-density circuitry.

The new technique, a high-volume, precision embossing technology, allows silicon originals to be kept as perfect masters from which an infinite number of replicas can be produced at relatively low cost.

Imprint patterning has advantages over the standard approach to high-density circuit fabrication based on photo imaging and laser drilling. Because the approach is padless, real-estate savings can be significant. In addition, full vias can be produced across the whole surface of the metal stamp in a single operation. The stamp can be used repeatedly.

IMPRINT PATTERNING is a new technique for making high-density electrical circuits.

TECAN INC.

MORE INFO: www.nickelmagazine.org/1104/4.htm

How To Eliminate Bio-films

Biofilms are less of a problem with stainless steel conveyor belts

More photos and text are available at the URLs given at the end of each article.

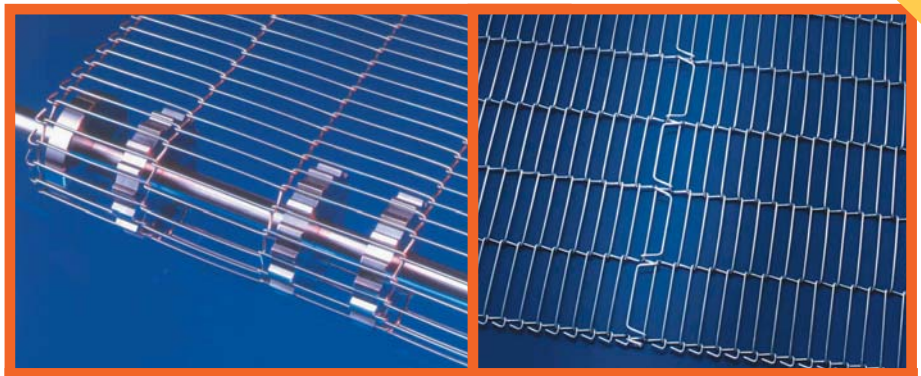
The next time you order chicken nuggets at a fast-food restaurant, think stainless steel. Chances are your meal has been breaded and pre-cooked on a conveyor belt manufactured by a New England company that specializes in food-industry production lines.

"Anything in a mass-production environment that has been coated, breaded or battered, and then cooked, has probably been on our conveyor belts," says Richard Spiak, vice-president of sales and marketing for Wire Belt Co. of America.

The leading supplier of open-mesh stainless steel belts, Wire Belt uses S30200 and S30400 stainless steel for its conveyors and the more machinable S30300 grade for sprockets and drive components. If the belt is to be subjected to high temperatures or contact with corrosive materials, the company opts for S31600 stainless because of its additional strength and durability.

"We choose those materials because they're easy to clean and sanitize, and they give us a great deal of strength and flexibility in the applications," Spiak explains. "You're looking at some demanding environments for these belts."

Bread coatings are highly abrasive. Temperatures inside bulk fryers and ovens may reach 200° C. The overriding challenge, though, is cleanliness. Belts must be kept free from food particles and bacteria in order to meet the rigid standards of government and industry. A major concern within the fast-food industry is eliminating biofilms, a tough layer of bacteria that builds up on the surface of food-handling equipment, much like plaque on teeth.



OPEN-MESH STAINLESS STEEL BELTS are typically made of S30200, S30400 or S31600 in high-temperature, more corrosive applications.

Stainless steel belts resist scratching, deny bacteria a foothold, and in most applications processors do not have to go to the additional time and expense of removing the belt from the production line for cleaning, says Spiak.

High-density polyethylene plastic has emerged as an alternative to stainless steel for food-processing applications that do not involve cooking. But plastic is more prone to scratching and can be tougher to rid of biofilms. Research at London's South Bank University found that plastic modular belting accumulated 10 to 100 times more bacteria than stainless steel belts.

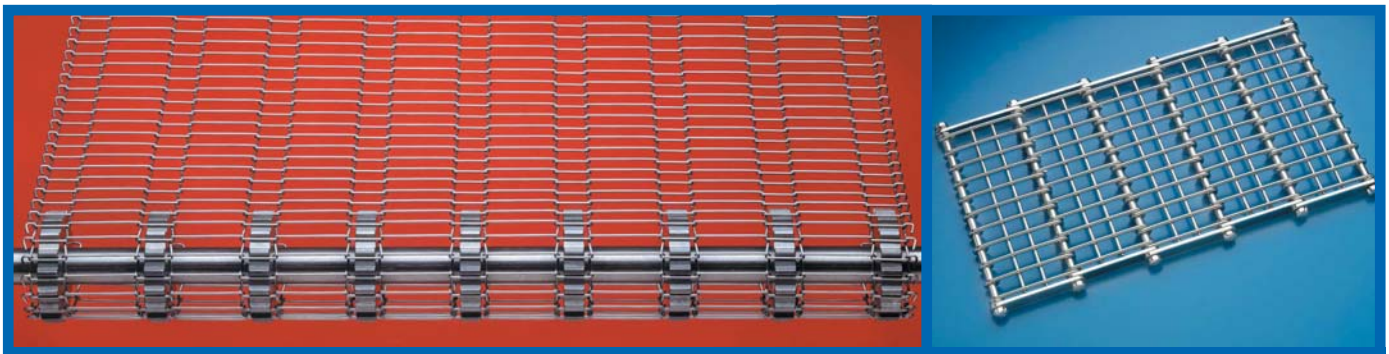
Wire Belt's open-mesh design allows for easy cleaning of the belts, improves airflow when individual products need to be heated or cooled, and reduces belt contact when products are coated or cleaned. The company produces more then 4,500 belt configurations, with mesh sizes of 50 to 400 millimetres (mm) wide and pitches (the spaces between rows of wire) ranging from as little as 1.5 mm to 20 mm.

