

New Applications Awards 2022



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Introduction

For the 7th time, our members have participated in the New Applications Awards.

For the New Technology Awards we are looking to recognise original concepts that make significant contributions in either the production methods for stainless steels or for the application of stainless steels in service. In the New Development category we are looking for highly original concepts that promote bespoke stainless grades, have a significant global market potential and offer strong environmental improvements in terms of preservation of scarce resources and/or reduction of GHGs and/or reduction in lifetime maintenance costs.

In each Awards category three winners are chosen, giving them a Gold, Silver or Bronze Award. The worldstainless Team strongly believes all case studies and all the work done at the member sites help companies to innovate and find novel

applications and technology for their products.

All companies supplying case studies for the application awards had to answer the following questions:

The Challenge

What problem were you trying to solve or what feature were you trying to develop?

Why?

Why did you decide it was necessary to address this challenge?

Needed Action

What action(s) did you take to solve the problem or undertake the development?

Action Review

Were the action(s) taken SMART? Specific, Measurable, Achievable, Realistic and Time-bound

Target Beneficiaries from the Action

Who are the people, organisations and/or communities who have benefited from the outcome of the above action? (e.g.; host company, employees, contractors, local community, regional community, customers, global community, etc.)

Horizontal Expansion Capability

Can the actions or approach taken be expanded for use elsewhere within your company and/or applied within other member companies?

Outcome

What benefits have you observed and quantified since you took the action? Please also explain the value of each of the stated benefits to employee health and well-being, job satisfaction, leading indicators (KPIs) and lagging indicators (KPIs).

We hope the case studies will give inspiration to other member companies worldwide.

The worldstainless Team

All case studies and all the work done at the member sites help companies to innovate and find novel applications and technology for their products.

Vertical Farming

Member Company

ACERINOX EUROPA, S.A.U.
on behalf of Farmitank

Category

Original application concept for stainless steels; Strong environmental improvement potential; reduction in routine maintenance costs; life-cycle costs (LCCS) lowest compared to competing materials

The Challenge

The objective is to allow you to grow crops anywhere in the world regardless of external climatic conditions. Vertical farming turns agriculture into an industrial process which constant costs, production and quality are achieved.

Why?

Because it was observed there will be shortage of food and water in the years to come and that will become a worldwide

issue. The challenge was carried out in order to prevent the future food crisis.

Needed Action

To develop a fully climate-controlled hydroponic farm that integrates an advanced technology to achieve the optimal climatic and lighting conditions that, combined with a perfect mix of nutrients, guarantees the maximum product quality. It is an isothermal, modular and scalable stainless-steel tank.

Action Review

Specific; It is developed to solve the problem detected.

Measurable; It is quantified the quantity of water it is being saved.

Achievable; It is achievable because it is already in use.

Realistic; It is designed as a modular system. It can be adapted to the client



needs.

Time-bound; It has been developed in phases starting from the idea, and passing through three different prototypes before having the final version.

Horizontal Expansion Capability

It is a patented system.

Outcome

The project contributes to territorial development allowing horticultural products processing in those regions and countries where it would not be possible to grow certain products, due to the climate conditions or the shortage of water resources.

The elevator system improves the employees' health and wellbeing at the same time that improves the business efficiency.



Stainless steel Chinese lanterns

Member Company

Australian Stainless Steel Development Association (ASSDA)

Category

Original application concept for stainless steels; Strong environmental improvement potential; Reduction in routine maintenance costs; Life-cycle costs (LCCs) lowest compared to competing materials

The Challenge

Chinese lanterns are a symbol of Chinese culture worldwide, initially used to provide light and later adopted for religious worship, decoration and celebration.

Traditionally made from silk or paper, the City of Melbourne recently evolved the Chinese hanging lanterns featured on Little Bourke Street from cloth to stainless steel. In extensive consultation with the Chinatown Precinct Association, the City of Melbourne and GHD (Structural Engineers)

reimagined the classic Chinese lantern with a detailed design that preserved the traditional aesthetics while examining a number of considerations.

Why?

Durability and product life cycle were strong factors to reduce maintenance and regular replacement of the lanterns. Strength-to-weight ratio and resilience to local weather conditions was also important, with the completed design required to stay below 7kg to be viable for use on the existing catenary lighting system.

Needed Action

ASSDA Member Draffin Street Furniture worked closely with the City of Melbourne to bring the design to life, assisting with the materials selection and manufacturability of the lanterns. Two prototype lanterns were installed at the corner of Heffernan Lane and Little Bourke Street to test the

design and seek feedback from local traders and the Chinatown Precinct Association.

Powder coated aluminium was initially selected as the design material, however, stainless steel superseded the specification primarily for its strength and the ability for a thinner section of material to be used (0.6mm stainless steel sheet vs. 1.22mm aluminium sheet). In addition, stainless steel offered a more sustainable solution with a 25-year design life and little-to-no maintenance.

The final design resulted in a 700mm wide by 500mm high spherical lantern made from 316 grade stainless steel, powder coated with a luminous metallic red colour. In Chinese culture, the colour red symbolises good fortune and joy.

The lanterns were formed using laser cut 0.6mm sheet, with each panel formed into shape and fixed to a central aluminium frame. The custom-designed lanterns were



manufactured by Draffin Street Furniture, and stainless steel material for the project was supplied by Steel Color Australia.

Action Review

Specific; To deliver a reimagined Chinese hanging lantern for the City of Melbourne's Chinatown that preserved the traditional aesthetic while considering product life

cycle, reduced maintenance, strength and product weight of below 7kg to be viable for use on the existing (stainless steel) catenary lighting system.

Measurable; Two prototype lanterns were designed, manufactured and installed to test the design, materials selection and seek feedback from local traders and the Chinatown Precinct Association.

Achievable; The stainless steel lantern met the brief because of its excellent material properties and was brought to life through the collaboration of expertise: Chinatown Precinct Association (Client), City of Melbourne (Client, Design), GHD (Structural Engineers), Draffin Street Furniture (Design and Manufacture).

Realistic; With the skills and expertise combined as above, stainless steel was a viable material option to meet the brief of the product life cycle, durability, low maintenance and aesthetics.

Time-bound; 80 new permanent lanterns were installed at the end of July 2020. It was delivered to coincide with the easing of COVID lockdown restrictions, to enhance and brighten the Chinatown precinct and welcome and encourage visitors back to support local traders.

Horizontal Expansion Capability

Chinese lanterns are traditionally made from paper and cloth, however, maintenance of these materials and product types are high and require regular replacement, particularly in urban areas with exposure to various weather. Stainless steel delivers a sustainable solution, offering strength, longevity, and consistent aesthetics. It also offers excellent life-cycle costs, with little-to-no maintenance, saving time and costs for councils and other government bodies supporting public infrastructure.

This is a very niche application of stainless

steel. While this product may not deliver scale in terms of tonnage, it is a unique application that can influence how we present decorative adornments in the public sphere globally. It is not limited to Chinese lanterns – this excellent example could influence other traditional decorations and celebratory products for Christmas for example. In a world where sustainable and reusable products are becoming more relevant, stainless steel offers a long-term (durable) and cost-effective solution for decorative products, especially when compared with materials that need to be replaced regularly.

Outcome

The successful outcome was a team effort by all parties involved, and all are proud of the end result. The product using stainless steel met the durability and life cycle requirements to reduce maintenance and regular replacement of the lanterns, as well as the strength-to-weight ratio and

resilience to outdoor weather conditions. It also satisfied the expectations of Chinatown Precinct Association, where traditional aesthetic was of utmost importance. Brought to life using local design expertise and stainless steel, the lanterns maintain its symbolic heritage and will continue to provide a festive welcome to visitors for at least the next 25 years.



Application and popularization of life cycle theory in coal mine field

Member Company

TAIYUAN IRON & STEEL (GROUP) CO., LTD.

Category

Original application concept for stainless steels; Reduction in routine maintenance costs; Life-cycle costs (LCCs) lowest compared to competing materials

The Challenge

To Solve the problem of oxidation and corrosion of underground materials and equipment in coal mine.

Brief introduction of coal mine conveying, water supply and drainage system:

1. Transportation system: the main transportation system of the mine is the transportation channel from the mining face to the bottom of the shaft and lifted to the ground;
2. Water supply and drainage system:

provide tap water source to the well water cooling and spray dust control firefighting equipment (require less suspended solids and less calcium). Collect the water gushing or inrush from the coal mine underground to the central water bunker and then discharge it to the ground;

Due to the need of spraying water for underground dust removal in coal mine, the equipment and steel materials of each system are in the environment of alternating dry and wet for a long time, which are easy to oxidize and rust within the service life, affecting the reliability, safety and service life of the system. The corrosion problem leads to material deformation and resistance increase, and the self-weight of ordinary materials is heavy, while the service life of coal mine is generally more than 30 years, The anti-corrosion of the system is difficult and the anti-corrosion cost is high, and the system maintenance is difficult and the



maintenance cost is high.

To develop special stainless steel to solve the problems of high cost and difficult maintenance in the whole life cycle of the equipment.

By optimizing the use of special stainless steel for belt conveyor equipment and steel materials under the special operation environment of coal mine, the purposes of prolonging service life, reducing self-weight, reducing use cost, energy conservation and environmental protection are achieved.

Why?

TISCO is located in Taiyuan, Shanxi Province. Its products radiate the key customers in the main coal producing areas in Northwest China (Shanxi, Shaanxi and Inner Mongolia). Shanxi, Shaanxi and Inner Mongolia are the most important coal producing regions in China. In 2021, China's total coal output was 4.07 billion

tons, and the raw coal output of Shanxi, Shaanxi and Inner Mongolia provinces (autonomous regions) was 2.93 billion tons, accounting for 72% of China's total output. In the future, China will continue to optimize the layout of coal development and promote the intelligent construction of large coal bases. Intelligent construction needs the support of full life cycle materials, while stainless steel has the advantages of safety, reliability, stability, long life and energy saving, and can be recycled as a green material. The above advantages are very consistent with the concept of intelligent coal mine construction, and can replace carbon steel and other materials in large quantities. It has broad application prospects in underground coal mining machines, various types of pipelines, support materials, related buildings and other fields.

