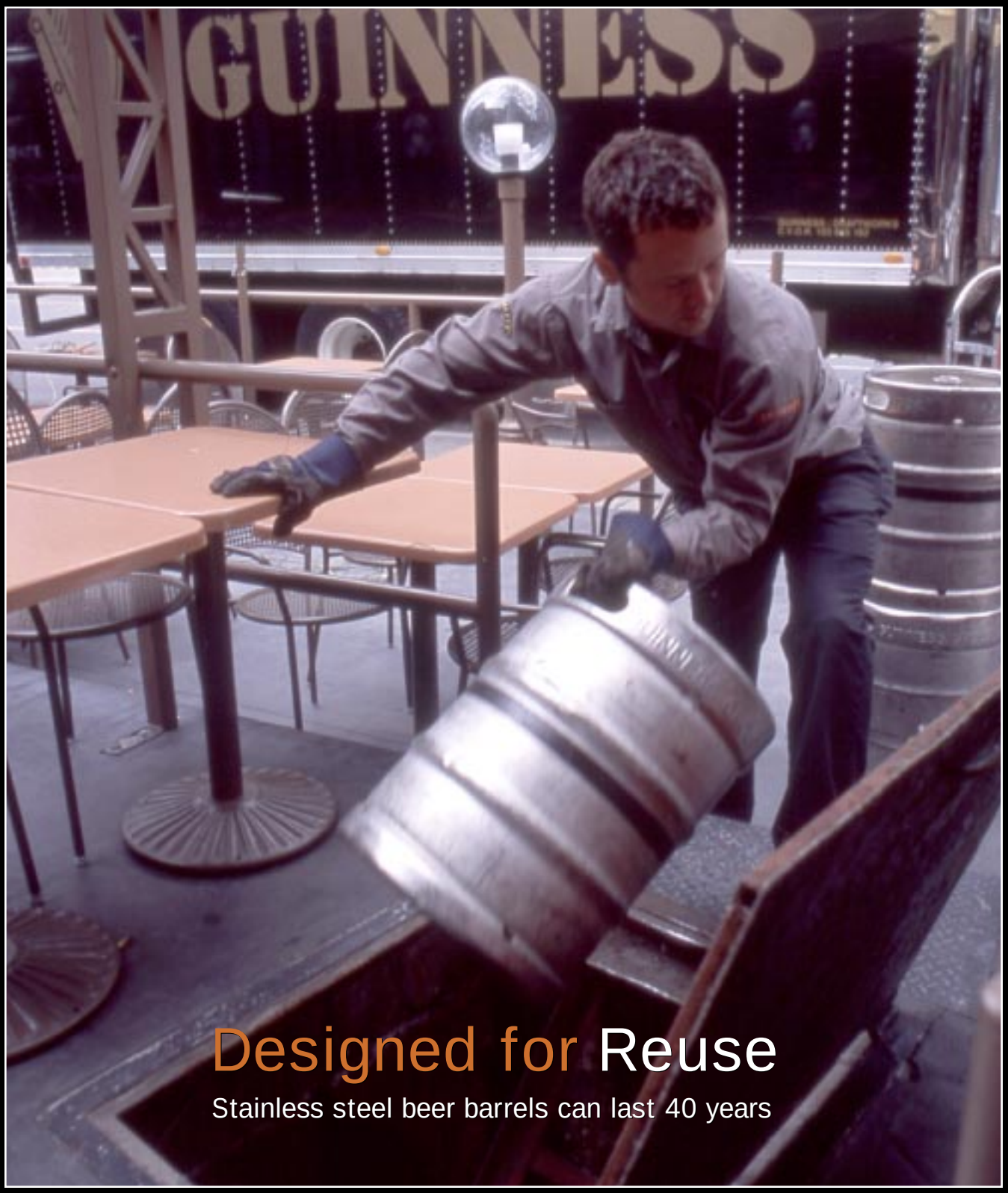
NICKEL

Le Cordon Bleu's Canadian Kitchen

Frames for flat-screen TVs

JUNE 2003 VOLUME 18, NUMBER 3 THE MAGAZINE DEVOTED TO NICKEL AND ITS APPLICATIONS

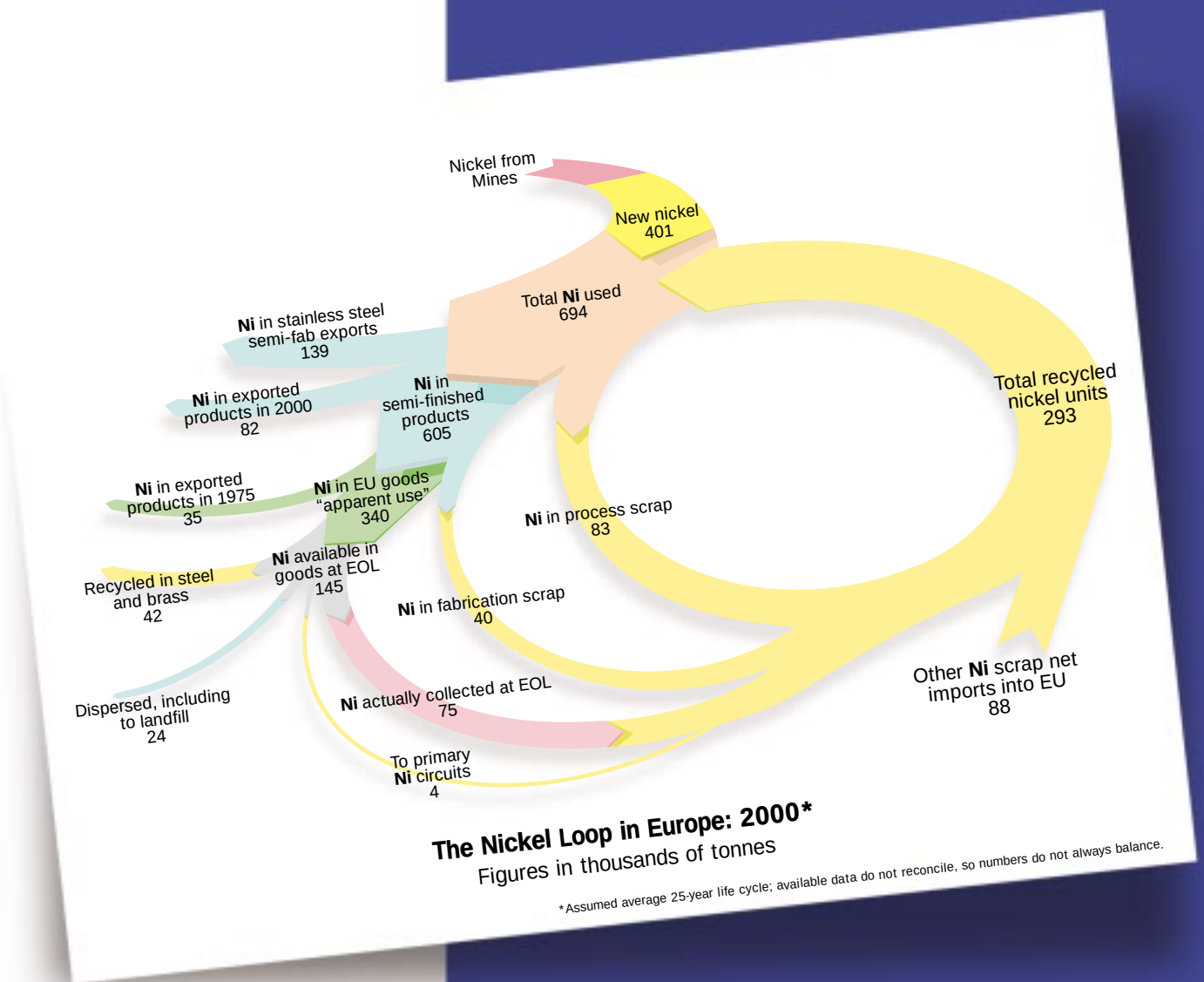


Designed for Reuse

Stainless steel beer barrels can last 40 years

FOLLOW DEVELOPMENTS IN THE

European Risk Assessment



Visit www.nickelforum-eura.org

The European Union (EU) is evaluating the risks to human and environmental health of producing and using five nickel compounds: nickel metal, nickel sulphate, nickel chloride, nickel nitrate and nickel carbonate.

The European Nickel Group Risk Assessment Team represents producers, importers and downstream users of nickel in Europe. It is organizing and funding the nickel industry's input into the EU risk assessment process to ensure that it is conducted with the best available information and sound scientific practice.

For more information on the EU risk assessment of nickel, please visit the web site of the European Nickel Group Risk Assessment Team:

www.nickelforum-eura.org

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European Nickel Group

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SABCO INDUSTRIES INC.

Designing for Reuse

IF ONLY IT WERE POSSIBLE TO DESIGN PATTERNS OF MATERIAL USE IN society (and here, I'm speaking of the inorganic variety) to mimic the cyclical patterns we see in nature. Economic activities would become closed loops; no materials would exit from these loops back into the natural environment from whence they came. These goals are laudable. But are they achievable?