Wire Belt also stresses the problem of detecting foreign matter in processed foods. Metal detectors are commonly used in the industry, but expensive and less-reliable X-ray machines are needed to find fragments of plastic from belts and other equipment. The company won an award in 2003 for advertisements that point out that virtually all food-product recalls for "extraneous material" in the U.S. involve plastics. The advertisements ask the question: "What's your conveyor belt made of?"

The company's belts have non-food applications, and are used on production lines for soldering and cleaning computer circuit boards and for cleaning coated lenses for eyeglasses. Some textile manufacturers use the belts in dryers and dyeing machines.

Founded in 1947, Wire Belt remains family owned and employs 150 people at its Londonderry, N.H. plant. Plants in Britain and Germany employ another 100. Spiak estimates the company produces several million pounds of stainless steel belting each year.

MORE INFO: www.nickelmagazine.org/1104/5.htm



STAINLESS STEEL FOOD BELTS resist scratching, deny bacteria a foothold, and in most applications processors do not have to go to the additional time and expense of removing the belt from the production line for cleaning.

WIRE BELT CO. OF AMERICA

Alternative Materials Were Not Suitable

S31600 ideal for pressure vessels designed to filter swimming pool water

Filtration & Pumping Commercial Ltd. (FPC) in New Zealand has been manufacturing S30400 pressure sand filter vessels for public swimming pools for 30 years. But when New Zealand began experiencing epidemic levels of *cryptosporidium oocysts*, there was a move to the use of pressure diatomaceous earth (DE) filter vessels, which trap smaller bacteria.

In 1998 FPC manufactured about 20 DE vessels out of mild steel with an epoxy coating (a materials choice driven by a concern for low initial cost), but with unsatisfactory results. "If the epoxy coating is not absolutely perfect, it fails in a very short time and the steel tank begins to corrode," explains David Cameron, contacts manager for FPC. "If the coating has a blemish or broach, the best we get is three to five years.

"Chloramines are very aggressive," he continues, "and it seems any chemical imbalance in the water – pH, total alkalinity, hardness and chlorine residual – has a detrimental effect on the steel and the coating." A competing importer of pressure DE filters made of epoxy-coated mild steel has also experienced many vessel failures.

For these reasons, FPC investigated the cost of manufacturing the DE tanks with S31600 stainless steel. S31600 was recommended by consulting engineers in New Zealand as an alternative material to mild steel and epoxy because of its superior corrosion resistance in the pool environment.

"We've never looked back," says Cameron. "The material cost is obviously higher, but when you factor in sand blasting, priming, undercoating, top coating, and the labour and material cost for the coating, it equals the increased cost for stainless sheet and plate. We no longer make sand filter vessels in mild steel at all."

FPC makes the tanks using 2.5- to 5-millimetre (mm) sheet for the domes (heads) and vertical sides. The pressure and tube plates are made from 8- to 16-mm plate, depending on the tank size. Pipework uses tubes of nominal sizes varying from 10.16 mm to 15.24 mm to 20.32 mm with wall thickness typically 2 mm. The tanks vary in size from 800 mm in diameter and 2 metres tall to 1,800 mm in diameter and 2.3 m tall.

The domes at each end of the filters are hydrostatically formed. All welds are two-pass and passivated.

"In nearly every instance where we remove an old steel pressure sand filter from a school or public pool, we install a stainless steel pressure DE filter," says Cameron.

FILTRATION & PUMPING COMMERCIAL LTD.

"IN NEARLY EVERY instance where we remove an old steel pressure sand filter from a school or public pool, we install a stainless steel pressure DE filter," says David Cameron.

MORE INFO: www.nickelmagazine.org/114/6.htm

Fuel Cell Manufacturing Takes Off

'Green' incentives and high traditional energy costs spur the market for fuel cells

Parts of the world with high electricity costs are welcoming fuel cells made of nickel and stainless steel as an alternative to traditional power generation.

