AUSTRALIAN STAINLESS

SPECIALISING IN STAINLESS STEEL AND ITS APPLICATIONS

52
SUMMER
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Image courtesy of TripleNine Stainless.

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Cutting a Carbon Footprint

Manifold to CIP plant

CIP tanks

Stainless steel filters

Stainless steel pipework

Coca-Cola Amatil is reducing the carbon footprint of its 600ml PET bottles by 22% with the help of stainless steel.

Innovation in process technology and the successful application of stainless steel has led to efficiency gains and sustainable outcomes for one of the world's most recognised brands in the food and beverage industry.

In 2011, Coca-Cola Amatil (CCA) announced a $450 million investment in PET bottle self-manufacture, or 'blow-fill' technology at its production facilities across Australia, New Zealand, Indonesia, Papua New Guinea and Fiji.

Blow-fill technology is a manufacturing technique that allows companies to produce their own PET (polyethylene terephthalate) bottles within their own facility. It allows manufacturers to form, fill and seal bottles in one continuous process at the one location without human intervention. Blow-fill has enabled CCA to make its PET bottles using significantly less PET resin, resulting in production of the lightest-weight bottles in the global Coca-Cola system.

Previously, CCA would buy blow-moulded bottles from a third party supplier, transporting them to its own facility to sterilise and fill with product. CCA's integration of these three steps into one operation has automated its production lines, creating economies of scale and optimising efficiencies of operation.

CCA's Kewdale facility in Perth is one packaging line that recently completed its installation of blow-fill equipment, procured from Krones AG, a German-based process manufacturer.

CCA engaged ASSDA member and Accredited Fabricator TFG Pty Ltd for the installation and fabrication of the stainless steel interconnecting pipework for the facility's new blow-fill equipment.

Sydney-based ME Engineering detailed the scope of works, and coordinated the process engineering and installation of the new equipment.

Over 6km of 304L and 316L AS1528 standard grade stainless steel tube was supplied by ASSDA sponsor Prochem Pipeline Products, ranging in size from 25mm-200mm diameter.

The TFG team purge TIG welded all stainless steel components on site and internally passivated the stainless steel using citric acid.

ME Engineering's Project Manager Andrew Meagher said grade 316L was specified for CCA's Kewdale facility because of the high chloride content of the water supply in Perth.

With spring water one of CCA's main products, sanitation is key to avoiding microbiologically-influenced corrosion.

Tom Moultrie, General Manager of TFG, said that whilst there are other materials that can be specified for equipment using compressed air, stainless steel provides aesthetic appeal, trusted hygiene and longer life span.

The use of stainess steel has been successful in the output of this project, with CCA's State Projects Engineer Simon Wall stating that 'as a beverage manufacturer, food safety aspects of our processes and equipment are critical to ensuring the integrity and quality of our products – an area that stainless steel ensures.'

Kewdale's new blow-fill line commenced operation in June 2012. It features 14 blowing stations, 108 filling nozzles and 18 capping stations, and has the capacity to produce 26,000 bottles per hour.

Mr Wall said the investment in PET bottle self-manufacture will continue to deliver savings in raw materials - bottles are made using less PET resin and less water is used in the bottling process - and meet future consumer growth and demand.

CCA's ongoing commitment to innovation and sustainability has maximised production capabilities whilst minimising the use of resources.

By the end of 2012, 10 blow-fill lines will have been deployed across CCA's production facilities in Australia, bringing self-sufficiency to over 70%. Once all 26 production lines are implemented, CCA estimates a saving of 7000 tonnes of PET resin per year, a 15% reduction in bottle weight and 50,000 truck movements eliminated per year. Overall, this is reducing the carbon footprint of every 600ml bottle by an average of 22%.

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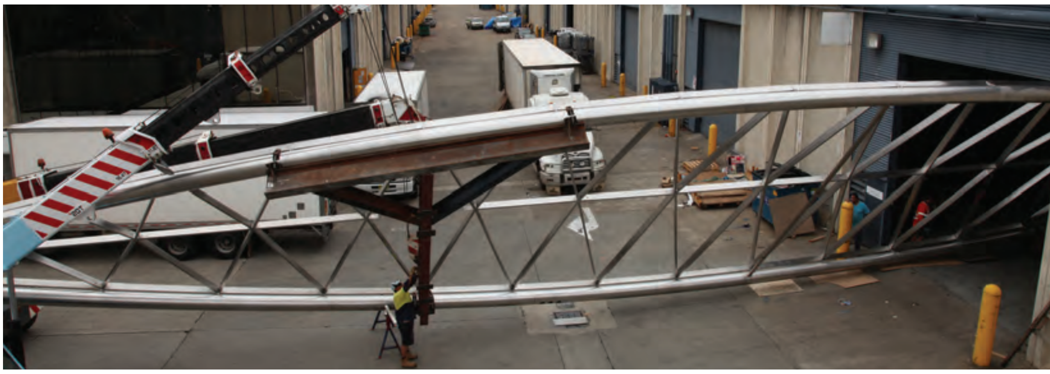
Images courtesy of TFG Pty Ltd.