We all know that reusing and recycling materials conserves natural resources, energy and the capacity of the natural environment to assimilate wastes. Nevertheless, the volume of nickel-containing materials that is available at the end of life for reuse and recycling is too small to eliminate the need for newly-mined nickel. Demand for nickel is growing at about 5% per year—too much to be supplied by recycling alone.

Nickel-containing products returned for reuse

Fortunately, very little nickel actually goes to landfill. In the European Union, almost all process scrap and more than 80% of end-of-life nickel-containing products are collected and reused by industry (see diagram on page 2). It is recycled mostly in the form of alloys. About half the nickel content of a stainless steel cooking pan, for example, will have come from recycled sources.

People who reuse and recycle nickel-containing materials are motivated by the high value of these products at the end of their lives. Nickel is worth too much for people to knowingly throw it away. The market price of nickel fluctuates but is about six times greater than that of aluminium and more than thirty times greater than that of carbon steel. Recyclers and industrial users recognize this value.

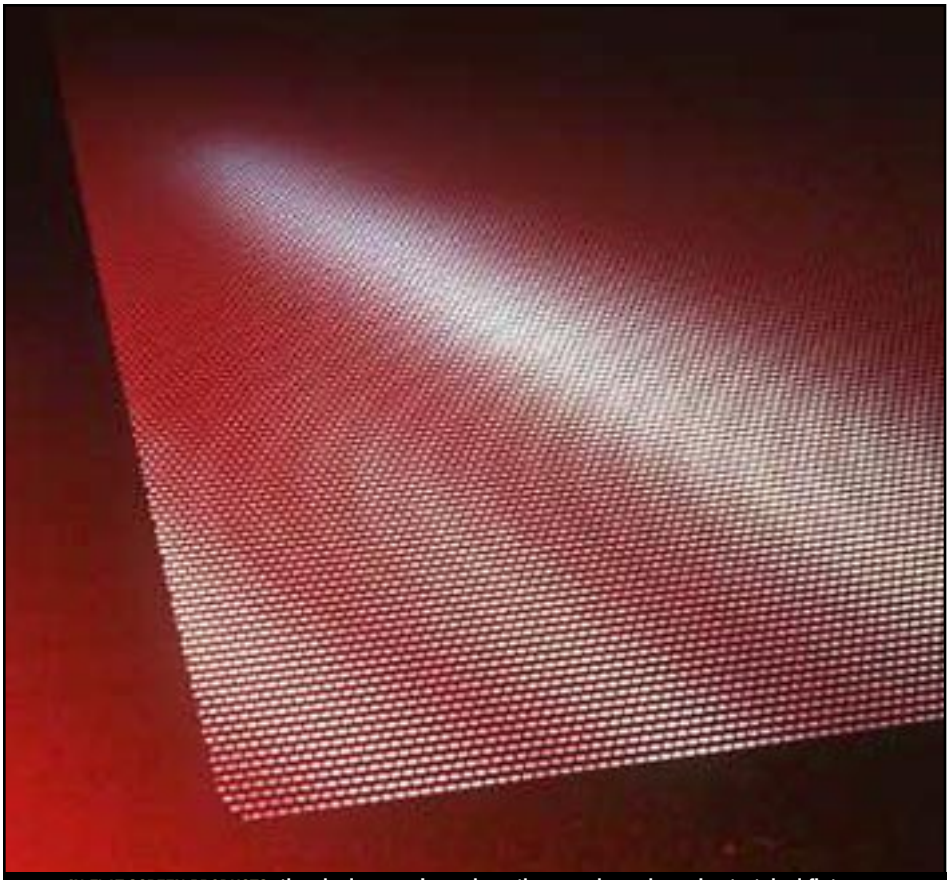
The collection, sorting and reuse of nickel-containing stainless steel is a sophisticated, growing industry in every country where nickel is used. In 2000, more than 290,000 tonnes of nickel were reused in the EU in the form of stainless steel scrap. As the average nickel content of the scrap was about 10%, that means the EU scrap industry handled about 3 million tonnes of nickel-containing stainless steel scrap that year.