Connecticut-based FuelCell Energy Inc., which delivered its first commercial unit of the nickel-bearing fuel cells at the beginning of 2003, has already installed 35 power plants in various countries, including Germany, Japan, Spain and the United States. And the market is broadening.

"Our targets are areas of the world where electricity is expensive and there is substantial incentive funding [for green power]," says Steven Eschbach, director of investor relations and communications for FuelCell Energy. "California and Japan are the most prolific markets today, but we think there are opportunities in the northeast (U.S.), where there are high electricity costs and high levels of pollution."

In the third quarter ended July 31 alone, FuelCell's product sales reached US$3.6 million. The company expects to ship another four to six power plants to customers in Japan and the United States by the end of the fiscal year.

The company's Direct FuelCells (DFC), so-called because they do not require external hydrogen generation but operate directly on available fuels such as natural gas, are high-temperature, high-efficiency molten carbonate fuel cells designed for applications where the generator is stationary.

FUELCELL ENERGY INC.

CALIFORNIA AND JAPAN are the most prolific markets today for stationary, molten carbonate fuel cells. But the northeastern U.S. is emerging as an important market as well.

The DFCs consist of a ceramic-based matrix layer sandwiched between an anode made of porous nickel strip and a cathode made of a nickel material alloyed with chromium or aluminum. A hydrocarbon, such as natural gas, is fed to the anode while air is fed to the cathode. In a process called "reforming," hydrogen is extracted from the fuel and reacts with the air inside the fuel cell to produce electricity, heat and water.

Nickel is used to make the anodes and cathodes because it is a good conductor of heat and electricity and is resistant to corrosion.

Although the cost of generating electricity from carbonate fuel cells is much higher (16 U.S. cents per kilowatt hour at current natural gas prices) than the average cost of electricity from traditional sources (about 10 U.S. cents per kilowatt hour), the environmental benefits are significant. FuelCell's DFCs emit considerably less carbon dioxide than engine-based technologies because they are twice as efficient as conventional fossil fuel-fired plants.

MORE INFO: www.nickelmagazine.org/1104/7a.htm

Stainless Rivets Solve Window Problem

Singapore's Building and Construction Authority (BCA), together with the Asian republic's Housing and Development Board (HDB), has launched a program to replace nine million aluminum rivets with stainless steel ones in the windows in 43,000 HBD flats.

Between 2000 and 2003, at least 190 window cases installed by HBD fell out of flats because aluminum rivets failed to hold the friction stays in the window casements. Corrosion and wear-and-tear, as windows are opened and closed, caused the failures. To solve the problem, the BCA is retrofitting using more durable and corrosion-resistant stainless steel rivets.

RESIDENTIAL FLATS in Singapore are getting more secure windows

PHOTOS.COM

The stainless rivets, which vary in length from 10 to 17 millimetres (mm) and are 4.8 mm in diameter, will be made from S30400. They have a tensile strength roughly three times that of the aluminum rivets.

The aluminum rivets were used for installing casement windows between 1987 and 1998 under the then-prevailing industry standards in Singapore and in effect internationally, according to HBD. Revised industry standards specifying stainless rivets were adopted in 2000, though HBD switched to using them in 1998. The replacement program will run from March 2004 to February 2005.

MORE INFO: www.nickelmagazine.org/1104/7b.htm

Stainless Steel Crab Traps

Virtually all of the traps used on the west coast of North America are made by one B.C. manufacturer

Stainless steel crab traps can be found all the way from Alaska in the north, down the west coasts of Canada, the U.S.A., and Mexico, to as far south as Chile.

Most traps are crafted in a small fishing community at the mouth of the Fraser River in British Columbia, which was once the home of nine salmon canneries. Ladner traps, as they are known, have been produced there for more than 30 years. S30400 stainless steel, containing 8-10.5% nickel, has been used in the framework for both crab traps, as well as prawn traps.

FISHERMAN ON THE west coast of North America use large circular traps made of stainless steel to capture crabs which are served up in restaurants all along the coast.

In the past year, more than 16 tonnes of S30400 stainless steel rod, 0.0375 to 0.0675 inches in diameter, have been rolled into hoops from 30 to 43-inch circular frames. They range from 12 pound light-weight traps for weekend sport fisherman to the ones found on commercial trawlers that weigh anywhere from 24 to 30 pounds apiece.

"The traps sell by word of mouth," says Kevin Zack, who has helped manufacture them for the past 30 years and who ships them across Canada to the eastern seaboard of the U.S. and to as far as Chile. So popular are the units that their brand name, Ladner Traps, is better known than the company that makes them, Sealtek Fabricators Ltd.