Needed Action

By comprehensively adopting stainless steel materials to replace the original carbon steel, PE and other materials in the field of coal mine, it has the following advantages:

Transportation system: Shendong group has done a lot of research to solve a series of problems such as heavy structure of underground conveyor belt system, difficult handling and installation of workers, easy corrosion of metal parts, serious adhesion of idler, short service life and high energy consumption, but has never found an effective solution. In 2013, TISCO's technical marketing team found the customer's demand and conducted joint research and development with a team composed of scientific and technological personnel of Shendong group. It went deep into the mine to investigate the service environment of steel, collected water sample data,

analysed corrosion components, and determined to improve the material performance based on ferritic stainless steel through optimized design. The most serious corrosion problem of idler and support affecting production in coal mine environment has been completely solved. Based on the batch use of stainless steel idler, aiming at the problem of heavy and serious corrosion of carbon steel support, the two sides jointly developed the all-stainless steel belt support system. The high-strength stainless steel square pipe structure is used to replace the traditional carbon steel angle steel and channel steel structure. The weight of a single support is reduced by 40%, the service life is longer, the anti-corrosion maintenance is free, and the comprehensive cost can be reduced by more than 50%.

Water supply and drainage system: TISCO set up a special development team to analyse the causes of pipeline failure and determine the material selection of

special stainless steel for water supply and drainage. Stainless steel has the advantages of corrosion resistance, anti-corrosion, service life of more than 30 years, high strength, anti-collision, light weight, high installation efficiency, multiple reuse and low fluid resistance. TISCO launched a series of products and continued to promote them in the water supply and drainage system.

Action Review

Specific; To reduce the life cycle cost of equipment and materials.

1. In various application fields, the service life of stainless steel is 3 ~ 5 times that of other materials of the same type, and the reuse rate of pipeline and structure is high;
2. Weight reduction: the weight of stainless steel idler is reduced by more than 20%, the weight of stainless steel support is reduced by 40%, and the

weight of stainless steel pipeline is reduced by more than 50%.

Measurable;

1. The corrosion rate of stainless steel and carbon steel is only 1 / 1 / 4 of that of stainless steel under the action of wet fog for 72 hours, and the average corrosion rate of stainless steel is only 1 / 1 of that of stainless steel under the action of wet fog;
2. Water supply and drainage pipe: comparison of uniform corrosion rate in different solutions. In mine water, the corrosion rate of stainless steel is 1 / 30 times that of carbon steel. In NaCl solution proportioned according to Cl ion concentration, stainless steel is 1 / 75 times that of carbon steel.

Achievable;

1. The pipeline and steel structure made of economical stainless steel have been operated for more than 30 years, with

the same service life as the mine;

2. Based on the existing high-strength ferritic stainless steel (50000 hour service life), continue to improve and develop 100000 hour stainless steel idler materials.

Realistic; In the "14th five-year plan" and for a long time to come, China's macro-economy will continue to maintain a stable growth in a reasonable range and drive the energy demand to continue to maintain moderate and stable growth. It is difficult to change the status and role of coal as a comprehensive guarantee of energy supply. At the same time, the goals of carbon peak and carbon neutralization force the acceleration of energy structure adjustment, the acceleration of transformation and upgrading of the coal industry, and the high-quality development of the coal industry is an inevitable trend. Intelligent construction needs the support of full life cycle materials, while



stainless steel has the advantages of safety, reliability, stability, long life and energy saving, and can be recycled as a green material. The above advantages are very consistent with the concept of intelligent coal mine construction, and can replace carbon steel and other materials in large quantities. It has broad application prospects in underground coal mining machines, various types of pipelines, support materials, related buildings and other fields.

Time-bound; To hold no less than three exhibitions and promotion meetings in 180 days to introduce the optimization scheme of underground materials and equipment to major coal enterprises around the world, and introduce a steel pipe manufacturing enterprise and stainless steel product manufacturing enterprise in Shanxi, Shaanxi and Inner Mongolia in 360 days.

Horizontal Expansion Capability

Transportation system: in Shanxi, Shaanxi and Inner Mongolia, the main coal producing areas of Shendong Coal Group

and Yulin Shenhua Energy, it is used for underground coal transportation industry;

Water supply and drainage system: Shendong Coal Group;

Emulsion supply system: China Huaneng Gansu walnut Yu mine project, the product is stainless steel emulsion tube.

This achievement will continue to expand to the mining and metallurgical system of Baowu group, and develop overseas markets and key coal mining enterprises in Shanxi Province.

Outcome

Over the past few years, the cumulative supply of stainless steel has exceeded 15000 tons. The development of the above stainless steel products has provided green material solutions for China's major coal groups, and provided ideas for supply side reform while reducing costs and increasing efficiency;

The energy-saving effect provided by customers shows that in the normal production process of coal, the power consumption of belt conveyor is reduced by more than 20%, and the annual income

from power saving of each 6000 meter conveyor is 1.43 million yuan;

If the stainless steel idler is comprehensively promoted in China, it will save more than 100 million yuan of electricity for coal enterprises in the field of coal every year;

The comprehensive cycle cost of stainless steel material can be reduced by more than 50%. The characteristics of maintenance free and lightweight greatly reduce the burden of workers.

3CR12 Mining Roof bolts: Mild steel replacement

Member Company

Columbus Stainless Pty (Ltd)
on behalf of Mpumatech Stainless Tube
(Pty) Ltd and Delberg Engineering

Category

Original application concept for stainless steels; Life-cycle costs (LCCs) lowest compared to competing materials

The Challenge

Underground mines require roof support systems which are sturdy and well suited to prevent roof collapse. Split set technology (comprising of friction bolt and plate) is used worldwide in a wide variety of mines, including gold and coal mines. These sections work as friction rock stabilisers. Traditionally, mining roof bolts are made from mild steel that is hot dip galvanised post fabrication. During installation (i.e. drilling the split sets into the rock formation), the zinc layer becomes

severely compromised, resulting in corrosion attack on the exposed mild steel substrate.

Corrosion compromises the structural integrity of the metal used in this application – which often leads to catastrophic loss of life and production.

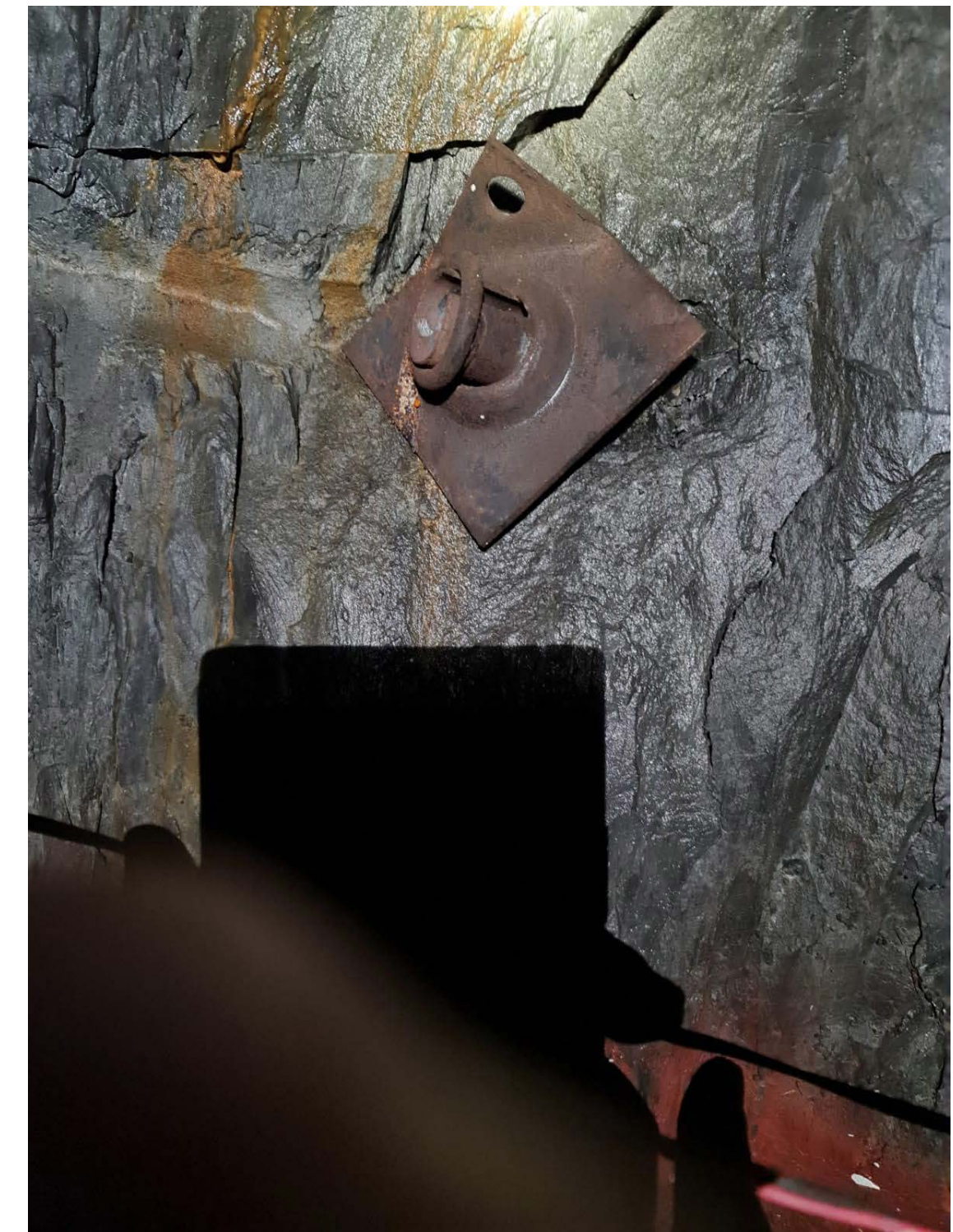
Why?