Stainless Steel Leads a Stellar Redevelopment

When Sydney's Star City Casino emerged from the chrysalis of its construction scaffolding, its metamorphosis included a gleaming 340m^2 stainless steel-and-glass canopy facing the harbour.

ASSDA member and Accredited Fabricator TripleNine Stainless fabricated and installed the canopy over the main entrance of 'The Star', as it is now known, as part of an $850 million redevelopment. This transformation saw Sydney's only casino swing its orientation 180° from Pyrmont's fish markets toward the city's glittering Darling Harbour.

The Star's façade was designed by Fitzpatrick + Partners and is comprised of 147 flags of clear, low-iron glass supported by two fingers of 20mm and 166mm plate stainless steel. The surfboard-shaped canopy is 40m x 8.5m and made of 300 nominal bore pipe with a lattice effect created by 100 x 50 rectangular hollow sections. All 18 tonnes of stainless steel is 316 grade and was supplied by ASSDA sponsor, Atlas Steels.



Peter Petro, the site architect for the project, says stainless steel was the obvious choice from both a practical and an aesthetic point of view. 'From a practical perspective, we chose stainless steel because it's so close to the water and we needed something that was resilient.'

In terms of aesthetics, Petro says they wanted a high-quality finish for the front of the building and stainless steel was a prime choice. 'We also had a lot of lighting design so we wanted something that would bounce the light around. We were able to give the stainless steel a polish that also matched the glass façade upstairs. This gives it a playfulness at night and a high finish during the day.'

TripleNine's Director, Justin Brooks, says electropolishing wasn't an option because of the massive size of the canopy. 'Instead, it was polished to 400 grit then passivated with an Avesta product.'

Brooks says the project's engineers and designers, Yuanda, employed a Feng Shui expert to sign off on the canopy before it was built at TripleNine's purpose-hired workshop. 'The basic geometry came from the client but we did the design detailing because of all the different shapes and angles,' explains Brooks.

The $1.4 million canopy project commenced in August 2010 and was completed in January 2011 with about 15 people assigned to the project. The canopy was built in one piece and transported with a police escort in the dead of the night on the back of a truck with front and rear steering. Installation took only two days, says Brooks.

During the design-detailing phase, TripleNine employed 3-D modelling and Yuanda's engineers gave careful consideration to expansion and contraction. 'Because [the canopy] was so big, we needed to include some bridge building technology,' says Brooks. 'We used expansion pads as the canopy was calculated to expand up to 50mm across the total length of it.'

'The Star' is a bright, light addition to the harbourside landscape. While the elements of Feng Shui can't be guaranteed to produce financial fortune in The Star's casinos, the stainless steel canopy is certain to maintain its appeal for decades to come.

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Images courtesy of TripleNine Stainless.

Proven Strength in Stainless

Stainless steel is the material of choice to specify for severe weather conditions.

The overhead netting of Perth Zoo's Australian Wetlands and Penguin Plunge Exhibit was badly damaged when a severe hailstorm and winds of up to 128km/h swept through Perth in March 2010.

During the storm, a tree collapsed onto the netting which was made from a nylon material.

The original concept for this major renovation project was to use stainless steel overhead netting and painted or galvanised steel for the cabling and the majority of other supporting infrastructure components.

However, when ASSDA members Structural Dynamics was awarded sub-contractor for the supply and installation of the new overhead netting system, it proposed using stainless steel for all components of the structure, including the cable tension system.

Working closely with Slatter Constructions (head contractor), Thinc Projects (project manager) and Pritchard Francis (structural engineers), stainless steel became the clear choice to provide strength and the crucial ability to withstand severe weather conditions.

Structural Dynamics Managing Director Darren Wills said the team agreed that specifying stainless steel would improve performance, product lifecycle and reduce the risk of galvanic reaction.

'Stainless steel materials break down at a much slower rate than galvanised materials,' Wills said.

In terms of longevity and durability, stainless steel was the better option given the conditions of the local environment and fresh-water animals.

Slatter Constructions' Project Manager Rob Murrell added that, on top of providing an aesthetic finish and prolonging the life of the enclosure, using stainless steel for the cables negated the need to ensure separation of different metal types.

Perth Zoo was convinced that stainless steel was the better long-term option and proceeded with stainless steel as the majority materials specification. With a life span of up to 20 years when compared with only up to 10 years using galvanised steel, the increased cost of using stainless was outweighed by the longevity of the product.