Once the stainless steel frame is jig-welded together, the traps are hand-woven, fishnet-style, with S30400 stainless steel wire, 0.041 to 0.048 inches in diameter. In the past 12 months, two full-time welders and 12 weavers managed to produce nearly 10,000 crab traps, plus more than 20,000 prawn traps. The latter entailed 48,000 pounds of nylon mesh stretched over an S30400 stainless steel stacking frame.

Commercial traps are larger and heavier – and less likely to move, owing to tides, deep-water currents, and underwater drifting. Some are lost at sea as a result of heavy ocean conditions and rocky bottoms. The seafood market is growing and, in season, there is a good local fresh market. The U.S. market is the largest, with San Francisco the pinnacle for fresh crab.

Learning how to weave S30400 stainless steel takes several months, but once the skill is mastered, a trap can be completed in less than two hours. S30400 stainless steel traps are among the best products on the market.

"The trap design has been around for a long time, and changes and improvements have evolved as a result of trial and error," says Zack. "Offshore importers have tried to copy the Ladner Trap, but they failed to stand the test of the sea."

"The key to the success of the Ladner Trap is the S30400 stainless steel construction."

MORE INFO: www.nickelmagazine.org/1104/8.htm

Nickel Alloy Puts the 'Spark' into Spark Plugs

The amount of nickel in each plug is only about a quarter of a gram, but more than 250 million plugs are made every year.

ABOUT 70 TONNES of nickel are used each year to make spark plugs for the estimated 56 million new vehicles manufactured worldwide.

BOSCH

Fuel-burning engines of all types require a device to ignite the fuel and thus power the engine. The common spark plug has served this purpose since the gasoline engine was introduced at the beginning of the 20th century.

The spark plug both ignites the fuel/air mixture in the combustion chamber and removes heat from the combustion chamber.

Spark plugs consist of a center electrode, a porcelain insulator, steel shell and a ground electrode. The centre electrode is usually copper with a nickel alloy tip. The side, or "ground," electrode is made of the same nickel alloy, usually N06600.

Spark plugs do not create heat. Heat is a byproduct of the ignition of the fuel/air mix, and the spark plug will remove some of the generated heat.

Temperatures at the "nose" of the spark plug in the combustion chamber are in the 870-925°C range. Thus what's needed is an alloy that can withstand these temperatures, as well as corrosion and erosion from the fuel combustion, to act as electrodes between which the spark occurs.

The popular choice for spark plug electrodes is nickel alloy N06600 (containing 72% nickel). Many spark plug manufacturers prefer to use their own proprietary alloy of about 90-96% nickel plus chromium, manganese, silicon and in some instances, yttrium. This nickel alloy is usually welded to a copper center core; the electricity travels from the ignition wiring to the bottom shell of the spark plug. In some designs, the nickel alloy electrodes are plated with platinum for enhanced spark plug life.

All variations of nickel alloy are readily weldable and ductile, so forming is easily accomplished, as is the subsequent adjustment of the gap when spark plugs are installed in an engine.

Nickel alloys are an ideal choice for electrodes because they resist corrosion and erosion from the combustion products and can endure the high temperatures generated. In addition, the nickel alloy is a good conductor of electricity and heat.

MORE INFO: www.nickelmagazine.org/1104/9a.htm

Laser Welding Eliminates Distortion

Kawasaki Heavy Industries (KHI) plans to introduce a robotic laser welding system at a plant in Hyogo, Japan, that assembles stainless steel railway vehicles. The projected cost is 700 million yen.

KHI has completed the trial manufacture of a stainless steel railroad vehicle using laser welding technology. By mid-2005, the laser welding mass production system will replace traditional spot welding.

One of the problems associated with spot welding is the welding mark that is left on the welded surface. Laser welding eliminates this mark, thereby improving the appearance and strength of the stainless steel being welded. The result is a vehicle of higher quality.

SURFACE UNEVENNESS is virtually undetectable.

KAWASAKI HEAVY INDUSTRIES

The overuse of spot welding in the assembly of stainless steel vehicles can result in distortions, mainly because of excessive heat. Many welding marks, of a diameter of about 1 centimetre, are left on the surface. Also, seal materials are needed to prevent water penetration through the roof of a vehicle. Laser welding solves these problems because it is a continuous process.

Typically the surface flatness of railway cars is specified at ±3 millimetres. Laser welding enables surface flatness to be maintained at about ±1 millimetre, and so unevenness on the surface is virtually undetectable.

MORE INFO: www.nickelmagazine.org/1104/9b.htm

Learning From Experience

Building pollution abatement equipment can now benefit from 30 years of operating experience with nickel alloys.

Coal is by far the most commonly used fuel to generate the world's electric power. But coal is not the cleanest fuel in the world. It is a major source of airborne pollutants such as particulate matter, sulphur dioxide and oxides of nitrogen. The cost of reducing these pollutants is high. Which is why users are looking hard for more cost-effective ways to clean up the gases generated by coal-burning plants.