The application of friction rock stabilisers for underground mines is a safety critical end use. Mining bolt split set friction anchors have been used as a primary roof support in the underground mining environment for many years. The anchor consists of an open seamed high strength steel tube with a face plate. One end is tapered for easy insertion into a pre-drilled hole. It is installed by driving the assembly into a marginally smaller hole than the split set friction anchor diameter and the welded steel ring then provides the necessary support to hold the washer

plate in place. The set then uses friction to anchor itself along the whole length of the bolt by relying on the radial spring force generated through compression of the tube.

The underground mining environment contains various chemistries of mine waters seeping through the rocks, some of which can be very acidic. The section of the roof bolt embedded in the rocks is more prone to corrosion attack – especially due to the damaged galvanised zinc coating. Ultimately, corrosion attack compromises the integrity of the mild steel support structures. Compromised structures result in loss of production but also more importantly, loss of life. Research of failures in South African coal mines estimate that mine roof collapse (i.e. falls of ground) contribute to as much as 25% of mining related fatalities.

The continuous development of a longer-lasting support structure solution not only



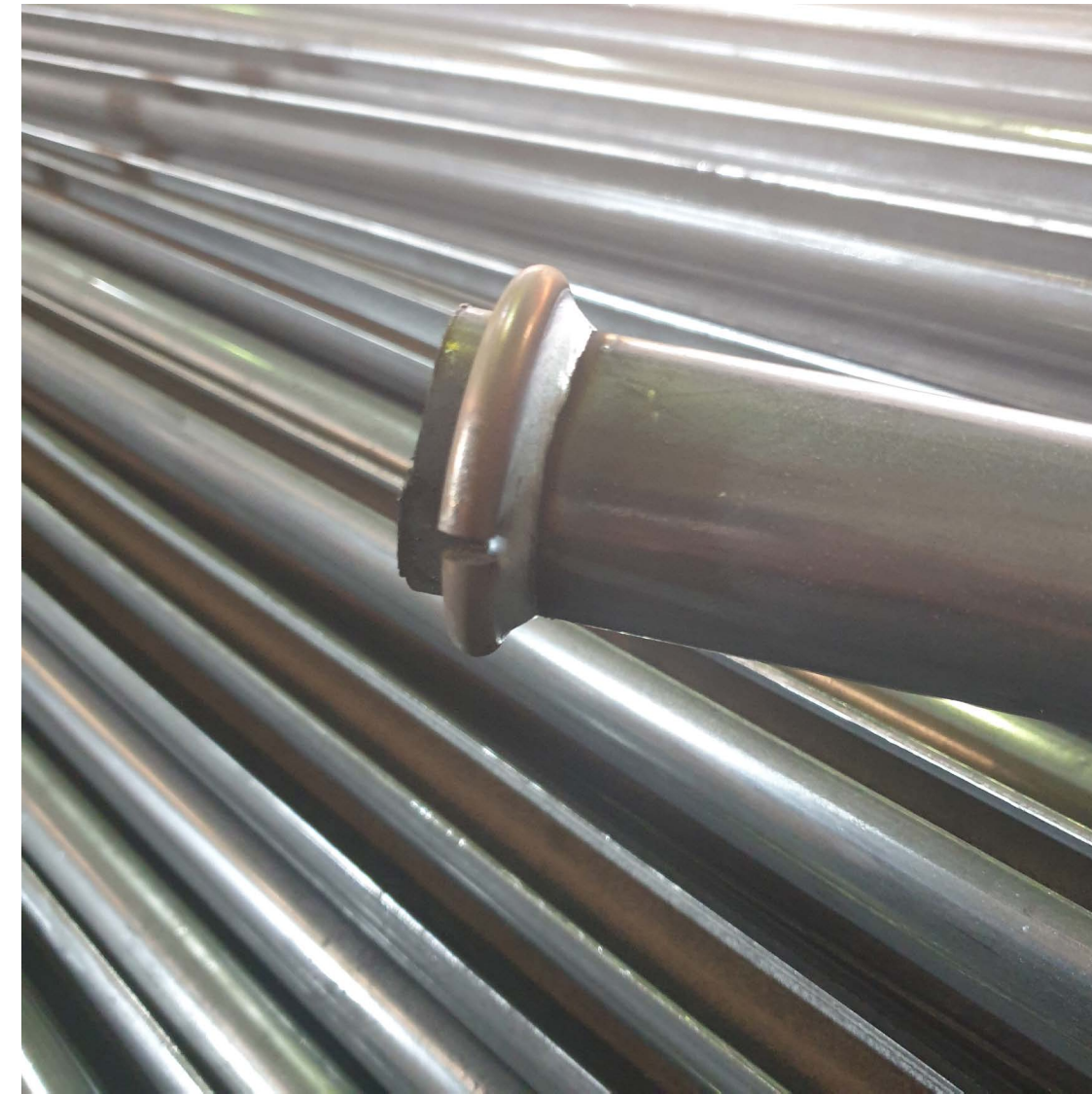
contributes to reduction in loss of life, but is also considered a more economic life cycle cost product for this application. This is the motivation behind the development of 3CR12 split set solution.

Needed Action

A key concern of split set friction anchors relates to their useful life span in an underground environment. They are vulnerable to corrosion and can become ineffective after a short period of time.

Mpumatech Stainless Tube has invested in a new product development initiative – identifying a suitable alternative metal of construction that meets the strength requirements of the traditional mild steel used, but offering superior – almost indestructible corrosion resistance. This alternative product line offers more permanent split set friction anchors which can be used in more permanent excavations.

This longevity and subsequently lower life cycle efficient product is attained by using grade 3CR12 stainless steel – a product which is best suited to withstand the harsh underground mine conditions



along with the wet-abrasion conditions created through lateral rock movements synonymous with the underground mining conditions.

The stainless steel split set anchor offers similar physical and mechanical properties to the traditional options available in the market; with the added advantage of an almost indefinite life



span due to the corrosion resistance offered by the tenacious chromium-oxide layer. Therefore, where peace of mind is required, especially in corrosive environments, 3CR12 split set meet even the most demanding safety standards.

The split sets manufactured by Mpumatech Stainless Tube are subjected to various quality assurance measures



and tests; including in-situ case testing at various sites. Third party verification tests are also conducted to ensure the product meets the stringent safety requirements stipulated in the mining roof support system standards. The company continues to invest in research studies to ensure that the product evolves with the safety requirements of the mining industry.

Action Review

Specific; (Goal) 3CR12 mining split sets are specifically designed to meet the operating conditions of underground mining excavations – offering both structural integrity through the product's strength and additional corrosion resistance in when exposed to mine waters with various chemical constituents.

Measurable; Number of units manufactured and sold per year.

Achievable; Yes – ongoing since the successful trial work and implementation since 2018.

Realistic; Mpumatec has grown their 3CR12 product line to a demand of over 60 tons/month. Within the past 6 months, the product demand has increased to roughly 150 tons per month. There is still great room for growth in the years to come.

Time-bound; Ongoing. The organisation strives to increase the stainless steel market share year on year as quickly as possible. Expansions are not only limited to South Africa, but also worldwide.

Horizontal Expansion Capability

With the need to reduce the life cycle cost of products, materials that offer greater longevity can be explored for other

product lines. The stainless steel solution allows for this to be possible in most applications.

Outcome

Business efficiency (Mill): The product uses 3CR12 in the hot rolled mill finish (HRA).

We have seen in the past the rise of the need for this lower cost alternative product in the hot rolled mill finish. This is beneficial to production capacity as the production process does not contribute to backlog/bottlenecking with other production processes downstream. Ideally, this is the type of product stream which

can afford greater capacity expansion without compromising product quality – since the finish is deemed fit for purpose.

Material quality (Client): More efficient product that can afford the product greater longevity in use. This ensures less maintenance and replacements within the underground environment. Ultimately, this is beneficial to the mines – offering improved safety features as a result of the product's corrosion resistance, without compromising the other safety features required for the product.

Liquefied Hydrogen Carrier the “SUIISO FRONTIER”

Member Company

NIPPON STEEL Stainless Steel Corporation

Category

Strong environmental improvement potential; GHG emissions reduction; Preservation of scarce resources

The Challenge

Brown coal, an abundant unused resource, can be used to produce hydrogen, and co-generated CO₂ is stored underground. The CO₂-free hydrogen is converted into liquefied hydrogen, which allows more efficient transportation of hydrogen to user countries

In order to build such a hydrogen supply chain, it was necessary to develop the world's first technology for mass transportation of liquefied hydrogen.

Why?

Hydrogen is considered to be one of the major clean energy sources in the future. In order to develop a sustainable economy, we believe that it is important to build a hydrogen supply chain.

Needed Action

It was necessary to establish technology for safe and efficient transportation of mass volumes of liquefied hydrogen.

Using existing technologies for construction of LNG marine carriers and for land transportation and storage of liquefied hydrogen, a new cargo containment system with cryogenic temperature (keeping the temperature at -253°C) and accumulated pressure to specifically transport liquefied hydrogen on a marine carrier has been developed.

Action Review

Specific; CO₂-free Hydrogen Energy Supply-chain Technology Research Association (HySTRA) has been working on demonstrating hydrogen supply chains in Australia and Japan. HySTRA asked Kawasaki Heavy Industries, Ltd. (Kawasaki) to build a liquefied hydrogen carrier including a liquefied hydrogen tank. Kawasaki used the stainless steel that Nippon Steel Stainless Steel produced for the material for the tank.

Realistic; Kawasaki developed the world's first hydrogen carrier named “Suiso Frontier”. The vessel is equipped with a 1,250 m³ vacuum-insulated, double-shell-structure liquefied hydrogen storage tank. Stainless steel was used for this tank because of its excellent performance under high cryogenic conditions as well as its corrosion resistance.