One way to increase recovery rates would be to make it easier for consumers to return products for recycling. Mobile phones, for example, may represent a small portion of total waste in the electronics sector, yet their recyclability benefits almost everyone in the developed world—and significant amounts of nickel can be recycled from them. In 2002, one company in the U.K., Shields Environmental, recycled a million nickel-containing batteries from mobile phones: 54% of them were nickel-metal hydride batteries, 30% were lithium-ion batteries, and 16% were of the nickel-cadmium type.

But leaving electronics aside, most nickel-containing products remain in use for an extended period of time. Since they are durable and have a long service life, nickel-containing products often provide the best solutions to today's environmental challenges. Durable products may be somewhat more costly to manufacture, but the payoff comes when they are used for many cycles with little further input. We report on a company that is reaping these benefits by refurbishing stainless steel beer kegs—a product in which nickel plays an important part.

Although closed material loops appear, at present, to be unattainable, the use and reuse of nickel can continue indefinitely. Nickel produced and put into use today should, therefore, be considered to be a resource for future generations.

Patrick Whiteway



IN FLAT-SCREEN PRODUCTS, the shadow mask, such as the one shown here, is stretched flat on a solid metal frame. Those metal frames must also be made of low-expansion nickel alloys.

Keeping Flat Screens Flat

A low coefficient of expansion is the key to alloy frames that support shadow masks

Two nickel-iron alloys, containing 36% and 42% nickel, have found a new application in the rapidly expanding market for large, flat-screen televisions.

Their main characteristic is an extremely low coefficient of thermal expansion, and that makes these alloys, including Imphy Ugine Precision's (IUP's) Invar® (K93600) and Thyssen-Krupp VDM's newer Pernifer® 42 (K94100), ideal for frames that support the shadow masks of new flat-screen products.

Here's why: The shadow mask is a grid that sits just behind the TV screen and provides picture clarity. Its job is to direct electron beams accurately to the hundreds of thousands of dots, or pixels, on the TV screen that convert energy from the electron beams into visible light. In conventional picture tubes, the shadow mask is curved, along with the screen, giving it greater strength. But in a flat-screen TV, the shadow mask must be stretched on to a solid frame to keep its shape. Under these conditions, it's essential the material in the frame does not expand and stretch the mask, even as it is heated up to temperatures as high as 100˚C during use.

The alloy also needs to resist the heat generated by the treatment process that blackens the frame and shadow mask to enhance picture quality. Again, a low coefficient of thermal expansion prevents the shadow mask from stretching out of shape and then losing tension when it cools down again.

ThyssenKrupp VDM's Pernifer 42 TVR (K94100), which contains about 43% nickel plus a trace amount of precipitation-hardening elements such as titanium and niobium, has a coefficient of thermal expansion 10 times lower than conventional steel at temperatures of 20-100˚C. The resulting material is weldable, has a tensile strength of 1,000 megapascals (MPa) and displays no creep expansion under stress. IUP's Invar, which contains about 36% nickel, has a tensile strength of 630 MPa.

"Export in Asia is growing fast," reports Sylvie Gindre, communications manager for IUP. "Today, one TV set out of three is made in China, and we supply Invar to both the manufacturers of TV tubes and their etchers."

Every year, more than 150 million TV sets are sold around the world. Although conventional sets still account for 96% of sales, U.S. market research firm iSuppli/Stanford Resources predicts that sales of flat-screen TVs will reach 12 million per year by 2005.

That's a brand new market for an old workhorse like Invar, which, since its discovery more than 100 years ago, has been used extensively in applications ranging from watches to thermostats.

MORE INFO: www.nickelmagazine.org/0603/4.htm

IMPHY UGINE PRECISION

Product Stewardship

Efforts are underway to recover more of the materials that go into mobile phones

Many of the world's major mobile phone manufacturers have agreed to take back old phones for recycling. In December 2002, ten manufacturers signed a declaration, in keeping with the United Nations Environment Programme (UNEP) Basel Convention to devise ways of keeping mobile phones, and therefore the materials they contain, out of landfills. The UNEP declaration follows a European Parliament and Council directive dealing with Waste, Electric and Electronic Equipment, which takes effect in 2004.

Of significant concern is the amount of lead, cadmium and mercury in mobile phones that end up in landfill sites. Other metals such as precious metals and copper could make it viable to recycle these seemingly ubiquitous electronic units. Nickel, by comparison, is less significant.

The amount of nickel in mobile phones (excluding the battery) varies by design, from 0.5 to 1 gram. But that goes up significantly when the rechargeable batteries are included. Nickel-cadmium (containing 16-20% nickel) and nickel-metal hydride batteries (28-35% nickel) used to be the main power source for the phones, but companies have since moved toward lighter lithium-ion batteries, which contain just 1-1.5% nickel.

Most European manufacturers collect phones through service centres or retail outlets. Nokia, one of the largest manufacturers, has been collecting phones in Europe through its service centres for several years now and intends to start similar programs in the Americas. In addition to service centres, several ideas are being considered, such as partnering with a cellular network provider, establishing a charity, or having a national logistics company collect the phones.

SOME OF THE **1.7 million mobile phones that were collected by one company in the United Kingdom in 2002.**

Currently anyone can arrange to return a phone to Nokia in North America through its web site. Nokia is considering different methods because "no one program is going to get all the phones back," says Donald O'Connell, vice-president of research and development for Nokia Mobile Phones.

According to Mats Pellbäck Scharp, Sony Ericsson's director of environment, health and safety, it is the cellular network providers who can best inform end-users about return programs, as they have a relationship with the end-users that manufacturers don't have.

A spokesman for Shields Environmental, a British company that collects old phones for manufacturers, says its collection program has saved 1.7 million phones from landfill per year and recycled 34 tonnes of batteries in the United Kingdom.

Shields collects and sorts phones for companies such as Virgin Mobile and Vodaphone. It refurbishes the phones it can reuse, and recycles the ones it cannot. The recycled phones are broken into components, which are then sent to recyclers.

MORE INFO: www.nickelmagazine.org/0603/5a.htm

SHIELDS ENVIRONMENTAL

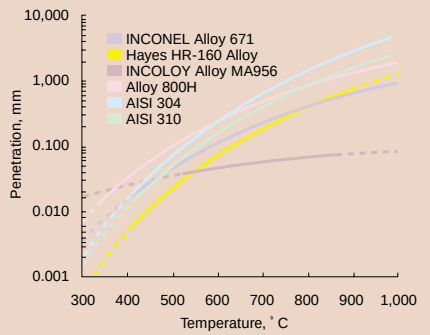
Managing Corrosion

Accurately predicting corrosion in the energy and chemical process sectors could help reduce costs

The U.S. Department of Energy (DOE) has agreed to provide roughly half the funding for a US$2-million project designed to expand the capabilities of ASSET, an emerging piece of software that can predict the corrosion of commercial alloys in high-temperature environments.