The new 91m long x 33m wide x 10m high netting and support structure was completed in early 2012, using the following stainless steel materials:

Backstay column support cables
- 440m of 16mm and 19mm HAMMA Pro Stand 1x19 AISI316
- 48 units of 16mm and 19mm Strudyna P2H Adjusters AISI316

Netting structural support cables
- 720m of 8mm and 10mm HAMMA Pro Strand 1x19 AISI316
- 56 units of 8mm and 10mm Strudyna AM Adjusters AISI316

Netting support cables
- 3900m of 5mm HAMMA x wire rope 7x19 AISI316

Netting
- 5,400sqm of ClearMesh zoological netting AISI316
- 15,200m of 1.6mm seizing wire 1x7 AISI304

Rodent proof barrier
- 300m of 5mm stainless steel angle AISI316 3000m x 150mm x 5mm

Miscellaneous
- 2,400m of 10mm threaded rod AISI316
- 600 units of 10mm eye bolts AISI316
- 600 units of 5mm turnbuckles AISI316

It was pivotal that the new cable structure could cope with extreme one-in-a-hundred year Perth storms, and the high tensile stainless steel structural cable components were ideal for this design parameter. Meeting a range of cable tensions, the HAMMA stainless steel cables installed are rigid to deal with high tensile loads, but also allow for some give to counter the effect of high winds and other harsh weather conditions. Their grade 316 stainless steel construction provides excellent corrosion resistance.

ClearMesh – often used in zoological enclosures globally - was applied to the overhead netting and netting mesh

wall that separates the Wetlands from the Penguin Plunge Exhibit within the enclosure. With mesh openings of 2mm, the lightweight and flexible characteristics of the ClearMesh display a transparent look that complements the landscaped environment and allows for give in case birds fly into the mesh.

Wills said the structure was designed to retain wildlife inside the enclosure and provide a close-to-natural environment for the Australian wetlands wildlife and penguins to thrive in. This resulted in an extremely high level of detail being specified, with stainless steel seizing wire used every 5mm on the seams of the stainless netting. Over 38,000 hand seizes were performed by the Structural Dynamics team.

As the enclosure was an established site prior to the storm, Perth Zoo required that construction had limited impact on the existing landscaping to assist with animals being reintroduced to their former habitat. Murrell said careful planning between Structural Dynamics and Slatter Constructions ensured the works were completed without harm to the existing vegetation and surrounding areas.

Further construction and landscaping works included a new timber deck walkway for visitors, a limestone block wall and vermin barrier to the perimeter of the wetlands area, an upgraded filtrations system and refurbishment of the existing penguin pool and surrounds.

The renovated enclosure has since survived the June 2012 storm with winds of up to 140km/h, and the cable netting structure and supporting infrastructure today remains as built.

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Images courtesy of Structural Dynamics.

12% Chromium Utility Stainless Steels

Cooling tower at a power station after 20 years service.

BACKGROUND

Almost all of the stainless steels in use have 16% chromium or more and have nickel or other additions to make them austenitic and hence formable, tough and readily weldable. However, the formal definition of a stainless steel is that it is an iron- and carbon-based alloy with more than 10.5% chromium. Historically, the corrosion mitigation industry regarded alloys with more than 12% chromium as stainless steels mainly because those alloys did not corrode in mild environments. Because of the perceived problem of high initial price when using stainless steels, alloys that are 'barely' stainless (and with low nickel to boot) are more competitive with painted or galvanised carbon steel than higher alloys.

HOW WERE THESE GRADES DEVELOPED?

More than 30 years ago, developments from the 409 grade (used for car exhausts) led to a weldable ferritic that was tough to sub-zero temperatures. Two versions were developed: a stabilised grade for corrosive environments and an unstabilised grade that matched international standards. One issue was that the titanium used for stabilisation was hard on the refractories and caused the surface finish of flat product to be less appealing. However, when end users moved to unstabilised versions, corrosion problems arose in some applications. Research lead to further alloy development and proprietary grades with outstanding resistance to weld sensitisation.

WHAT IS DIFFERENT ABOUT THESE MATERIALS?

- They are ferritic (and attracted to a magnet), and can be bent, formed, cut and electric process welded like carbon steels.
- The balance of their metallurgy limits grain growth when heated. So, unlike the ferritics used for cladding, thick sections can be welded without excessive grain growth and embrittlement.
- After welding, they have a duplex ferritic-martensitic microstructure that does not usually require heat treatment.
- As ferritics, their thermal expansion is low (actually less than carbon steel) which reduces distortion risk during welding or furnace operations.
- They have good scaling resistance in air to ~600˚C and reasonable strength at that temperature compared with more expensive austenitics with a scaling limit of ~800˚C in air.
- Like duplex alloys, they do not suffer from chloride stress corrosion cracking.
- They provide excellent and economic resistance in corrosive wear applications compared to hardenable carbon steels, surface-treated materials of higher alloys.