Time-bound; Kawasaki began development

of a hydrogen carrier in July 2017 which was completed in March 2020. In December 2021, the “Suiso Frontier” became the world's first vessel to be officially classified as a liquefied hydrogen carrier, after being registered by the General Incorporated Association Nippon Kaiji Kyokai (ClassNK). In the same month, HySTRA demonstrated the world's first technology for long distance transportation of large volume liquefied hydrogen.

Horizontal Expansion Capability

This case proven that stainless steels can play an important role in the storage and transportation of liquefied hydrogen. We believe that stainless steel can also be used in other projects related to liquefied hydrogen.

Outcome

The demonstration of hydrogen supply chain will be an important step toward achieving a carbon-neutral society. We will continue to explore new applications for stainless steel in the processes of hydrogen production, transportation, storage, and utilization. This will contribute to both the promotion of carbon neutrality and to the development of the stainless steel industry.



Super Austenitic Stainless Steel NAS254N (SUS836L) for Soy Sauce Brewing Tanks

Member Company

Nippon Yakin Kogyo Co., Ltd.

Category

Reduction in routine maintenance costs

The Challenge

Stainless steels have been used for food processing industries because of their easiness of cleaning and their good corrosion resistance against many food materials. For example, standard grade stainless steels, such as Type304 and 316L, have been widely used for brewery and winery tanks and piping systems. However, many seasonings, such as soy sauce, contain high concentration of salt which leads to severe corrosive conditions for the stainless steels. Therefore, localized corrosion such as pitting corrosion and crevice corrosion tend to occur in seasonings processing environments. In the soy sauce brewing

process, long-term fermentation leads to a drop of pH from production of organic acids making soy sauce tasty, such as glutamic acid and acetic acid, which makes the corrosive condition more severely. In this environment, carbon steels with resin linings and FRP have been used as brewing tanks' materials. However, regular maintenance and repairing were necessary.

Why?

The main reason why we had decided to address this challenge is; We were asked the cooperation to reduce the maintenance cost of the soy sauce brewing tanks (maintenance-free) from a soy sauce production company. The second reason is to expand sales of our company's high corrosion resistant stainless steels to the new field.

Needed Action;

In order to lower the maintenance costs of the soy sauce brewing tanks (maintenance-free), we considered the application of a super austenitic stainless steel "NAS254N" (SUS836L, UNS S32053: 23Cr-25Ni-5.5Mo-0.2N), which has excellent corrosion resistance in comparison with the standard grade stainless steels. We carried out the long-term field test in the soy sauce brewing tank at the soy sauce producer's site and the corrosion test at the laboratory. From the results of those tests, we confirmed that pitting and crevice corrosion, even stress corrosion cracking, did not occur at NAS254N in the soy sauce. This demonstrated the excellent corrosion resistance of the super austenitic stainless steel NAS254N in the soy sauce brewing environment.

The soy sauce brewing tanks are fabricated by welding plates. Normally, corrosion resistance of the welded part

of the stainless steels tend to deteriorate compared to the base metals. In order to maintain the corrosion resistance of the NAS254N's welds, the suitable conditions of factory and on-site welding were investigated. It was confirmed that TIG, MAG and PLASMA welding for NAS254N do not deteriorate the corrosion resistance of the welds with adequate filler metals.

Action Review

Specific; Based on the excellent corrosion resistance of the super austenitic stainless steel NAS254N in the soy sauce brewing environment, it was applied to the brewing tanks of a Japanese soy sauce production company. The operation has been successfully continuing for 20 years without trouble of corrosion.

Measurable; Because NAS254N does not corrode in the soy sauce brewing environment, the brewing tanks of NAS254N do not require the regular

maintenances for inside of the tank. It means maintenance-free.

The maintenances were necessary when they had used the conventional tanks with resin linings and FRP tanks.

Achievable; It is already in use.

Realistic; It is already in use.

Time-bound; It is already in use.

Horizontal Expansion Capability

From 2017 to 2021, a large amount of NAS254N had been applied to the soy sauce brewing tanks of Korean soy sauce company "Sempio Foods" whose market share of the soy sauce is No.1 in South Korea. Approximately 620 tons of NAS254N plates with thickness of 2mm to 10mm were used. It is expected that the application of NAS254N to the soy sauce brewing tanks will expand in the future.

Outcome

Application of NAS254N to the soy sauce brewing tanks do not require the regular maintenance which is required for the conventional lining tanks and FRP tanks. It contributes to the long-term benefit for the clients by meeting the requirements of reducing maintenance and management costs.



New Jersey 9-11 Memorial

Member Company

North American Stainless (NAS)
on behalf of Stainless Structural

Category

Reduction in routine maintenance costs;
Life-cycle costs (LCCs) lowest compared to
competing materials

The Challenge

Increase life Cycle and reduction of costs
of New Jersey's 9-11 Memorial by means
of selection of materials that would reduce
corrosion thus extending life Cycle of the
project as well as reduction in the amount
of maintenance needed.

Why?

The application being exposed to the
elements needed to be manufactured with
corrosion resistant materials.

Needed Action

The decision was made to fabricate the
Memorial using NAS stainless grade
316L due to its high degree of corrosion
resistance.

Action Review

Specific; Yes, specific grade was identified
as being optimal for the purpose

Measurable; Yes, corrosion resistance will
be measurable and lower maintenance
costs can be recorded

Achievable; Yes, fabrication was made as
per requirements

Realistic; Yes, based on available data, use
of T316L as optimal is realistic

Time-bound; Life Cycle of the 9-11
Memorial is expected to increase as a
result of material chosen

Horizontal Expansion Capability

The use of T316L NAS stainless can be
applied to similar projects at other venues.

Outcome

The benefit of maintenance cost savings
will be measured over time, job satisfaction
was achieved as fabricator supplied the
finish product and was accepted.



Stainless Steel Vehicle Defence Barriers

Member Company

North American Stainless (NAS)
on behalf of Shaw Stainless and Alloys

Category

Reduction in routine maintenance costs;
Life-cycle costs (LCCs) lowest compared to
competing materials

The Challenge

Increase life Cycle and reduction of costs of
Vehicle Defence Barrier Bollards by means
of selection of materials that would reduce
corrosion thus extending life Cycle of the
project as well as reduction in the amount
of maintenance needed.

Why?

The application being exposed to the
elements needed to be manufactured with
corrosion resistant materials.

Needed Action

Decision was made to fabricate the Vehicle
Defence Barrier Bollards with NAS stainless
grade 304 due to its high degree of
corrosion resistance.

Action Review

Specific; Yes, specific grade was identified
as being optimal for the purpose

Measurable; Yes, corrosion resistance will
be measurable and lower maintenance
costs can be recorded

Achievable; Yes, fabrication was made as
per requirements

Realistic; Yes, based on available data, use
of T304 as optimal is realistic

Time-bound; Life Cycle of the Vehicle
Defence Barriers Bollards is expected to
increase as a result of material chosen.

Horizontal Expansion Capability

The use of T304 NAS stainless can be
applied to similar projects at other venues.

Outcome

The benefit of maintenance cost savings
will be measured over time, job satisfaction
was achieved as fabricator supplied
the finish product and was accepted as
optimal.



| Picture courtesy of Shaw Stainless & Alloys

Lighthouse Stainless Steel Lantern Room

Member Company

North American Stainless (NAS) on behalf of Carlson Sheet Metal Works

Category

Reduction in routine maintenance costs; Life-cycle costs (LCCs) lowest compared to competing materials

The Challenge

Increase life Cycle and reduction of costs of Lighthouse Lantern Room by means of selection of materials that would reduce corrosion thus extending life Cycle of the project as well as reduction in the amount of maintenance needed.

Why?

The application being exposed to the elements on the top side of a lighthouse needed to be manufactured with corrosion resistant materials.

Needed Action

The decision was made to fabricate the “lantern Room” for the Lighthouse using NAS stainless grade 304 due to its high degree of corrosion resistance.

Action Review

Specific; Yes, specific grade was identified as being optimal for the purpose

Measurable; Yes, corrosion resistance will be measurable and lower maintenance costs can be recorded

Achievable; Yes, fabrication was made as per requirements

Realistic; Yes, based on available data, use of T304 as optimal is realistic

Time-bound; Life Cycle of the Lantern Room of the lighthouse is expected to increase as a result of material chosen

Horizontal Expansion Capability

Use of T304 NAS stainless can be applied to similar projects at other venues.

Outcome

The benefit of maintenance cost savings will be measured over time, job satisfaction was achieved as fabricator supplied the finish product and was accepted.



Pictures courtesy of Carlson Sheet Metal Works



Stainless Steel Smokehouse Oven

Member Company

North American Stainless (NAS)
on behalf of Fusion Tech

Category

Reduction in routine maintenance costs;
Life-cycle costs (LCCs) lowest compared to
competing materials

The Challenge

Increase life Cycle and reduction of
costs of Smokehouse Oven by means of
selection of materials that would reduce
corrosion thus extending life Cycle of the
oven as well as reduction in the amount of
maintenance needed.

Why?

The application being subject to food
processing industry sanitary regulations
needed to be manufactured with corrosion
resistant materials that would both ensure
compliance to the regulations as well as

increase life cycle of the oven.

Needed Action

Decision was made to fabricate the
Industrial Parts Washer using NAS
stainless grade 304 due to its high degree
of corrosion resistance at elevated
temperatures.

Action Review

Specific; Yes, specific grade was identified
as being optimal for the purpose

Measurable; Yes, corrosion resistance will
be measurable and lower maintenance
costs can be recorded

Achievable; Yes, fabrication was made as
per requirements

Realistic; Yes, based on available data, use
of T304 as optimal is realistic

Time-bound; Life Cycle of the Smokehouse
oven is expected to increase as a result of
material chosen

Horizontal Expansion Capability

The use of NAS T304 stainless can be
applied to other similar ovens.