The software, known as ASSET (Alloy Selection System for Elevated Temperatures), was developed by Shell Oil and further advanced by the DOE and a growing consortium of companies which are funding the other half of the current project. As a result, the program's database now contains more than 10.2 million hours of corrosion data for 91 commercial alloys, including many nickel-containing stainless steels and several nickel alloys. The software operates on a personal computer using the Windows operating system.

The project, which was scheduled to begin in May 2003 and last two years, is designed to improve predictions for a wider range of alloys exposed to a variety of corrosive conditions at temperatures ranging from 200˚C to 1,200˚C. The study will focus on modes of corrosion in chemical processing equipment, including corrosion by chlorine and hydrochloric gases, cyclic oxidation and metal dusting.



Plot showing predictions of metal thickness loss by corrosion in 5%H_2S- 5% H_20-90%H_2 after one year for several nickel-containing alloys, as predicted by ASSET. Dashed portions of lines are extrapolations.

"There is a compelling opportunity to increase the accuracy used in predicting equipment lifetimes, as they are limited by corrosion in high-temperature gases," says Randy John of Shell Global Solutions, which is spearheading the project. "Benefits in improving corrosion management will be far-reaching in the chemical industry and the United States economy."

Among the benefits are significant energy savings and reduced carbon dioxide emissions for industry sectors such as power generation, petroleum, chemicals and pulp and paper. Specific applications of the technology include: analyzing equipment failures to reduce maintenance costs and improve safety; selecting cost-effective alloys; and developing equipment design and operation guidelines to reduce costs.

Access to the ASSET software is currently limited to the roughly 60 companies participating in the project, however other companies are welcome to participate.

MORE INFO: www.nickelmagazine.org/0603/5b.htm

IN HEAT TREATMENT furnaces, rollers made of nickel aluminide can last up to five times longer than conventional alloy steel rollers.

Exotic Alloy Finds Niche

Nickel aluminide, an intermetallic alloy, cuts the cost of heat-treating

An intermetallic material, nickel aluminide (Ni_3Al), is enabling manufacturers to slash the energy, product recycle, and capital equipment costs associated with austenitizing, carburizing and other heat-treating furnace applications.

Containing 80% nickel, this advanced alloy is beginning to challenge more traditional materials in some applications. For example, a steel plate austenitizing furnace at Bethlehem Steel's Burns Harbour plant, in Chesterton, Indiana, U.S.A., has more than 130 tonnes of the alloy in the form of transfer rolls, while a carburizing furnace at the Delphi Saginaw Steering Systems' automotive parts plant in Saginaw, Michigan, U.S.A., has more than 110 tonnes in various fixtures.

Demand could double in two years as new applications, such as radiant burner tubes and seal rolls (now under trial), come into use.

Developed jointly by the U.S. Department of Energy's Oak Ridge National Laboratory (ORNL) in Tennessee, U.S.A., and Delphi Automotive Systems Corp. in Troy, Michigan, U.S.A., the alloy becomes stronger at around 900˚C. That's because of its highly ordered structure and creep resistance, the properties underlying its superior performance.

The alloy, known as IC-221M, contains nickel combined with aluminum, chromium, molybdenum, zirconium and boron. The addition of boron is critical in increasing the ductility of the alloy and it was this discovery that allowed the alloy to become commercially producible. Melted and cast by ORNL's Exo-Melt™ process, the alloy is supplied by half a dozen licensees in the U.S.

NICKEL ALUMINIDE rollers do not blister or need grinding.

IC-221M is superior to conventional alloys. For example, traditional heat-resistant steel alloy HP (N08705, containing 25% chromium, 35% nickel) transfer rolls blister under use at 950˚C, with several costly consequences:

- the furnace is shut down weekly to grind blisters off the roll surfaces, wasting heat and cutting production;
- as much as 40% of the steel plate product is down-graded by scratches caused by the blisters, resulting in decreased revenues, and
- the rolls must be replaced frequently, some annually, with corresponding capital replacement costs.

However, the nickel aluminide rolls do not blister or need grinding, enabling manufacturers to save on energy costs and enhance production revenue. In addition, they last three to five times longer than steel alloy rolls, so life-cycle costs are lower.

Conventional alloy steel fixtures in carburizing furnaces cause other problems: catastrophic failure of a fixture can jam the furnace, which must be shut down, wasting energy and possibly compromising the quality of the product being treated. Nickel aluminide fixtures, on the other hand, have three times the life of steel fixtures, decreasing both the number of fixtures needed and also the number of furnaces required for a given production rate. Energy, product replacement and capital costs are therefore all lower with the nickel aluminide alternative.

Few engineering materials are developed without technical challenges, and IC-221M alloy is no exception. The very features that underpin the remarkable performance of nickel aluminide ñ its highly ordered, stable structure and great creep resistance ñ also make it difficult to weld. In a roll application, for example, welding is essential for connecting the trunnion to the roll body. This was a problem in early trials, but the welding technology has developed so that automated GMAW (MIG) procedures now produce consistent, reproducible welds.

Not surprisingly, the initial cost of nickel aluminide can be up to twice that of conventional heat-resistant steel alloys, but because of its performance, the life-cycle cost of the nickel aluminide alternative is considerably lower. Consequently, we are likely to see more Ni_3Al in rolls, fixtures, burner tubes and other applications.

IC-221M alloy is covered by ASTM A1002-99, 'Standard Specification for Castings, Nickel-Aluminum Ordered Alloy.'

MORE INFO: www.nickelmagazine.org/0603/6.htm

OAK RIDGE NATIONAL LABORATORY

When all is Said and Done

In the United States, stainless steel has been used to make caskets since 1989

Product familiarity is always important, especially when making a purchase under difficult circumstances. The most traditional, trusted material for caskets is wood, but another is stainless steel.

"From the aesthetics standpoint, consumers are readily familiar with products made of stainless steel. This is a material with which they are very accustomed," explains Joe Weigel, the director of communications with the Batesville Casket Company in Batesville, Indiana.

Batesville Casket, which goes back to 1884, has been manufacturing stainless steel caskets since 1989 and presently produces five different styles. The premium model is the Millennium Casket, which receives hours of hand polishing, followed by a clear top coat. All of the models are manufactured with 20-gauge S30100, which, says Ned Rogers, manager of the metal commodity team, "offers the best mechanical properties for drawing."