However, there are a few cautions:

- Low chromium, low nitrogen and no molybdenum means thay have low corrosion resistance (PRE~11). They will pit in marine environments and in less severe conditions they cannot be used if aesthetic appearance is critical. Painting is a useful option in aggressive environments.
- Neither cold work nor heat treatment will increase their strength, although they are slightly stronger than 300 series stainless steels. Because they do not cold work, they should be less susceptible to galling then austenitic stainless steels.
- While it is nothing to do with the material, supply is mostly limited to sheet or plate, i.e. bar, hot-formed sections, hollow sections and wire are generally unavailable.

WHAT ARE THE ALLOYS?

There is a plethora of proprietary and standardised grades with between 10.5% and 12% chromium. The Ferritic Solution booklet available from the ISSF [www.euro-inox.org/pdf/map/The_ferritic_solution_EN.pdf] lists about a dozen. In Australia, the major proprietary grades are 3Cr12 and 5Cr12 where the '3' and '5' are labels, not compositions, and may include additional letters for other grades in the family. However, these labels cover three different material design decisions – and only those in (A) below are standardised:

A. Low chromium, no molybdenum and low nickel, carbon and nitrogen. These are covered by S40977/1.4003 in ASTM A240/EN10088.2 respectively or S41003 in ASTM A240.

B. As above, but with stabilising titanium or titanium plus niobium. There are several rules for titanium content but 4 (C+N) with a limit of 0.6 is used. The Ti/Nb will lock up C and N and reduce the risk of sensitisation, i.e. it limits corrosion associated with welds.

C. As above, but with lower carbon and nitrogen limits and specific controls on ferrite and austenite stabilising elements. This gives immunity to sensitisation in corrosive environments where there is a risk of fatigue.

REPLACEMENT OF GALVANISED OR COATED CARBON STEEL BY Cr12

The cost of steel that has been galvanised is currently up to 30% less than the cost of a 12Cr utility stainless steel when transport, pickling and other costs are included. When added to the cost of better trained (and hence more expensive) staff required for fabricating stainless steel, it is apparent that on a prime cost basis, even this basic stainless steel will not be cost competitive. However, on a LCC basis, the 12Cr grades have a significant advantage primarily because of durability.

Table 1 shows the relative lifetime of zinc (as a proxy for galvanising) and aluminium vs a 12Cr stainless steel in a medium and low corrosivity environment where the atmospheric corrosion rates for carbon steel are listed averaged over a 20-year

TABLE 1

ZINC	**ALUMINIUM**	**Cr12** [RATIO TO ZINC]	**CORROSIVITY** (MILD STEEL CORROSION RATE)
15	80	315 [21]	Medium (33μm/yr)
7	60	200 [28]	Low (24μm/yr)

Years of life with mild steel = 1 year

exposure. It is clear that the life cycle cost of the 12Cr stainless steel is much better than either of the alternatives listed.

WELDING OF Cr12 STAINLESS STEELS
AS/NZS 1554.6 deals with welding of structural stainless steels and compacts all three branches of the 12Cr grades under '1.4003' for selection of consumables. The recommendation is to use a 309L consumable although 18-8Mn (Note 8) is also prequalified. Heat input should be between 0.5 and 1.5kJ/mm and the interpass temperature should not exceed 150˚C.

As with all stainless steels, contamination by carbon steels must be avoided and any heat tint should be removed prior to exposure to corrosive service. While owners using Cr12 alloys for corrosive abrasion service regard the in-service removal of heat-tint surface layers as sufficient, this is only true if sufficient material is removed to expose the virgin stainless steel before the first rest period with corrodents on the surface could promote pitting.

APPLICATIONS FOR 12Cr STAINLESS STEELS
Applications include piggeries, rail cars, road transport, sugar and mineral industry (especially with corrosive wear), effluent tanks, under pans for conveyors, ducting (including furnaces), BBQ plate, electrical meter boxes, floor plates, gravel screens, railway overhead support towers, etc.

ACKNOWLEDGEMENTS
This paper has been prepared with support from ASSDA colleagues and especially Acerinox, Atlas Steels and Sandvik. Their assistance is gratefully acknowledged.

A 12% chromium mesh fence unscathed after a bushfire. A galvanised fence would have lost its zinc protective coating and corroded.

Brightly polished 12% chrome stainless steel after abrasive wear in a sugar cane conveyor.

Stainless Steel and Nickel - 100 Years of Working Together

This is an abridged version of a story that first appeared under the same title in Stainless Steel Focus No. 07/2012.

The Nickel Institute's director of promotion, Peter Cutler, and consultant Gary Coates, reveal some of the reasons for the continuing popularity of nickel in stainless steels.