Outcome

The benefit of maintenance cost savings
will be measured over time, job satisfaction
was achieved as customers accepted the
Smokehouse oven as optimal.



Picture courtesy of Fusion Tech



Stainless Steel Automated Aqueous Parts Washer

Member Company

North American Stainless (NAS)
on behalf of Alliance Manufacturing

Category

Reduction in routine maintenance costs;
Life-cycle costs (LCCs) lowest compared to
competing materials

The Challenge

Increase life Cycle and reduction of costs
of Automated Aqueous Parts Washer by
means of selection of materials that would
reduce corrosion thus extending life Cycle
of the machine as well as reduction in the
amount of maintenance needed.

Why?

The application being exposed to water,
cleaning agents and acid/heat and
therefore needed to be manufactured with
corrosion resistant materials.

Needed Action

Decision was made to fabricate the
Automated Aqueous Parts Washer using
NAS stainless grade 304 and 316L due to
its high degree of corrosion resistance.

Action Review

Specific; Yes, specific grade was
identified as being optimal for the
purpose

Measurable; Yes, corrosion resistance
will be measurable and lower
maintenance costs can be recorded

Achievable; Yes, fabrication was made
as per requirements

Realistic; Yes, based on available data,
use of T304 and T316L as optimal is
realistic

Time-bound; Life Cycle of the
Automated Aqueous I Parts Washer
is expected to increase as a result of

material chosen.

Horizontal Expansion Capability

The use of NAS T304 and T316 stainless
can be applied to other similar machines.

Outcome

The benefit of maintenance cost savings
will be measured over time, job satisfaction
was achieved as customers accepted the
Automated Aqueous I Parts Washer as
optimal.



| Picture courtesy of Alliance Manufacturing

Market Development Award

Member Company

Tsingshan Industry

Category

Promotes a bespoke or non-standard grade.

The Challenge

It has been well recognised that the conventional 304 austenitic stainless steels has rather good corrosion resistance, formability and weldability and been applied extensively in various markets. The strength of 304 steel at annealed condition is, however, too low, being only at 235MPa level, which could not meet well the requirements in many fields, such as construction and building, art and street furniture, home and office appliance, cookware, transport, etc, where both the corrosion resistance and the strength should be maintained high. In addition, 8% nickel gives the product of 304 steel a

high alloy cost and also a risk as the nickel resources and price fluctuates.

Can we develop a nickel saving steel austenitic stainless steel grade with at least the same corrosion resistance and higher strength and promote its application into different markets.

Why?

The total consumption of stainless steel in the year 2022 worldwide is around 56 millions tons. Among them, around 50% is the 304 type stainless steel. The total consumption of nickel within 304 steel its alone would be 4.5 millions tons. Such amount of nickel consumption of might be a very big challenge due to nickel resources.

Because of its low corrosion resistance, the current standard 200 series with high manganese and 3~4%Ni alloyed can not replace 304 steel in those application although it has much higher strength.

There is, therefore, an urgent need for developing a new type of austenitic stainless steel with no less than corrosion resistance and higher strength and even lower cost as compared with 304 in those applications where both corrosion resistance and strength are highly required.

Needed Action

1. Product development

In 2018, Tsingtuo Group, a Tsingshan Industry Holding Company, has developed a high nitrogen alloyed QN1803 steel with the same amount of chromium (18%) while much lower nickel (~3%) as compared with 304. Since then, more QN series steel grade—namely QN1804, QN1906 and QN2109 have been developed successfully.

2. Patent

The Chinese patent with ZL 2020 1 0672735.4 (a nickel saving and high

nitrogen austenitic stainless steel with good pitting corrosion resistance and sulphuric acid corrosion resistance and the manufacturing process) has been authorised.

3. Product Standard

Totally, the 16 product standards in terms of steel industry, construction and building, as well as elevator have been promoted, which provide the base for the market development.

4. Market development

The QN series steel have been promoted into various market for different applications, such as building and construction, home appliance, etc.

Action Review

Specific; The new steel grade QN1803 was developed in Nov., 2018 with the alloy compositions shown below. Apparently, QN1803 has 3.35% nickel, being much

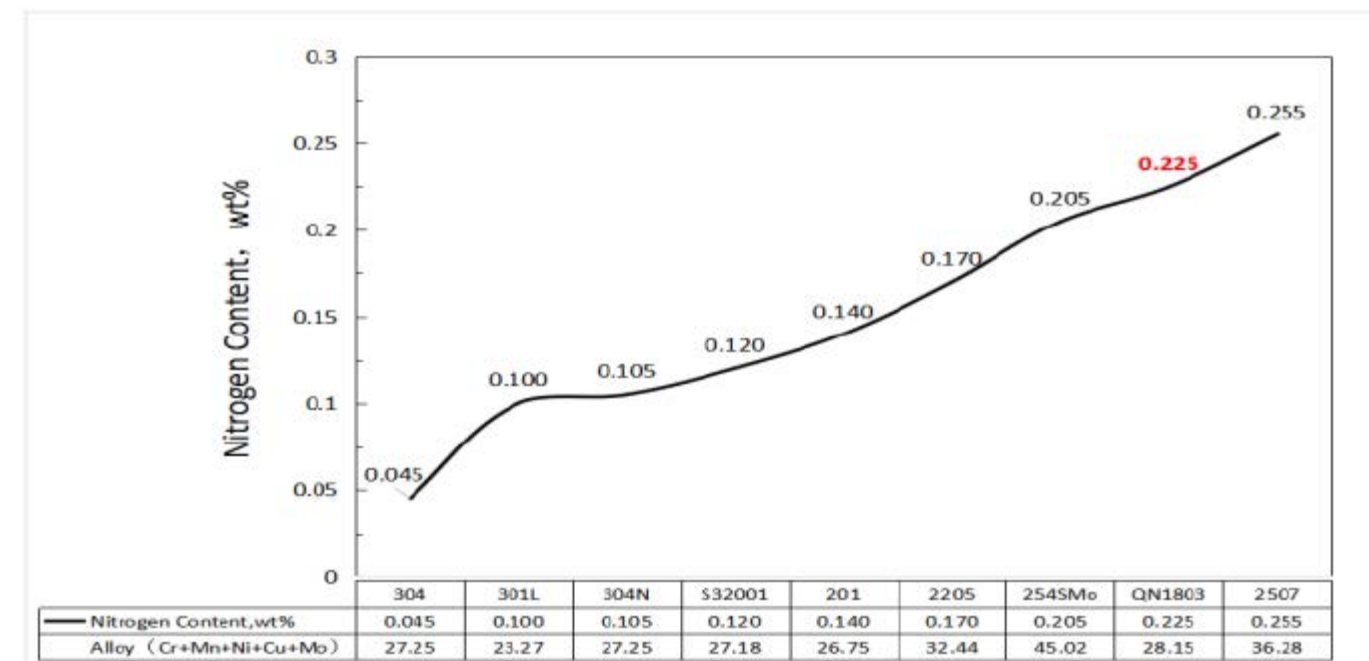
lower than 304 steel while the nitrogen content of the former is 0.225%, being much higher than the latter.

Alloy compositions of QN 1803 and 304 steels (wt%)

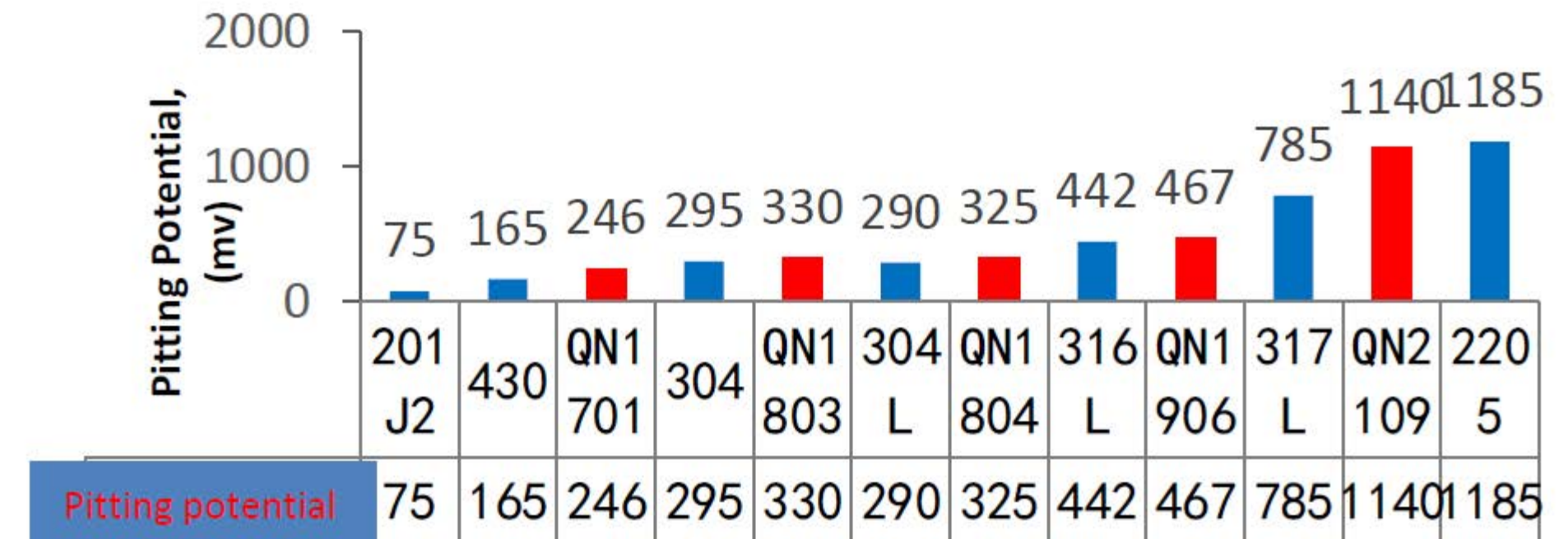
Grade	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	N	PREN*	MD30
304	0.045	0.40	1.15	0.037	0.004	18.20	8.05	0.04	0.15	0.046	18.6	5.0
QN1803	0.075	0.40	5.85	0.038	0.002	18.20	3.35	0.10	1.05	0.225	19.2	-15.0