The operators who build and run coal-fired electric generating stations are looking for ways to build pollution abatement equipment that has a longer service life. Alloy selection and quality of fabrication are seen as ways to increase reliability and to reduce maintenance costs.

The percentage of chromium, nickel and molybdenum in the alloys used to make this equipment determines the material's resistance to corrosion. And many operators now have up to 30 years of experience working with different nickel alloys and stainless steels.

That's why, in August, NACE International arranged for William Mathay, a Nickel Institute consultant, and Ronald Richards of Enerfab to chair a meeting of engineers in Washington D.C. During the one-day symposium some valuable operating lessons were heard.

For example, in 1986, duplex stainless steel S32550 was used to line the absorber tower at Gibson Unit #5 in Owenville, Indiana. During inspections in 2004, the material was found to exhibit minimal signs of chemical attack or erosion damage, reported Steven Alston and Ronald Richards.

"Even at the inlet wet/dry interface, the duplex alloy is holding up with only generalized shallow surface pitting," the authors said.

Gibson is one of the largest electric-generating stations in the U.S. It is operated by PSI Energy Inc., a wholly-owned subsidiary of Cincinnati-based Cinergy Corp.

In addition, nickel alloy N06022 was used in 1986 as a wall-paper lining in the outlet ductwork in Unit #5. "To date, this lining has eighteen years of service and looks essentially the way it did the day it was installed," the authors say.

In another example, experience with corrosion in a pilot wet electrostatic precipitator was presented by CR Clean Air Technologies and Enerfab Inc.

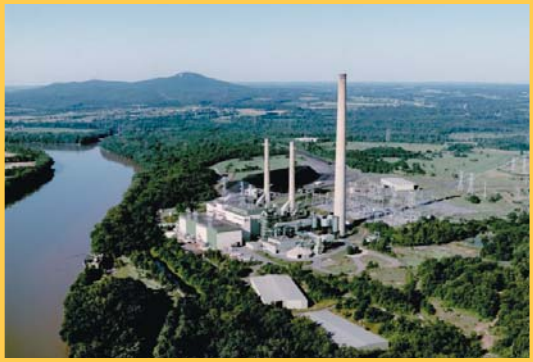
The question that perplexed these authors is why corrosion appeared in one part of the unit and not in another part when both areas were constructed of the same material: S31603.

What they discovered after a corrosion investigation is that strong oxidizing agents, such as ozone generated within the precipitator, acted to passivate the collecting tubes which exhibited no corrosion. This suggests that a slightly lower grade material can be used in this section of the plant;

PHOTOS.COM

potentially valuable observation for the designers of future such units.

One company that should benefit from its more than 30 years of experience in pollution abatement equipment is Oregon-based PacifiCorp. In August 2004 it announced it will spend US$120 million to, among other things, install a new wet-lime scrubber at its Huntington 2 plant near Salt Lake City, Utah. The investment will reduce sulphur dioxide emissions from the plant by about 15,000 tonnes per year.



S31603 WAS USED to fabricate this parallel wet scrubber and wet electrostatic precipitator at an industrial facility in the U.S.A.(left). Mirant's 853-MW Dickerson Station in Maryland is pictured at right.

The company has operated flue gas desulphurization (FGD) systems in more than 20 coal-fired plants in the U.S. for more than 30 years. So it has lots of experience with various FGD materials of construction that can be applied at Huntington. A summary of that experience was presented in Washington by G. W. Betenson.

Nickel alloy N10276 was recently installed at the company's Hunter 2 unit using pulsed arc welding, for example. The same material was used in the unit in 1986, but suffered a "massive failure" because it had been welded using short circuit gas metal arc welding procedures.

"Corrosion of the liner attachment welds to the carbon steel substrate coupled with vibration of the duct mechanically fatigued the remaining attachment welds," the authors say, "resulting in a massive failure of the liner system. Improvements were made to the design of the dissimilar metals welds near the duct expansion joints and the outlet duct."

AS COAL-FIRED ELECTRIC generating plants become more heavily regulated, operators are looking to enlightened companies which have extensive experience and expertise building pollution abatement systems that are long-lasting and dependable. Many of these systems use nickel alloys.

Other operating experiences related to relatively simple things such as good housekeeping. High concentrations of fluoride in FGD systems can cause corrosion challenges even for nickel alloy N10276, for example. However, corrosion can be greatly reduced by installing a water wash system that allows duct floors to be washed regularly, report Michael Hoydick, project manager for Wheelabrator Air Pollution Control and Kevin Frizzell, technical services superintendent of Owensboro Municipal Utilities (OMU).

This lesson was learned after 10 years of operating experience at OMU's Elmer Smith 441-MW coal-fired electric generating station in Owensboro, Kentucky, U.S.A.

High fluoride concentrations were blamed for what is called "under-deposit" corrosion of the nickel alloy. The alloy was used in the inlet ductwork of the limestone-based wet FGD system. That system was installed in 1994.