Stainless steel is everywhere in our world and contributes to all aspects of our lives. We find stainless steel in our homes, in our buildings and offices, in the vehicles we travel in and in every imaginable industrial sector. Yet the first patents for stainless steel were issued only 100 years ago.

How did this metal become so desirable over the past century that more than 32 million tonnes was produced in 2011? And how does nickel, a vital alloying element in most stainless steel alloys, contribute to the high demand for stainless steel?

THE 'CREATION' OF STAINLESS STEEL

By definition, a 'stainless' steel has a minimum level of about 10.5% chromium, so the discovery of chromium in 1799 by Nicolas Louis Vauquelin in France was the first key event in the creation of stainless steel. In 1821 another Frenchman, Pierre Berthier, published research that showed a correlation between increasing chromium content and increasing corrosion resistance, but the high carbon content of his alloys prevented them from showing a true 'stainless' behaviour.

Still in France, in 1904 Leon Guillet first published his metallographic work on alloys that today would be classified as ferritic and martensitic stainless steel. In 1906 Guillet published his work on the nickel-containing austenitic stainless steel family, but his studies did not include corrosion resistance. Albert Portevin then continued to build on Guillet's work.

In 1911, a German scientist named Philip Monnartz reported that as the chromium content neared 12% in a steel with a relatively low carbon content, the alloy exhibited 'stainless' properties. Further developments then rapidly occurred in many other countries. In the United States, Elwood Haynes started working with martensitic alloys while Becket and Dantsizen were developing a ferritic stainless steel as lead-in wires for electric light bulbs. In 1912, Great Britain's Harry Brearley worked on a 13% chromium martensitic alloy, initially for high temperature service in exhaust valves for aeroplane engines.

Meanwhile in Germany, Eduard Maurer and Benno Strauss were testing nickel-containing alloys and, in 1912, two patents were awarded. One of these grades, containing about 20% chromium and 7% nickel, was called V2A, and was found to have exceptional corrosion resistance in nitric acid. That grade had a relatively high carbon content compared to today's stainless steel, and would be similar to a Type 302 (EN 1.4317) stainless steel. 100 years later, the most commonly used alloy for nitric acid is 304L (EN 1.4307) with approximately 18.5% chromium and 8.5% nickel, quite similar to the V2A composition other than having a much lower carbon content.

Brearley's martensitic stainless steel alloy would not rust when wet. He worked with Sheffield cutlery manufacturers to forge it into knife blades and then harden it, replacing the carbon steel blades they were then making. Stainless steel knives rapidly became a common household item. However, for forks and spoons, where high hardness was not so important, the 18-8 (302) composition became the most commonly used alloy.

300 SERIES

We normally think of the austenitic or 300 series family of stainless steels as the 'nickel stainless steels', but many other families contain nickel. One of the prime reasons for using nickel in the 300 series alloys is that nickel is an austenite former, but other reasons include:

› Nickel adds *corrosion resistance*, especially in certain aqueous environments, and in certain high temperature environments.

Stainless steel in use

Food and beverage industry

The popularity of stainless steels in kitchens did not go unnoticed in the food and beverage industry.

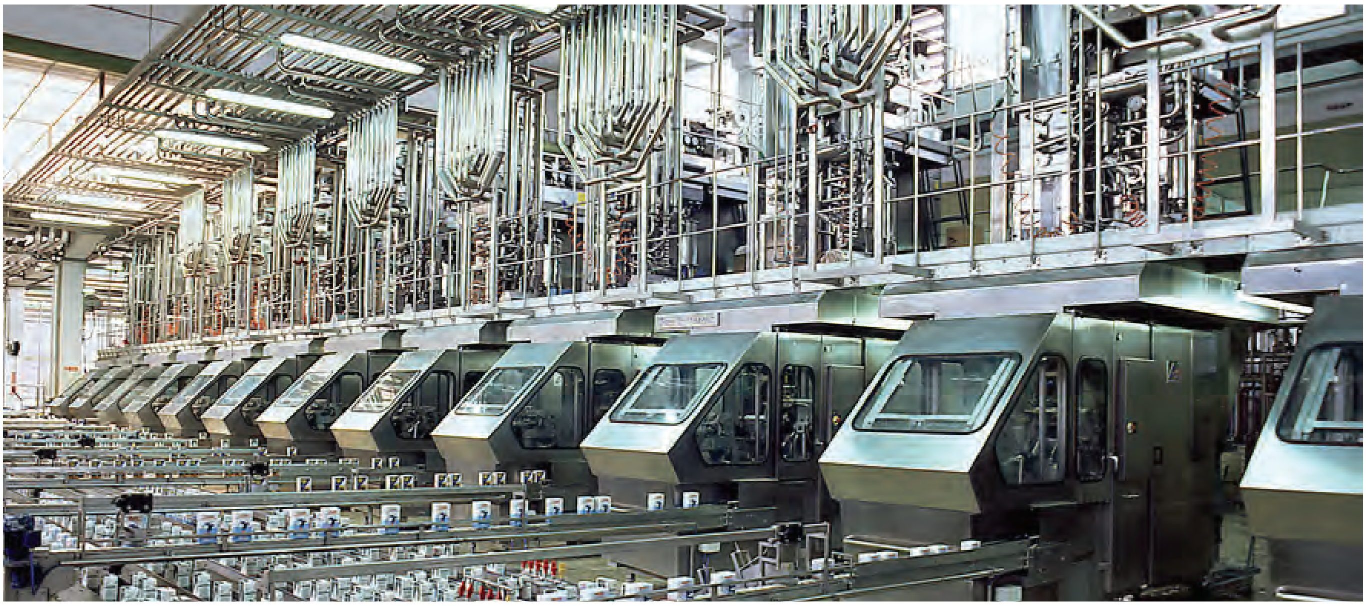
If we take milk, we know of an early stainless steel bulk milk tank truck from 1927 in the USA. A paper entitled 'The Corrosion of Metals by Milk' from the January 1932 *Journal of Dairy Science* by Fink and Rohrman states: 'It has long been known that milk in contact with iron and copper will not only acquire a metallic taste, but corrode these metals readily'. At that time, tin-coated metals were commonly used. It went on to say that 'High chromium nickel (18-8) iron alloys … are very resistant to corrosion by milk and are satisfactory for dairy equipment …'. The modern milk processing industry is filled with stainless steel equipment, mostly of Type 304 (EN 1.4301) or 304L.