Measurable;

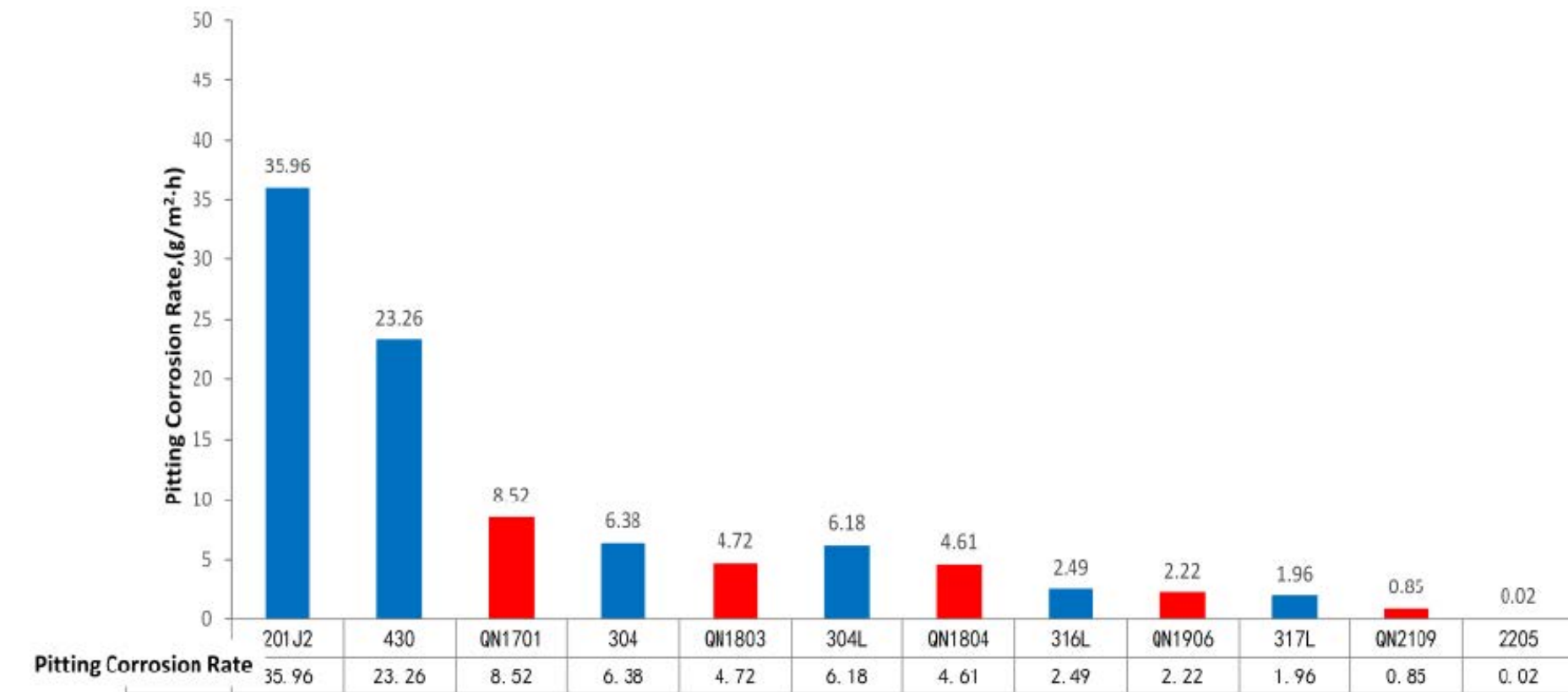
1. Nitrogen content in QN1803 steel is the highest considering the total alloy content (Cr+Mn+Ni+Cu+Mo)



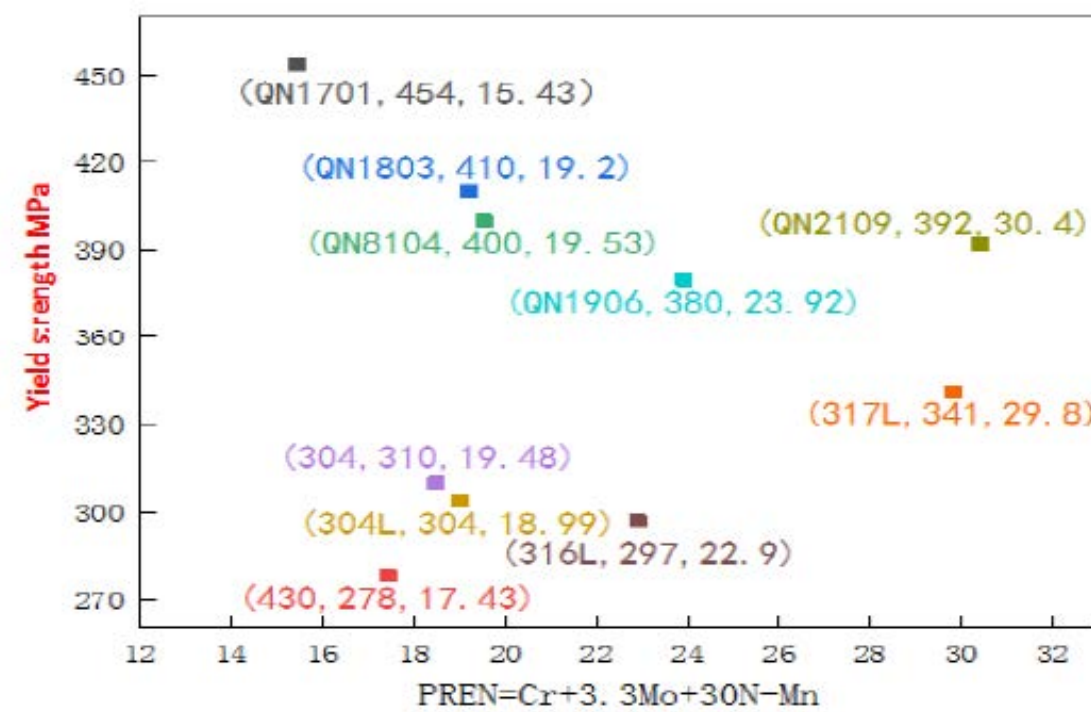
2. Pitting corrosion resistance of QN 1803 steel is slightly higher than 304 steel



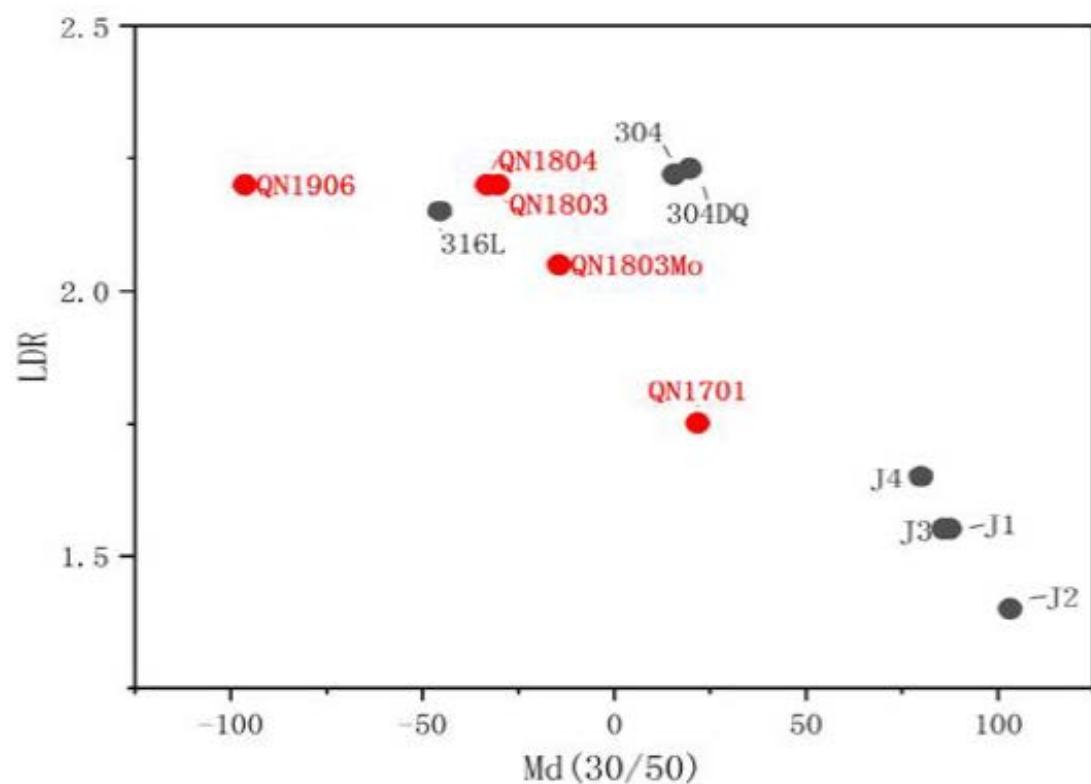
The comparison of Pitting Corrosion rate of stainless steel