AESTHETICS, not cost, is the main reason people choose to purchase a stainless steel casket. This model uses S30100, containing 7% nickel.

Each casket requires about five square metres of sheet steel. The sheets are run through multiple, automotive-type presses for blanking, forming and drawing operations. The caskets are of 100% welded construction using continuous seam welding. Resistance, MIG, TIG and plasma processes are used. "These are the most efficient processes we can use," says Rogers. "They do the least amount of distortion to the finished metal."

MORE INFO: www.nickelmagazine.org/0603/7a.htm

Critical Research

Can corrosion-resistant nickel alloys be used as liners of supercritical water oxidation reactors?

Members of an international consortium looking into supercritical water oxidation (SCWO) as a means of destroying organic chemicals are cautiously optimistic about research at the H. H. Uhlig Corrosion Lab at the Massachusetts Institute of Technology (MIT).

Preliminary results indicate that SCWO reactors may not have to be lined with platinum, but instead could possibly be lined with less expensive nickel alloys.

In the SCWO process, hazardous or toxic organic contaminants in aqueous wastes are rapidly oxidized at temperatures of about 600˚C, pressures of 24 to 30 megapascals, a pH range of 2 to 12, and oxygen concentration levels ranging from parts-per-million up to percentage levels. Under these conditions, water acts like a dense gas, becoming very soluble to organic substances and gases like oxygen and nitrogen, creating a highly corrosive environment. Many organic compounds are completely oxidized in single-phase reactions to carbon dioxide, water and various acids.

The consortium, which includes of some of the world's largest producers of nickel alloys (including Special Metals, Haynes, ThyssenKrupp VDM and Mitsubishi) and the Nickel Development Insitute, met recently at the annual conference of NACE International, which was held in San Diego, California, U.S.A. in March.

The consortium was formed in October 2000 to explore several questions, one of which is: Can operators control the rate of corrosion of the reactor shell, and thus control the liner's susceptibility to failure, by controlling the feedstock parameters to a SCWO reactor?

Although no actual feedstocks will be tested, the researchers want to understand what parameters cause high rates of corrosion in these alloys. This will allow operators to select the most cost-effective material based on the type of feedstock.

Using sensors developed at Penn State University, researchers at MIT are testing various nickel alloys at many different temperatures, oxidizing potentials and pH conditions.

Although limited data have been generated so far, they indicate that nickel alloys may perform satisfactorily at relatively high oxidizing and pH conditions—conditions which are ideal for the destruction of dangerous chemicals inside these reactors.

In the first tests, samples of N06022 wire showed significant "de-alloying" of nickel at a pH less than 2 and no corrosion at a higher pH of 4.5.

"Initial experiments look promising," says Ronald Latanision, Professor of Materials Science and Engineering at MIT. "Nickel-chromium alloys have a larger operating 'window' than other alloys, therefore show the most potential for use in this service."

"Platinum is not the answer for this technology," Latanision says. "It's too expensive."

SCWO will be discussed at a session at the next NACE International annual conference, to be held in New Orleans, Louisiana, U.S.A.

MORE INFO: www.nickelmagazine.org/0603/7b.htm

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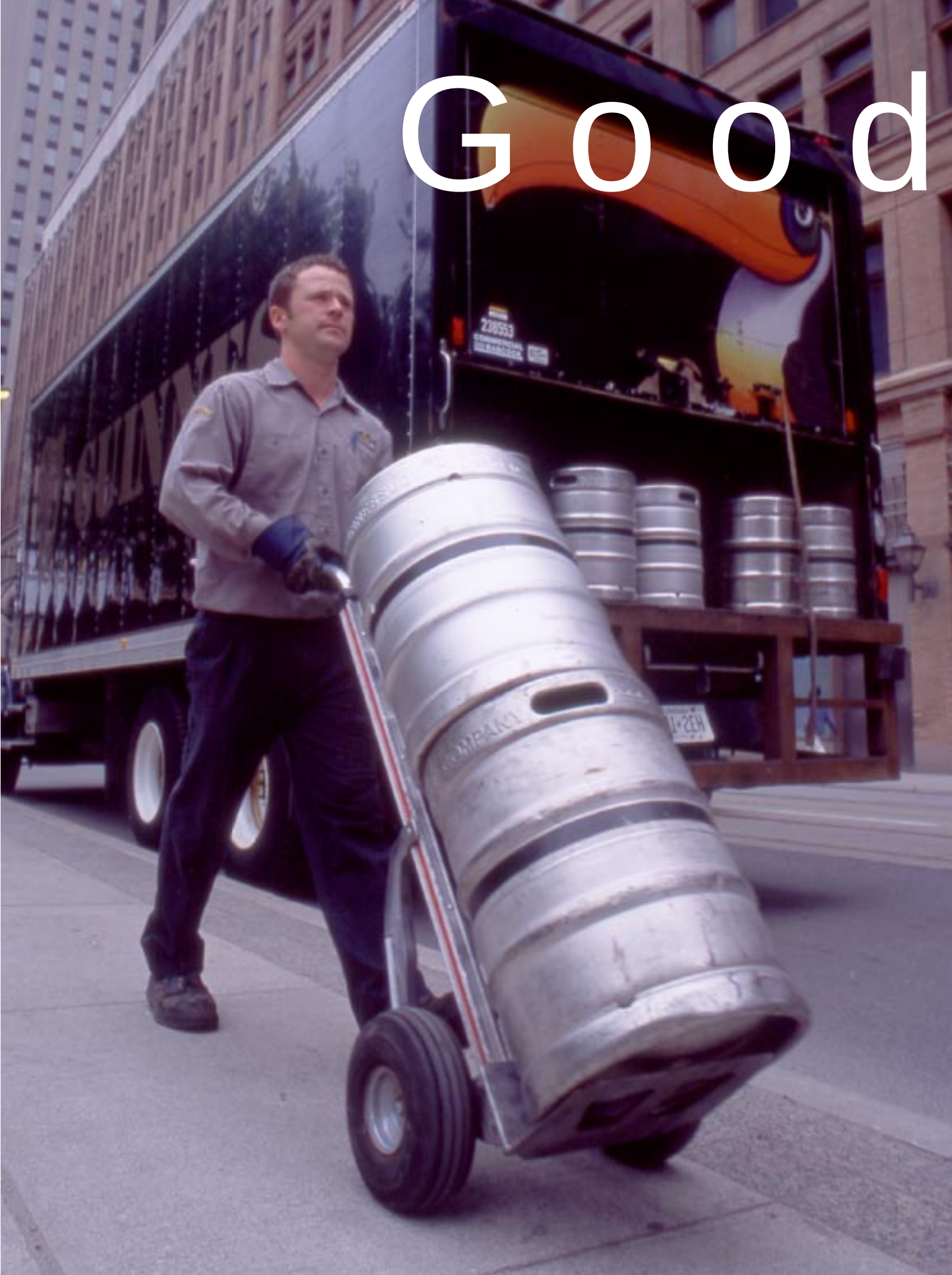
Good

as new

Durable, cleanable stainless steel beverage kegs are reused over and over. *By Dean Jobb*

Be forewarned if you happen to sing, or even whistle, Roll Out the Barrel within earshot of Robert Sulier: at any given time, the president of Sabco Industries Inc. could oblige with one of the tens of thousands of beer and soft-drink kegs on hand at his busy plant in Toledo, Ohio, U.S.A.