If proper heed is given to these experiences, new pollution abatement equipment that will be required due to tightening regulations should be long-lasting and reliable.

The complete proceedings of this symposium, which includes papers on high alloyed stainless steels, nickel alloys, clad, non-metallic materials and electrochemical protection, are available on CD from NACE International.

MORE INFO: www.nickelmagazine.org/1104/10.htm

GOOD

The operator of a wastewater treatment plant in the U.S. recently installed some stainless steel equipment and piping only to find that after just six months of operation, pitting corrosion occurred around some of the pipe joints. An inspection by a qualified corrosion engineer revealed that the corrosion happened because, at the time of fabrication, the heat tint around the internal weldments had not been removed. As a consequence, the operating life of the system would be significantly shortened, with large amounts of maintenance required to stop the leaks and extend the life of the equipment.

This could have been avoided had the fabricator and installer been familiar with "good practices" when working with stainless steel. While this is just a hypothetical example, in reality such events happen regularly in all geographic regions of the world.

PRACTICES

A new on-line training module summarizes how austenitic stainless steels should be transported, stored, cut, formed, welded and cleaned

When fabricating austenitic stainless steels, certain practices need to be followed to maintain the material's inherent corrosion resistance," says Dr. David Jenkinson, Director-Australasia for the Nickel Institute. "Failure to do so can result in unwanted corrosion of critical engineering components."

To help materials specifiers, fabricators and users of stainless steel prevent such problems, the Nickel Institute has created an on-line training module that outlines the "good practices" that should be followed to achieve the long, low-maintenance service life and aesthetic appeal in stainless steel.

PHOTOS.COM

Building on the success of the Nickel Development Institute's face-to-face workshops and print publication (NiDI series No. 11007), the on-line module uses interactive techniques to explain how austenitic stainless steels should be transported, stored, cut, formed, welded and cleaned.

Information on the welding and fabrication of stainless steels is frequently requested by users of the Nickel Institute web site, so the on-line module will fill an important void.

The module will provide practical advice on, for example, how to avoid contamination of stainless steel during transport and storage; how carbon steel strapping can contaminate the surface of stainless steel during transport (and how this can be avoided); how storage indoors or under cover from the elements can help to maintain the condition of stainless steel; and how sparks created by the grinding of nearby carbon steel can become embedded in the surface of stainless steel.

Mechanical and thermal methods of cutting stainless steel are listed, and also some pointers on "springback", with the emphasis on the differences between stainless and carbon steels.

The most extensive portion of the module deals with welding. All types of welding, including shielded metal arc, gas tungsten arc and gas metal arc, are discussed, along with their advantages.

Cleaning procedures prior to welding are reviewed in detail.

Differences in the welding characteristics of austenitic stainless steels to carbon steels, such as the effect of a higher coefficient of thermal expansion, weld joint design, choosing appropriate filler materials, and the welding of dissimilar metals are also discussed.

Considerable attention is given to post-welding cleanup, in particular the removal of arc strikes, heat tint and surface contamination, which might not be a cause for concern with carbon steels. Details on how to properly pickle and electro-polish stainless steels, and the consequences of not doing so, are illustrated. Heat tints in the internal surfaces of piping are specifically discussed.

The module is recommended for all materials specifiers, fabricators and users of stainless steels.

MORE INFO: www.nickelmagazine.org/1104/12.htm

Socio-economic Reports Available On-line

In 2003, the Nickel Institute commissioned a report into the socio-economic aspects relating to nickel in Europe. The report, produced by The Weinberg Group, an international science and regulatory consulting firm, gives the first independent assessment of the socio-economic significance of the full nickel value chain to the economic prosperity of the European Union (EU).

The report concluded that the overall value of the EU nickel business is much more important than the usual political perception because much of this value is in so-called first use and end use industry.

In Germany, for example, companies in the end use sector add most value to the nickel value chain (65%). The most important segments are gas turbines and process plant equipment for the food and drink industry (where German companies have a 35% share of the market), automotive diesel turbo chargers and high precision replication of CDs and DVDs (where German companies have a 30% market share).