3. QN1803 has the higher yield strength than 304 steel

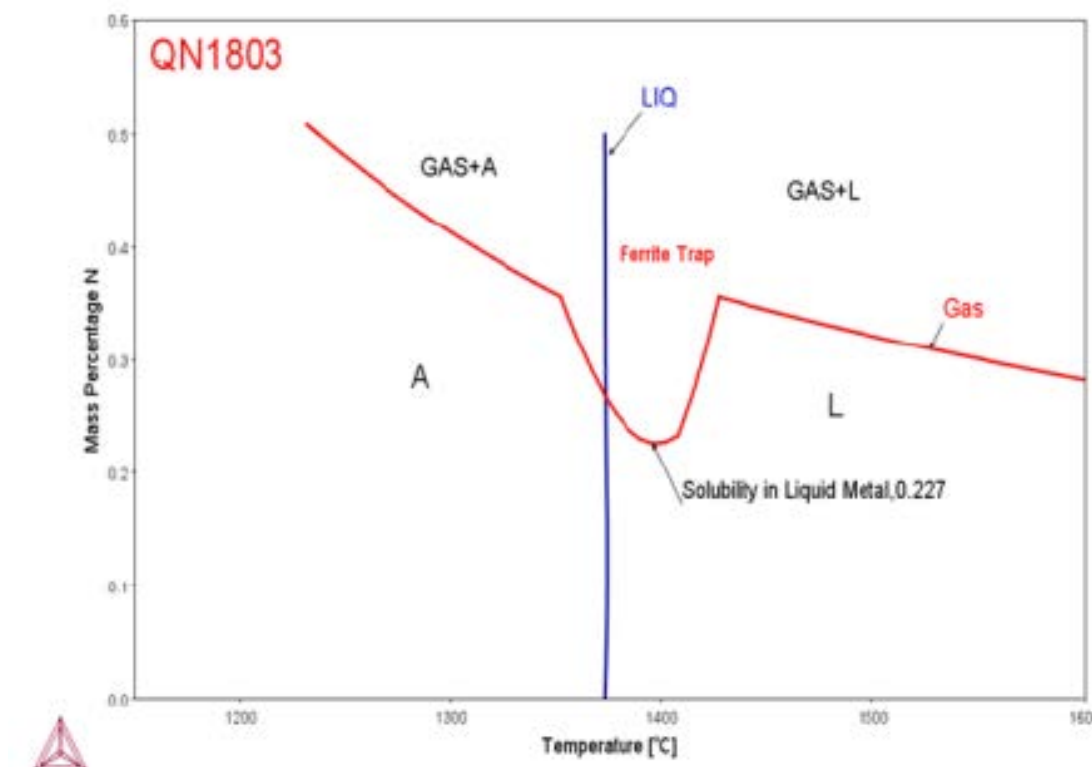


4. QN1803 has the similar cold deep drawability as 304 steel



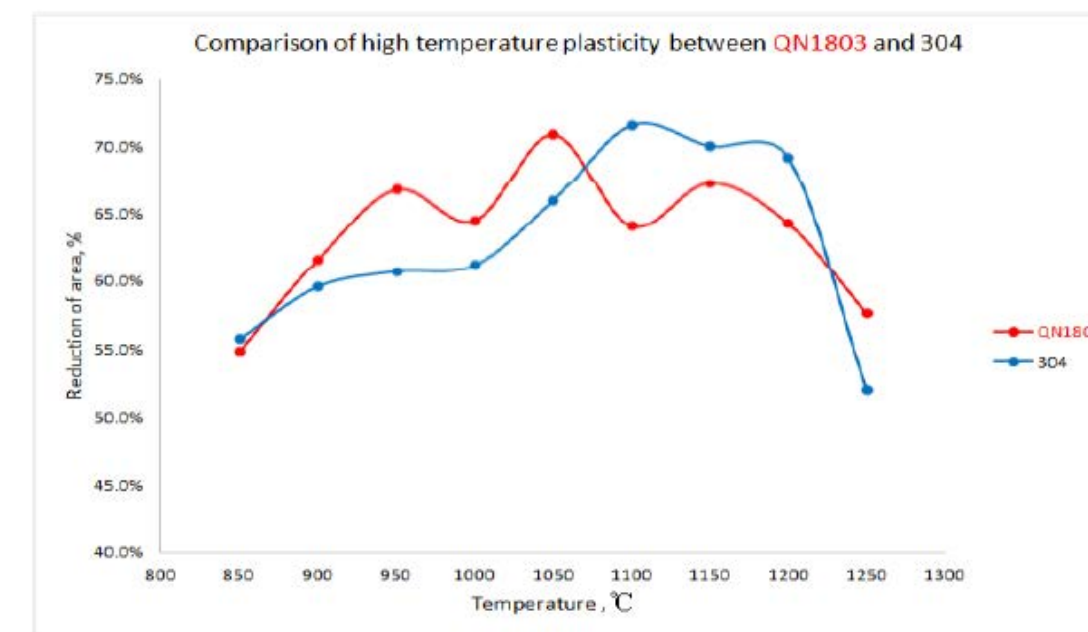
Achievable;

1. Nitrogen solubility during continuous casting
 Through the optimization of continuous casting processing parameters, such as the tundish temperature, the cooling rate, etc., the nitrogen solubility above 2000 ppm in liquid steel of QN 1803 could be ensured and the nitrogen pore on the surface of slab could be prevented.

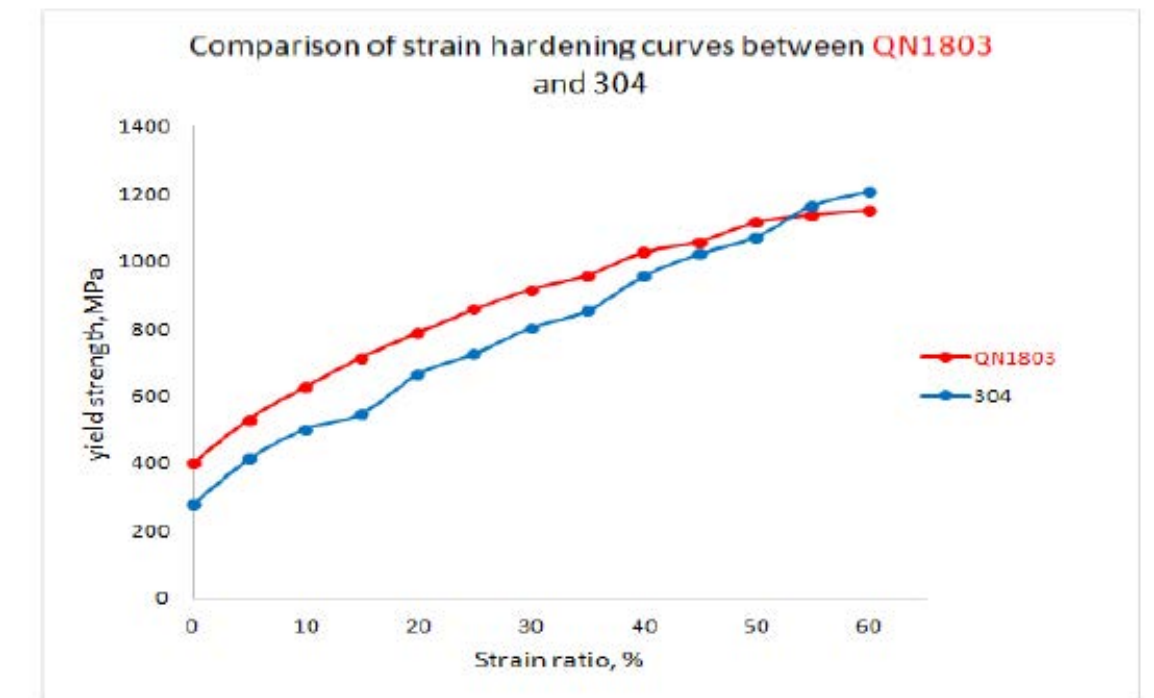


2. Hot workability
 QN1803 steel has lower high

temperature plasticity due to the high nitrogen content, which needs optimization of hot working processing to ensure the good surface and edge quality of the hot strip.



3. Cold workability
 QN1803 steel has slightly higher strain hardening behaviour in the beginning of cold working process. As the cold reduction is higher than 50%, QN 1803 has even slightly lower hardening behaviour, which makes QN1803 as easy cold work as 304 steel.



Realistic;

Obviously, QN1803 steel has no less pitting corrosion resistance, higher mechanical strength, slightly lower deep drawability as compared with 304 steel. Such good properties give QN1803 steel a very promising platform to replace 304 in many application fields.

Until now, over 200000 tonnes of QN series steel have been produced and applied in terms of cold strip, hot strip and wire rod in Chinese markets, such as construction and building, home appliance,

cookware, etc., with the representative pictures shown on this page.



| Office Building in Changsha Broadway Co.



| Decoration wall of office building.



| Welded Tube



| Refrigerator



| Roof and wall of the factory



| Elevator

Time-bound; The development work of QN series steel in terms of product design, processing innovation and the market exploration have been carried out since 1, Nov., 2018. Great success has been achieved until now.

Horizontal Expansion Capability

The QN series steel have been listed as the standard product and are open for the whole stainless steel industry since 2021. Nowadays, BaoWu steel is following to produce BN1803, which is similar as QN1803.

Outcome

QN1803 has at least 20% less of the alloy cost as compared with the conventional 304 steel, its application in different markets could definitely help reduce the cost of the customers, which will increase the competence of the such product and even the stainless steel industry. In addition, more than half percent of nickel is saved for QN1803 steel as compared with 304 steel, which help save the usage of nickel metal, which is in a quite shortage storage worldwide.

Development of a Low-Cost Stainless Steel with High-Strength and Toughness and Its Application

Member Company

TAIYUAN IRON & STEEL (GROUP) CO., LTD.