Sabco is North America's largest recycler of stainless steel kegs, repairing and reconditioning more than 100,000 units each year for breweries and beverage producers in the United States, Canada and Mexico, as well as a few overseas customers.

Founded in 1961, Sabco (derived from the company's original name, Save-A-Barrel Corp.) has refurbished more than 3.5 million barrels. Among its 1,500 clients are beer giants Miller and Fosters, soft-drink icons Pepsi and Coca-Cola, and numerous micro-breweries.

"We recondition kegs fully, disassembling and rebuilding them to meet federal specifications for capacity and cleanliness," says Sulier. "We also recondition the valves that go in the kegs. We know of no other company that specializes in stainless steel food product containers which is as focused as we are on breweries and beer kegs."

The containers are made from S30400 stainless steel, which welds cleanly and provides the smooth interior needed to prevent bacteria from gaining a foothold (S30403 is used in newer models), according to John Pershing, vice president. Reusing 58.7-litre beer barrels and their slimmer cousins, the 19-litre soda keg, is not just environmentally responsible; it makes good economic sense. New barrels cost in the range of US$70 each, but Sabco resells kegs it has bought, cleaned and reconditioned for about US$50.

Sabco's 30 employees also perform routine maintenance on customers' kegs. Large breweries have a great many barrels in their inventory, and they routinely truck these to Toledo for restoration.

Says Sulier: "If you send me a keg that's totally out of commission because of either denting or valve malfunctions, or just completely filthy on the inside, I will give it back brand-new, inside and out, and I'll do it for less than 20 dollars."

Compare that with the scrap value of the 14 kilograms of metal in a typical beer keg (about US$8), and the advantage of using stainless steel kegs is clear. Brewers routinely buy surplus kegs from competitors that are scaling back or go out of business, then bring them to Sabco for a refit.

"Companies that purchase kegs from other companies will usually arrange to have them sent to us first for a clean-up, before receiving them," says Sulier. "That way they know what they're getting."

Durability is another plus—a properly maintained barrel will have a lifespan of 30 years or more. "They're incredibly durable," says Sulier. "We recondition kegs from the 1970s that are in perfect condition; some are from as far back as the early 1950s." (Brewers stopped using the traditional, slightly rounded barrel once operations became automated to handle newer, straight-sided models.)

Sabco's services vary in accordance with a customer's needs and the condition of the barrels. Some brewers want new labels applied or an existing name removed. The metal skirt at the bottom of a barrel, prone to damage if the container is dropped, may have to be replaced. Valves may need to be cleaned or replaced, or the entire barrel may have to be disassembled and rebuilt.

Dents can affect the capacity of a keg or prevent it from being handled and washed by automated machinery; Sabco workers remove dents by hand or insert the keg in a mould and use pressurized water to pop them out. Caustic solutions and acid baths are used to thoroughly clean barrels before they leave the plant.

By Dean Jobb, a Halifax-based writer.

MORE INFO: www.nickelmagazine.org/0603/8.htm

■ **More than 100,00** stainless steel beverage kegs, each weighing about 14 kilograms, are refurbished and reused in North America every year. ■ **Reconditioned,** 19-litre soda kegs are considerably less expensive than new units. ■ **A refillable** beer barrel, made of S30400 or S30403 nickel stainless steel, has a capacity of about 60 litres and can dispense beer for up to 40 years. ■ **Straight-sided** models are the norm.

TIM PELLING/NIDI SABCO INDUSTRIES INC.

Le Cordon Bleu's Kitchen

Classical French cuisine is taught in a new, state-of-the-art stainless steel kitchen in Ottawa, Canada.

By Carroll McCormick

Synonymous with the *plus haute* of the *haute cuisine,* Le Cordon Bleu has an international reputation as the school for learning classical French cuisine. Founded in 1895 in Paris, Le Cordon Bleu draws amateurs and culinary professionals from more than 50 countries to its teaching kitchens.

In 1988, Le Cordon Bleu opened Le Cordon Bleu Paris Ottawa Culinary Arts Institute, its first school outside France. Nestled among the world's embassies to Canada, it is known as the Ambassador of French Gastronomy in North America.

Le Cordon Bleu Paris Ottawa Culinary Arts Institute has five kitchens: a prep kitchen for the restaurant kitchen, where meals are prepared for the three-story mansion's 86-seat restaurant; a demonstration classroom with seating for student chefs and a fully-outfitted one-chef kitchen and video recording capabilities; a 16-work-station "practical cuisine" kitchen, where students work around an enormous stove known as a French piano; and a pastry kitchen. A sixth kitchen, part training kitchen and part banquet preparation facility, is being built in the basement.

Nickel stainless steel is the material of choice for professional kitchens, and in Cordon Bleu's Ottawa facilities, the ubiquitous gleam of steel reflects the material's dominance. Practically everything in sight—bread trays, coffee pots, creamers, counters, cupboards, refrigerators, ovens, pots, pans and pastry racks, range hoods, rotisseries, shelves, stoves, sinks, serving bells and serving dishes, even the swinging doors and doorframes, are all made of S30400 or S31600.

The new banquet kitchen, measuring about 30 by 17 metres, will be outfitted predominantly with stainless steel counters, cupboards, fixtures and cooking equipment made of S30400 and S31600, according to project manager Pierre Harvey of Quebec City-based SML Stainless Steel Group, which specializes in building and installing custom kitchens. "It doesn't rust, it takes a good cleaning and it is sanitary," Harvey says of the material.

And general manager Christine Maassen: "It's all about long-term maintenance." The kitchens receive tremendously heavy use from early morning to nearly midnight, and there is no time to coddle the capital assets. Clouds of steam rise constantly from giant cooking pots and sinks, and a non-stop blur of chefs slide, scrape, plunk, bump and whisk their creations. Occasionally, they even use the counters as impromptu cutting boards.