The report also went on to state that some materials that are otherwise suitable for processing of milk '…do not stand up well to the action of cleaning compounds that are commonly used in dairies', but that the 18-8 alloy was suitable for those cleaning compounds. Today, the typical cleaning acids and hypochlorite sanitising compounds that are used not only in the dairy industry but also in most food and beverage plants worldwide, require that same 18-8 alloy as a minimum. A correctly chosen stainless steel alloy will not change the taste or appearance of the food product. However, it is the ability to withstand repeated use of the sanitising chemicals over the lifetime of the equipment that has led to the widespread use of stainless steel in all sectors of the food and beverage industry. Producers are then able to guarantee the safety of their food products.

Architecture

Another area of quick acceptance was in architecture. The first recorded use for that purpose was in 1929 in London at the Savoy Hotel where a sidewalk canopy and a sign were erected with the 18-8 alloy. These were soon followed by two iconic skyscrapers in New York that used stainless steel as a dominant element on their exteriors: the Chrysler Building in


Hydroelectric dam (China). Credit: iStock Photo© Menabrea.


Tetra Pak milk packaging line. Image courtesy of Tetra Pak.

Stainless steel in use

1930 and the Empire State Building in 1931.

Since then, many prestigious buildings around the world have used stainless steel, including the Petronas Tower in Kuala Lumpur, the Trump Tower in Chicago, and the Jin Mao Tower in Shanghai. Related to architecture is sculpture, and Isamu Noguchi convinced the Associated Press in 1940 to approve stainless steel instead of bronze for his sculpture above the entrance to its building in New York. Since then, artists around the world have been using stainless steel, mostly either 304L or 316L (EN 1.4404), in their works. The St Louis Arch in the USA, Frank Gehry's Peis (Fish) in Barcelona, Spain, and more recently Genghis Khan in Mongolia are examples of what can be done with stainless steel.

Transportation
During the Great Depression in the USA, Edward Budd realised the untapped potential for stainless steels. Although their use in aeroplanes was his first application, his legacy remains the building of more than 10,000 passenger railcars, some of them still in use today.

Around the world, stainless steel is used extensively for passenger rail cars for subways, commuter trains and long distance trains, ensuring safety plus long life and low maintenance costs. In addition, stainless steels are used to transport cargoes such as food products, petroleum products and corrosive chemicals by rail, road, water and even air, both domestically and internationally.

Energy
In the broad field of energy, stainless steels have been used to extract oil and gas containing hazardous substances as well as for use in the refining stages. For power plants, stainless steel is used extensively at both low and high temperatures, whether the fuel is coal, oil, gas, uranium or waste products. Hydroelectric stations use stainless steel for dam gates as well as turbines. Many of the established sustainable energy technologies such as solar and geothermal are using stainless steel, as well as the present biofuels industry with corn or sugar cane as feed stock.

- Nickel can *retard the formation of embrittling intermetallic phases at elevated temperatures,* a major downfall of the non-austenitic families.
- The austenitic structure can mean *high toughness at cryogenic temperatures.*
- The advantages of the 300 series extend to *welding and forming operations.*

A fuller discussion of these topics can be found in 'The Nickel Advantage - Nickel in Stainless Steels', available on the Nickel Institute website.