- Germany is a major user of nickel. Total German use in 2002 was 165,000 tonnes (primary and recycled nickel units) which represented around 23% of total demand in the EU. This demand is satisfied through imports of refined nickel and recycling of existing nickel.
- Whilst the nickel industry itself is relatively small, it has a significant impact on the German economy through its value-chain. Through its critical use in nickel-containing alloys, it has a major impact on leading German industries such as stainless steel. In turn, the use of nickel-containing alloys in many important products manufactured in Germany means that the impact of nickel is substantial in many end-use markets.
- As a consequence, the total value-added in Germany by nickel and its value-chain is estimated to be Euro 11 billion.
- Moreover, the direct nickel industry and the industries in its value chain that are critically dependent upon it, employ a substantial number of people. Total employment in Germany in the direct nickel industry, "First Use" industries and Intermediaries, and "End Use" industries that are critically dependent on nickel is estimated to be approximately 125,000. Some 60,000 additional jobs have been created in the economy through income and supplier "multiplier" effects and capital expenditure effects. Hence around 185,000 jobs are "critically dependent" on nickel.
- The industry and its value-chain also contribute significantly to the German economy through high levels of investment. Total research and development by the direct nickel industry and industries critically dependent on nickel is estimated to be Euro 500 million. Annual capital expenditure by these sectors is estimated to be Euro 600 million and total capital employed is estimated to be Euro 10.5 billion.
- The nickel industry and its value chain also account for substantial tax revenues. Total taxes (on employment and sales) paid by the direct nickel industry and industries critically dependent on nickel are estimated to be Euro 3.8 billion. This excludes corporate taxes.

MORE INFO: www.nickelforum-eura.org/

UNS details

UNS Detailed 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	N	Ni	P	Pb	S	Si	Ti	V	W	Zr
N06022 P.11	-	-	0.015 max	2.5 max	20.0-22.5	-	2.0-6.0	0.50 max	12.5-14.5	-	rem	0.02 max	-	0.02 max	0.08 max	-	0.35 max	2.5-3.5	-
N06600 P.9	-	-	0.15-max	-	14.00-17.00	0.50 max	6.00-10.00	1.00 max	-	-	72.0 min	-	-	0.015 max	0.50 max	-	-	-	-
N10276 P.11	-	-	0.02 max	2.5 max	14.5-16.5	-	4.0-7.0	1.0 max	15.0-17.0	-	rem	0.030 max	-	0.030 max	0.08 max	-	0.35 max	3.0-4.5	-
S30200 P.5	-	-	0.15 max	-	17.00-19.00	-	-	2.0 max	-	-	8.0-10.0	0.045 max	-	0.030 max	1.00 max	-	-	-	-
S30300 P.5	-	-	0.15 max	-	17.00-19.00	-	-	2.00 max	0.60 max	-	8.00-10.00	0.20 max	-	0.15 min	1.00 max	-	-	-	-
S30400 P.5,6,7,8,14	-	-	0.08 max	-	18.00-20.00	-	-	2.00 max	-	-	8.00-10.50	0.045 max	-	0.030 max	1.00 max	-	-	-	-
S31600 P.5,6	-	-	0.08 max	-	16.00-18.00	-	-	2.00 max	2.00-3.00	-	10.00-14.00	0.045 max		0.030 max	1.00 max	-	-	-	-
S31603 P.10	-	-	0.030 max	-	16.00-18.00	-	-	2.00 max	2.00-3.00	-	10.00-14.00	0.045 max	-	0.030 max	1.00 max	-	-	-	-
S32550 P.10	-	-	0.04 max	-	24.0-27.0	1.50-2.50	-	1.5 max	2.9-3.9	0.10 0.25	4.50-6.50	0.04 max	-	0.030 max	1.00 max	-	- -	-	-
S66286 P.16	0.35 max	0.0010-0.010	0.08 max	-	13.50-16.00	-	-	2.00 max	1.00-1.50	-	24.0-27.0	0.040 max	-	0.030 max	1.00 max	1.90-2.35	0.10-0.50	-	-

NICKEL INSTITUTE

Large, New Market for Stainless Steel

Water distribution networks represent a largely untapped market for stainless steel. The reason is that it is a relatively new material to this sector and there is a general lack of understanding of how to use it correctly. There is also a lack of appreciation of its potential cost effectiveness.

For these reasons, a consortium of stainless steel companies and two metals associations, including the Nickel Institute, has created an organization to market nickel-containing stainless steels to the potable water distribution industry. Called SPLASH, which stands for "Stop Leaks, Ask for Stainless Help," the consortium launched a web site (www.s-p-l-a-s-h.com) and rented tradeshow space at the recent American Water Works Association's annual water distribution and plant operations conference in Chicago, Illinois, U.S.A.

The initial focus of the consortium's efforts is the U.S. market, but that will eventually expand to include other countries.

One of SPLASH's key tasks over the next year will be to demonstrate the effectiveness of the material by installing some stainless steel distribution pipe along side of a ductile iron pipe at a site in Flint, Michigan. This will allow the performances and costs of the two materials to be accurately compared.

SPLASH also intends to submit the duplex stainless steel S32205 for approval for drinking water use under the ANSI/NSF 61 standard.

For more information about how to join the consortium, or to learn more about it, go to:

www.s-p-l-a-s-h.com

Chicago's 'Jelly Bean'

Visitors to Chicago's Millenium Park got a sneak preview of Anish Kapoor's stainless steel sculpture "Cloud Gate" for one brief week in July 2004. The sculpture, which measures 20 metres long and 10 metres high, has been covered up again so that the plates of mirror-finished stainless steel (S31600) can be welded together and the seams buffed to blend into the surrounding plates. The final sculpture is to be totally seam free and was be unveiled again in November.