MORE INFO: www.nickelmagazine.org/0603/10.htm

Fine cuisine by Le Cordon Bleu

Practically everything in sight in Le Cordon Bleu's new kitchen in Ottawa, Canada is made of nickel stainless steel.

S30400 and S31600 were chosen for cleanability, durability and corrosion resistance.

FAST-TRACKING LNG Carriers

Requirement for faster, better welding met by variant of Invar 'workhorse'

France's Imphy Ugine Precision (IUP) has developed a variant of K93600, more commonly known as Invar®, that meets the new weldability requirements for carriers using the Gaztransport Technigaz (GTT) design. The revised alloy, Invar M93, allows for faster, better-quality welding, an important feature now that liquefied natural gas (LNG) carriers are being constructed in a record 8-12 months.

Over the past decade, IUP has become a key player in the growing market for LNG tanker liners by providing an affordable solution to the thermal stresses the tanks endure as they transport their cryogenic cargo to ports around the world.

Since 1963, shipbuilders designing LNG carriers to the specifications of GTT of France, one of the main suppliers of LNG containment systems, have used IUP's Invar, an iron-nickel alloy, to line the carrier's gas tanks.

Using the GTT design, the tanks are fully integrated into the hull of the ship. The cargo containment system, which is fitted inside the tanks between the inner hull and the gas cargo, has a liner consisting of two separate metallic membranes about 0.7 millimetre thick and 500 millimetres wide. The membranes are made of Invar, a special 36%-nickel iron steel alloy with an extremely low coefficient of thermal expansion. At temperatures of -163˚C (the temperature of liquid methane, the main component of natural gas), Invar provides a high level of ductility.

The chief advantage of the variant alloy is that it reduces the total cost of lining a tank. Using Invar M93 to line a tank is less costly than using other liner materials such as stainless steel because the strips can be made thinner and don't need to be corrugated before they are applied to the tanks.

As a result of these factors, the market share for LNG carriers using Invar technology has doubled to 60% today from 30% in the mid-1990s, according to IUP.

"IUP has supplied Invar for 68 LNG carriers, including 42 in operation and 26 under construction, since 1963 thanks to its know-how and special finishing equipment," says the company's communications manger, Sylvie Gindre.

Since natural gas is relatively clean to burn, compared to coal or oil, its popularity is increasing worldwide. According to Gindre, world consumption of LNG is expected to grow by 10% between 2000 and 2005, including a 45% jump in consumption in the United States. There is a corresponding boom in the LNG shipbuilding business.

GTT recently launched a new containment system that can carry up to two million cubic metres of LNG. The system uses an Invar primary membrane for quick assembly and reinforced polyurethane foam panels for insulation. The second membrane is made of a composite aluminium-glass fibre called triplex.

MORE INFO: www.nickelmagazine.org/0603/12.htm

IMPHY UGINE PRECISION

THE COLD ROLLING MILL at Imphy where coils of low-expansion nickel alloy are produced.

THE TANKS that hold the LNG at temperatures of -163˚C are lined with low-expansion nickel alloys

NACE INTERNATIONAL President Elaine Bowman presents NiDI consultant Gerard Sorell with a NACE Fellow Award, March 2003.

NACE Fellow Award

Gerard Sorell is the fifth consultant to the Nickel Development Institute (NiDI) to be honoured by NACE International for distinguished contributions in the field of corrosion and its prevention.

Sorell received the NACE Fellow Award from the association's president, Elaine Bowman at the awards banquet of the 58th Annual NACE Conference and Exposition, held in San Diego, California, U.S.A.

The award recognizes Sorell's career-long demonstration of technical excellence in the application of materials in areas with difficult corrosion problems, including petrochemicals, fossil energy technologies and waste incineration.

Sorell is the author of NiDI Technical Series No. 10086: *"Corrosion- and Heat-Resistant Nickel Alloys: Guidelines for Selection and Application"* and NiDI Reprint Series No. 14045: *"The Role of Chlorine in High Temperature Corrosion in Waste-to-Energy Plants."*

NiDI consultants who have received this award previously include: Paul Dillon (1993), G. B. Elder (1995), Bruce Craig (1996) and Jim Jenkins (2001).

The annual NACE Corrosion Conference is the largest gathering of corrosion specialists in the world. Total attendance at this year's meeting exceeded 4,200.

NACE International has a membership of 15,000 from 91 countries, making it the largest organization committed to the study and prevention of corrosion.

Welding and Fabrication of Nickel Alloys

A two-day, hands-on workshop will be held in Cleveland, Ohio, U.S.A., November 4-6, 2003 at Lincoln Electric's Welding Technology Centre. Two Nickel Development Institute consultants: W. L. (Bill) Mathay and Richard (Dick) Avery will provide information on the most recent welding technology, material science, and fabrication methodology of nickel alloys. The purpose of the workshop is to provide welding, metallurgical and construction practice information to design engineers, welding engineers, technicians, technologists and welders regarding the joining of nickel alloys.

The technical program specifically deals with the thin-sheet metallic lining methods of FGD installations and nickel alloy clad base material used for chimney construction. Additionally, the program features hands-on welding presentations and all are encouraged to participate.

Attendance is restricted to 25 participants, and attendees are encouraged to bring along their own welding gear for the hands-on portion of the program. Contact: Dorothy Steinbach, The Welding Technology Center, 22801 St. Clair Avenue, Cleveland, Ohio, U.S.A. 4417-1199. Tel: +1 216 383 2240. Fax: +1 216 383 8025 E-mail: dorothy_steinbach@lincolnelectric.com Web site: www.lincolnelectric.com

NiDI Appointment

LONDON OFFICE—Kati Aaltonen will be joining the Nickel Development Institue on 1st July 2003 as European Environment Project Officer. Kati will be working with Dr. Sally Williams, European Director—Health and Environment, on projects related to the European Union Nickel Risk Assessment but will also be involved with other EU health and environment issues.

KATI AALTONEN: European Environment Project Officer

Kati has a masters degree in Environmental Engineering from the Lappeenranta University of Technology, Finland and a B.Sc. degree in Environmental Technology. In addition to working on environmental issues in Finland with AvestaPolarit and Outokumpu Poricopper Ltd., Kati has experience in The Netherlands, Egypt, Thailand and the UK. She speaks Finnish, English and some Swedish.