200 SERIES

The 200 series stainless steels are also austenitic in structure. The standardised 200 series grades, which have chromium contents close to the level of a 304L alloy (about 18%), have an intermediate level of nickel. The 'non-standardised' 200 series not only have lower contents of nickel, but also lower contents of chromium, with the net effect of significantly reduced corrosion resistance, although still an improvement over the 11-13% chromium ferritic stainless steels.

DUPLEX

The duplex (austenitic-ferritic) family of alloys also need some nickel as well as nitrogen to ensure proper austenite formation. Most 'matching' duplex filler metals are actually over-alloyed with nickel to ensure that the welds have the required properties.

PRECIPITATION HARDENABLE

The precipitation hardenable (PH) stainless steel family contain nickel, which increases their corrosion resistance, ductility and weldability compared with hardenable non-nickel-containing stainless steel alloys. One of the other major advantages of the PH grades is that, unlike the martensitic grades, they do not need a quenching operation, which considerably reduces risk of distortion. Some of the martensitic grades also contain a small nickel addition. In the higher chromium types, the nickel is needed for the martensitic transition. In all nickel-containing martensitic grades, nickel improves their corrosion resistance, ductility and weldability.

Some of the lower alloyed ferritic grades such as UNS S41003 (EN 1.4001) and S40975 contain a small intentional nickel alloying addition that allows for grain size control, which aids especially in welded constructions. A few of the higher alloyed ferritic grades also have a small nickel addition to increase toughness and ductility, which is beneficial during both hot rolling and in their end use.

Clearly, it is important for each specific application to select the appropriate alloy or alloys to give the desired properties.

FIGURE 1 **% OF TOTAL PRODUCTION BY FAMILY (2011)**

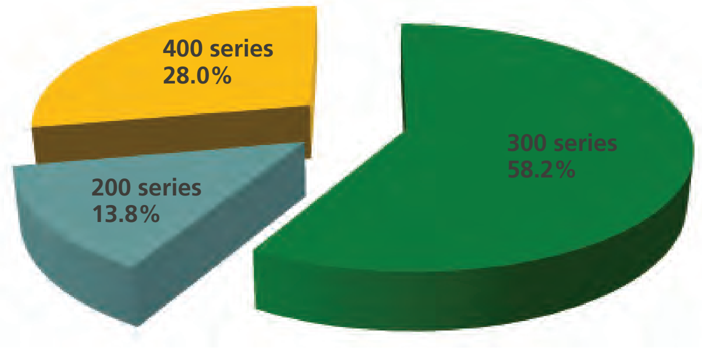
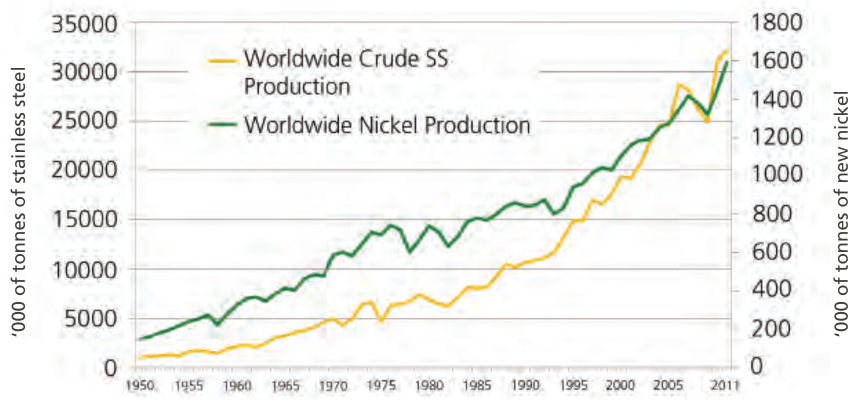


FIGURE 2 **WORLDWIDE PRODUCTION GROWTH**



Stainless steel in use

Water

Fresh water is an essential commodity for mankind, and stainless steel is used extensively in treatment plants for potable water as well as for wastewater. Cost effectively producing fresh water from seawater or brackish water by desalination also requires the use of stainless steel. In some countries, underground stainless steel pipe is used to deliver potable water to homes to prevent leakage, or in other special cases to protect either the environment outside the pipe or the water inside the pipe. Stainless steel plumbing is also common in certain countries and offers a long lasting, low maintenance option.

Surgery

The first recorded example of an austenitic stainless steel surgical implant is from 1926. Medical instruments are also known from that time period. The ability to easily and repeatedly sterilise components that come in contact with the human body or are used in hospitals and clinics contributed to the early acceptance of stainless steel. Today, there are well-established international specifications for materials used in this industry. For example, stainless steel alloys for implants must meet stringent metallurgical cleanliness requirements and be completely non-magnetic so that the patient can safely undergo diagnosis by Magnetic Resonance Imaging.