Cloud Gate's mirrored finish is forged of a seamless series of 168 highly polished, stainless steel "plates," and its elliptical shape reflects the activity and lights of the park and the surrounding city skyline. With a 4-metre high concave area underneath, the sculpture invites visitors to visually interact with its mirror-like surface. According to Kapoor, he wanted the piece to have a classical feel yet at the same time to be very contemporary.

THOMAS READY/NICKEL INSTITUTE

MORE INFO: www.nickelmagazine.org/1104/15b.htm

@www.nickelinstitute.org

- **SUBSCRIBE** to Nickel Magazine on-line and be notified by e-mail when a new issue is on-line.
  www.nickelonline.org/subscribe
- **FOLLOW** the regulatory process in the European Union as it relates to the classification of nickel compounds.
  www.nickelforum-eura.org
- **LEARN** about the advantages of using stainless steel in the potable water distribution industry.
  www.s-p-l-a-s-h.com

'Green' Materials for Architects

Today's architects are deeply concerned about the environmental sustainability of our cities, society and planet. Therefore, they strive to become fully aware of the environmental impacts of their individual projects. The materials they select have the greatest potential to impact the environment compared with any other single element of their project.

That is why, to be able to compare various materials, it would be beneficial for architects and other designers to have at their fingertips a database of objective life-cycle impact information about all materials. Unfortunately, such a database is not available. Instead, architects rely on the information available to them from competing materials associations.

The Nickel Institute strives to provide relevant information to architects on the environmental and aesthetic performance of nickel-containing stainless steels through the web site www.stainlessarchitecture.org

One of the most recent additions to that website is a brief, nine-page document by Nickel Institute consultant Catherine Houska. It summarizes why nickel-containing stainless steels are an excellent choice for protecting the environment and creating comfortable, attractive structures. Topics include: a summary of the recycling of stainless steel, the relationship between corrosion and the environment and ways that stainless steel can be used to enhance the indoor and outdoor environment.

The document also discusses the long service life that stainless steels offer, how natural resources are conserved by choosing stainless steel over other materials, the role stainless steel plays in building restoration, and how it is reused.

This is an important document for architects to read because it puts stainless steel into the context of today's complex array of available materials.

To download this document, go to:

www.stainlessarchitecture.org/index.cfm/ci_id/44/la_id/1.htm

Foundry Award

Nickel Institute consultant John C. Morrison has been awarded the prestigious British Foundry Metal and Prize for 2004. The award was presented for his paper entitled "Ductile Ni-Resist Type S2W for the Pump Industry," which was published in the January 2003 issue of *Foundryman*.

The award was presented at the Institute of Cast Metals Engineers' centenary awards dinner which was held at Ettington Chase, England on October 22, 2004.

A Superalloy Solution

NASA's fix for the space shuttle

When the U.S. space shuttle *Discovery* flies again, in May 2005, the area where insulating foam broke away, causing terminal damage to *Columbia*, will be redesigned to include high-temperature superalloy S66286 (alloy 286) end covers.

LOCKHEED MARTIN/NASA MICHOUD

The affected area is in the forward bipod area, where struts join the giant external fuel tank to the shuttle. In the old design, the two bipod fittings, which are the attachment points for the 135-centimeter-long struts, were covered with wedge-shaped foam structures called bipod ramps. These prevented the build-up of ice on the fittings caused by the minus 253˚C cryogenic liquid hydrogen fuel in the external tank. The bipod ramps, which measured 76 centimetres (cm) long by 36 cm wide by 31 cm tall, also protected the bipod fittings from aerodynamic stresses.

When *Columbia* left the launch pad in January 2003, a piece of one of the bipod ramps broke free, striking and breaching the leading edge of the shuttle's left wing. On re-entry, superheated gases entered the hole made by the foam chunk, causing *Columbia* to break apart, killing all seven astronauts on board.

In the new design, the bipod ramps have been eliminated. Instead, the bipod fittings will be left exposed, with rod heaters beneath them to prevent ice buildup. Since the bipod fitting end covers will be exposed to much higher temperatures, they have been redesigned using S66286 (containing 24-27% nickel), which can withstand temperatures of up to 1,093˚C. The covers will reach a temperature of 510˚C at the highest point of aerodynamic heating when the shuttle hits a top speed of four times that of sound (Mach 4).

The redesign, with the S66286 end covers, will be retrofitted on the fleet's eight exisitng external tanks and all new tanks. *Discovery* will be the first space shuttle to be launched since the *Columbia* disaster.

MORE INFO: www.nickelmagazine.org/1104/16.htm