UNS details

Details of the chemical compositions (in percent by weight) of the 9 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	S	Si	V	W	Zr
IC-221M P.6	7.3-7.8	0.003-0.012	0.08 max	-	7.5-8.5	-	1.00 max	-	1.20-1.70	-	bal.	-	0.020 max	-	-	-	1.6-2.10
K93600 (Invar) P. 4,12	-	-	-	-	-		64	-	-	-	36	-	-	-	-	-	-
K94100 P.4	0.10 max	-	0.02 max	-	0.025 max	0.5 max	bal.	0.7 max	-	41-43	-	-	-	0.2 max	-	-	-
N06022 P.7	-	-	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	- -
N08705 P.6	-	-	0.35-0.75	-	24.0-28.0	-	rem	2.00 max	0.50 max	-	35.0-37.0	0.04 max	0.04 max	2.50 max	-	-	-
S30100 P.7	-	-	0.15 max	-	16.00-18.00	-	-	2.00 max	-	-	6.00-8.00	0.045 max	0.030 max	1.00 max			
S30400 P.8,10	-	-	0.08 max	-	18.00-20.00	-	-	2.00 max	-	-	8.00-10.50	0.045 max	0.030 max	1.00 max	-	-	-
S30403 P.9	-	-	0.03 max	-	18.00-20.00	-	-	2.00 max	-	-	8.00-12.00	0.045 max	0.030 max	1.00 max	-	-	-
S31600 P.10	-	-	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	-	-	-

NIDI

FOR ANSWERS to all your questions about the European nickel risk assessment go to www.nickelforum-eura.org

ASTM Defines 'Nickel' and 'Nickel Alloy'

After four years of committee work, ASTM has come up with definitions of 'nickel' and 'nickel alloy.' The new definitions appear in ASTM B 899-02: Standard Terminology Relating to Non-ferrous Metals and Alloys.

It defines nickel as "a refined nickel primarily produced from ore or matte or similar raw material containing a minimum of 99.80 percent nickel by weight."

Similarly, a nickel alloy is defined as "a material that conforms to a specification that requires, by weight percent, more nickel than any other element, with the possible exception of iron"

In an explanatory note, the standard says: "Prior to 1992, 'nickel alloys' were defined as alloys nominally containing less than 50% iron with nickel as the highest nonferrous element present. Under the current guidelines, only alloys containing nickel as the principal constituent will be considered as a nickel alloy for the purpose of new coverage in B02 specifications."

Since they are not used in ASTM standards, the terms 'nickel-base alloy' and 'nickel-based alloy' are "not preferred" terms within ASTM B 899.

ASTM Subcommittee B02.91 Editorial and Terminology defines new terms under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys. The B02.91 subcommittee meets twice a year.

The next meeting will be held in Tampa, Florida on Wed. Nov. 19, 2003 at 8:00 AM.

@www.nidi.org

- **NICKEL/COBALT:** Keynote address by NiDI President, Dr. Ivor Kirman: www.nidi.org/index.cfm/ci_id/12229.htm
- **RISK ASSESSMENT:** Search the FAQs of the European nickel risk assessment at: www.nickelforum-eura.org/index.cfm/ci_id/12254.htm
- **NiDI TOP 10:** A list of the most downloaded NiDI technical papers: www.nidi.org/index.cfm/ci_id/12228.htm

COMING EVENTS

Marine Corrosion

The Sea Horse Institute will provide an open forum through which practical information and solutions related to marine corrosion and biofouling can emerge. The conference will be held at Wrightsville Beach, North Carolina, U.S.A., August 10-14, 2003. Active participation is encouraged from all attendees who typically come from a broad range of disciplines and with varying levels of expertise. The format of the meeting is unique and very informal. Although there is an agenda, attendees are encouraged to bring examples (slides, view graphs, etc.) of marine corrosion problems and solutions for "show and tell" during the technical sessions. Input is encouraged. Contact: Lisa Weiss, Conference Coordinator, Tel: + 1 910 256 2271 ext. 300; Fax: + 1 910 256 9816; E-mail: seahorse@laque.com; Web site: www.marine-corrosion.com

OFFSHORE EUROPE 2003 The Nickel Development Institute will have a stand at this oil & gas exhibition and conference which will be held September 2-5, 2003 in Aberdeen, Scotland, Europe's centre of excellence for offshore technology. Thousands of oil & gas operators, engineering contractors, drilling contractors, manufacturers of rigs and platform equipment, production and process equipment, subsea systems, downhole services and marine services are expected to attend. Contact: The Offshore Europe Partnership, Apex Tower, New Malden, Surrey KT3 4LH, United Kingdon. Tel: +44 (0) 20 89 49 9888. Fax: +44 (0) 20 89 9889. E-mail: oe2003@spearhad.co.uk Web site: www.offshore-europe.co.uk

STAINLESS STEEL IN ARCHITECTURE The Specialty Steel Industry of North America (SSINA) and the Nickel Development Institute (NiDI) will hold half-day workshops in four U.S. cities (Pittsburgh, Cleveland, Detroit and Chicago), September 9-12, 2003. Architects and other materials specifiers will have an opportunity to learn about new, innovative and cost-effective applications of stainless steel . Suitable for both new and experienced stainless steel specifiers, these events are interactive and questions are encouraged. Participants receive 6 CE units of Health, Safety and Welfare hours applicable toward the AIA annual requirement of eight hours. Contact: Ellen Edwards, Specialty Steel Industry of North America, 3050 K Street, N.W. Suite 400, Washington, D.C., U.S.A. 20007. Tel: 202 342 8630. Fax: 202 342 8631. E-mail: eedwards@colliershannon.com Web site: www37.rapidsite.net/ssinac/wr_form.html

METAL MARKET FORUM Metal Bulletin will hold a "Nickel, Stainless and Special Steels Forum" at the Radisson SAS Palais Hotel in Vienna, Austria, September 22-25, 2003. Get the whole supply-demand picture from nickel raw materials through to stainless and special steels demand. Contact: Eva Claramonte. Tel: +44 (0) 20 7827 5289. E-mail: eclaramonte@metalbulletin.com

WORLD STAINLESS 2003 Stainless Steel World will hold its third world Conference & Expo November 11-13, 2003 in Maastricht, the Netherlands. The aim is to provide a platform for materials professionals to update their knowledge of corrosion resistant alloys. Emphasis is placed on applications and end-use experience. Some 3,000 suppliers, engineering companies, fabricators, manufacturers, steels works, welding companies and research institutes are expected to attend. Concurrent with the conference will be a exhibition dedicated to corrosion resistant alloys. An exposition programme includes seminars by industry forecasters and experts. About 150 exhibitors are expected to participate. Contact: Mrs Marion Barth, KCI Publishing BV, P.O. Box 396, 7200 AJ Zutphen, the Netherlands. Fax: +31 575 511 099. E-mail: ssw2003@kci-world.com Web site: www.stainless-steel-world.net

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