Future uses of stainless steel

Strong growth in the use of stainless steel has continued in the past decades despite the rapid and diverse developments in other materials and the more recent economic turmoil. The nickel-containing alloys in the 300 series still account for nearly two thirds of current stainless steel production worldwide, and there is nickel in the 200 series, duplex and precipitation hardening families, as well as in some of the martensitic and ferritic alloys. The reason for this is the great value that is placed on the properties which nickel provides.

Society is rapidly evolving and facing challenges on a global scale. Population is increasing, expectations are growing and

GROWTH IN DEMAND FOR STAINLESS STEEL

According to the ISSF, 300 series stainless steel still dominates the worldwide production figures, as shown in Figure 1.

The properties of the various 300 series grades - created by the addition of nickel - are clearly valued by users, both in industry and the general public. Upwards of two thirds of all stainless steel produced in 2011 fell within the 300 series and close to three quarters of all stainless steel producedcontains nickel.

The growth of worldwide production of stainless steel over the past 100 years has been steady, if not spectacular. This has meant that the demand for new nickel has steadily increased along with the demand for stainless steel, as shown in Figure 2. Recycled stainless steel is also a very important component in the alloy supply chain.

EFFICIENCY AND 'GREEN' CREDENTIALS

Resource efficiency is a recurring theme as the global economy faces economic challenges. Stainless steel not only contributes towards efficiency in many applications, it also shows continuous improvement in the resource efficiency related to stainless steel itself.

There are three important factors:

1. *Stainless steel's long service life,* which might average 15 to 20 years, although much longer in prestigious buildings.
2. *The extent of recycling:* The percentage recovered and recycled at end-of-life - around 90% - is amongst the highest of all materials. Moreover, this recycling can be repeated many times without loss of quality. While the recycled content may appear to be relatively low, this is simply a result of stainless steel's long service life (15 to 20 years) coupled with much lower global production 15 to 20 years ago.
3. *Continual production improvements for stainless steel and its raw materials.* For example, whilst the ores being processed today are of lower grade than before, the extraction and recovery processes are more efficient.

THE FUTURE

The history of stainless steel would be incomplete without celebrating the extent to which it has enabled innovation not just in the area of improved performance, but also in the more intangible, aesthetic aspects. From chemical plants to medical equipment to iconic stainless steel-clad buildings, stainless steel has made - and will continue to make - a major contribution to almost every aspect of our lives.

With durability, recyclability, versatility and aesthetic appeal at the core of its appeal, stainless steel - with nickel as one of its trusted alloys - is well placed to continue to innovate and expand its applications.

Pictured on right:
Trump Tower, Chicago USA.
Image courtesy of C. Houska.

Stainless steel in use

resources are limited. Therefore we must use those resources more efficiently. This is particularly apparent for energy where stainless steel, and especially the nickel-containing alloys, already plays a major role in the more difficult to extract fossil fuels. Stainless steel's corrosion and heat resisting properties are key to more cost-efficient operations. This also applies to the renewable sources that are now being developed, such as wave power and biofuels from new organic sources.

The worldwide need for higher quality, safe food and beverages and water will only increase, especially as food products can come from anywhere in the world. Stainless steel has evolved as the material of choice in this industry, both industrially and domestically, and it is likely to continue to meet the demands of a global population that is predicted to increase to nine billion by 2050.

This growing population, combined with a rapid movement to urbanisation, requires an expanded and more efficient transport infrastructure. The characteristics of stainless steel enable it to deliver lightweight and durable designs, leading to more efficient performance, safety, lower energy requirements and reduced emissions while giving lower life-cycle costs.

Stainless Steel Training Delivers a Strong Industry

The Australian Stainless Steel Development Association's (ASSDA) Stainless Steel Specialist Course is a breakthrough educational tool that provides a standard level of knowledge and qualification across the stainless steel industry.

The course contains 17 challenging and rewarding Training Notes covering a wide range of topics about stainless steel from introductory to more complex material. Input from the industry has ensured that topics covered are relevant to the workplace. Each module comprises a set of Training Notes and a multiple-choice test.

Two levels of qualification are offered. Students complete a minimum of five modules to achieve an Intermediate Certificate or a Full Certificate is awarded for the successful completion of a minimum of 12 Training Notes.

Individual modules may also be purchased, allowing companies the flexibility to select modules for training staff according to company operations.

Providing a standard level of knowledge and recognised level of achievement, this course will give existing and new workers to the industry a greater depth of understanding of stainless steel.

For enrolments and further information, contact ASSDA on +61 7 3220 0722 or assda@assda.asn.au.

SPECIAL READER OFFER

Enrol in an Intermediate Certificate or upgrade to a Full Certificate and receive a 2012 Australian Stainless Reference Manual **FREE!**

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