Category

Original concept for production of or application of stainless steels; Significant global market potential (>2.0m tons) or reduction in operational costs; Significant global market potential (>2.0m tons); Strong environmental improvement potential; GHG emissions reduction; Preservation of scarce resources; Reduction in routine maintenance costs; Life-cycle costs (LCCs) lowest compared to competing materials

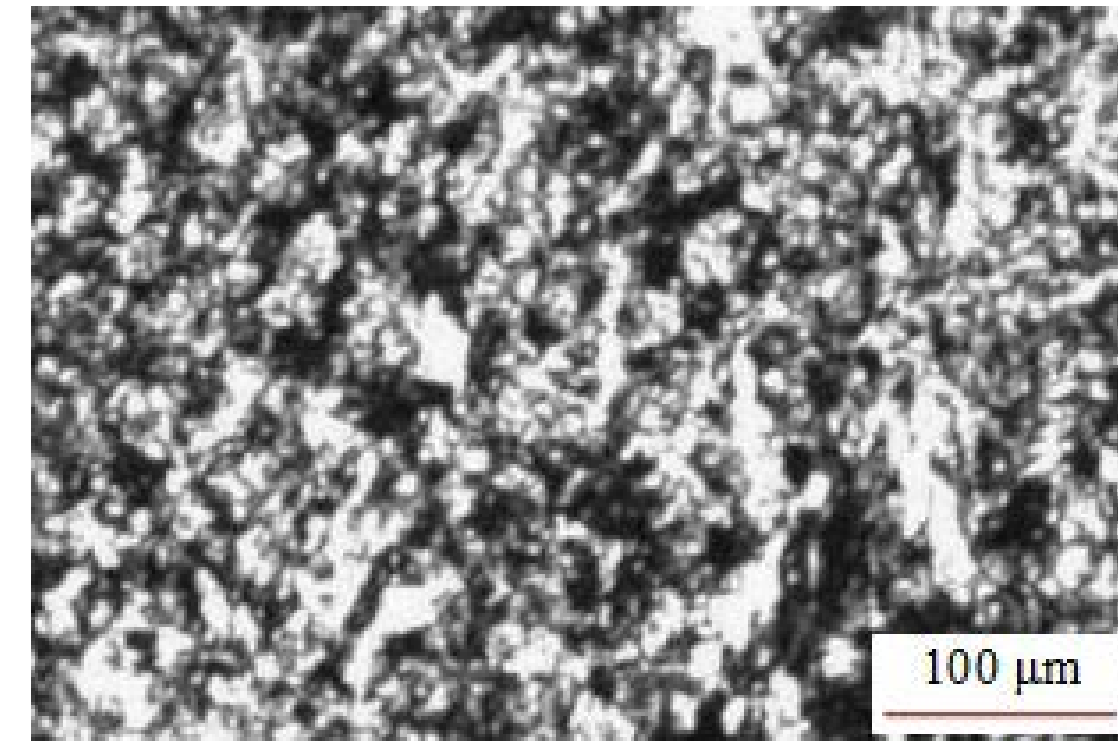
The Challenge

Belt conveyor is the key production equipment in the coal mining industry, which plays an important role in the efficient transportation of coal from one location to another. As an important part of the belt conveyor, the rollers are the

most numerous rotating parts, and the cost of which accounts for more than 30% of the total cost. In addition, the rollers run in series, and the quality of which has a great influence on the efficiency of the belt conveyor and the reduction of production cost.

However, working in an adverse environment with high humidity and high concentrations of coal dust and acidic material, the roller tube (made of carbon steel) is prone to corrosion and easy to be stained with coal dust, which leads to the occurrence of a series of problems, such as the increase in surface roughness, running resistance and energy consumption, and the decrease in roundness and service life (the average service life is not more than 30,000 hours).

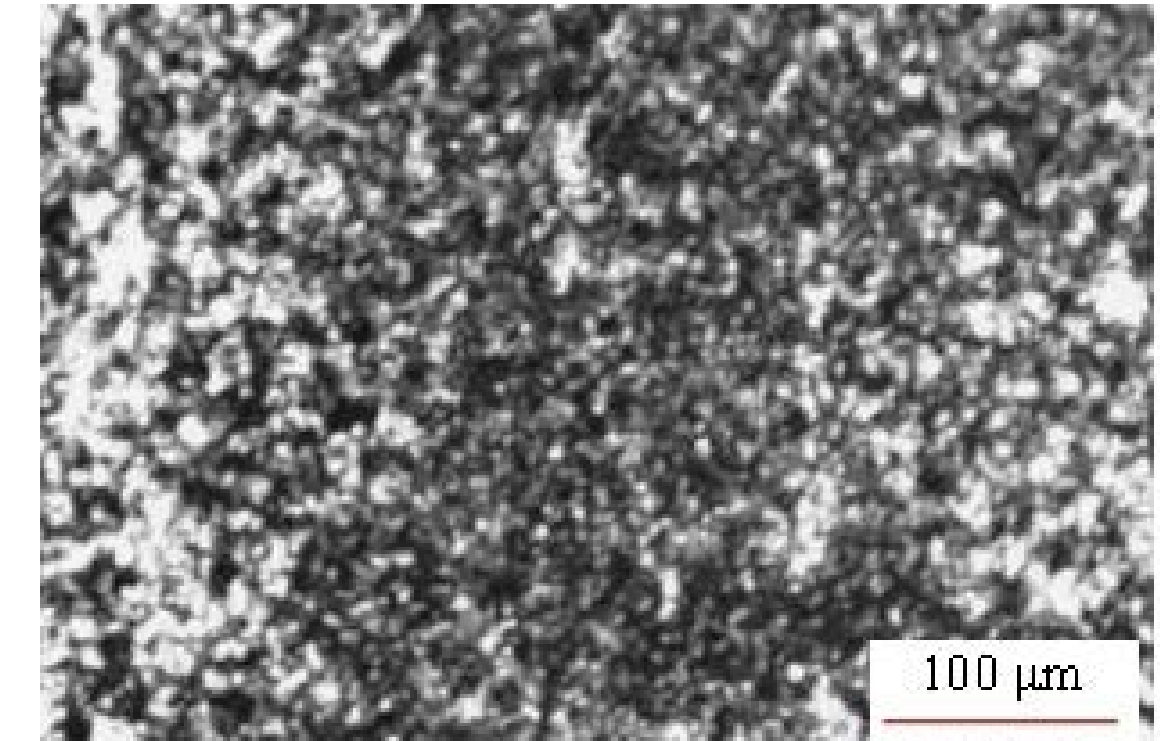
In addition, the load-bearing bracket of the belt conveyor is also made of carbon steel which is susceptible to corrosion, and usually the safe service life of which is



The roller tube with high-frequency induction welding has fine grains in the centre

less than 10 years, even with galvanizing treatment and regular paint maintenance. Due to the low strength of carbon steel (the yield strength grade is 350 MPa), the bracket has to be designed as thick section and high weight (a single bracket is about 40kg), which increases the working intensity of manual installation and removal.

In China's coal mining industry, the annual consumption of the carbon steel used in the manufacture of roller tube and bracket



The roller tube with high-frequency induction welding has fine grains in the welding heat affected zone (HAZ)

for belt conveyor is about 200,000 tons, and the above-mentioned problems have been pain points for long time. Therefore, there are urgently needed to develop long-life, economical and environmentally-friendly products to solve the problems and help upgrading the production lines to achieve better performance.

Why?

Stainless steel is a material with excellent corrosion resistance and good mechanical properties, long service life and low maintenance cost, and 100% recyclability. If a low-cost, high-strength and toughness stainless steel can be developed to replace the traditional carbon steel used in the manufacture of roller tube and bracket of the belt conveyor, it can reduce the energy consumption in the whole life cycle, save resources and be environment-friendly, and meet the needs of low-carbon, green and sustainable development of the belt conveyor for the coal mining industry.

Needed Action

Cr12 ferritic stainless steel belongs to resource-saving stainless steels and it has the lowest alloy content in the stainless family. It shows good corrosion resistance in the atmosphere and weakly corrosive environment, and is considered to be ideal

material to replace carbon steel in the environment with high requirements for stress and corrosion resistance.

Since the coal belt conveyor works in a weakly corrosive environment, replacing carbon steel with Cr12 stainless steel is the most economical way to solve the above problems caused by corrosion. However, traditional Cr12 stainless steel has low yield strength, only about 300MPa, and it has no advantage over carbon steel. In order to reduce weight and production cost, the yield strength of the material should be improved to 460 MPa.

Therefore, it will be a huge challenge to achieve a substantial increase in the strength of Cr12 stainless steel and maintain good plasticity and toughness at the same time by material design and process innovation in industrial production with nearly no cost increase. Additionally, welding is required in the production of roller tube and bracket of coal belt



The stainless steel roller in service has a bright and smooth surface

conveyor. How to solve the welding brittleness problem of Cr12 stainless steel is also a key technical problem before large-scale application.

After years of unremitting research, through the unique composition design and the innovation in annealing process, a low-cost, high-strength and toughness stainless steel with ferrite and martensite dual phase structure was developed



There is no apparent rust on the surface of the stainless steel brackets which are removed out of a coal mine after 6 years of cumulative service (the black/gray is coal residue)

on the basis of the conventional Cr12 ferritic stainless steel, and the strength is significantly improved, meanwhile, good plasticity and toughness are achieved. The yield strength of the steel is higher than 460 MPa (the average yield strength is about 500 MPa), the total elongation is $\geq 20\%$ (the average total elongation is about 24

%), and the DBTT (ductile-brittle transition temperature) is ≤ -20 °C, and it has good bending performance.

According to the product form and service characteristics of coal belt conveyor roller, high precision stainless steel roller tube with good welding seam quality (Figure 1), straightness ≤ 0.5 mm/m and non-roundness ≤ 0.2 mm, has been successfully developed with the new high strength stainless steel by using low heat input high frequency induction welding, on-line induction heat treatment of weld and cold rolling process. As a result, the wall thickness of the roller tube has been reduced by more than 20%, the roller made of the new stainless steel has been well working for more than 50,000 hours (the designed service life is 70,000 hours), and the energy consumption of the belt conveyor has been reduced by more than 20% and the operation efficiency has been significantly improved (Figure 2, 3).

The bracket for belt conveyor with newly developed stainless steel (Figure 4) was successfully produced by MIG welding method and with suitable commercial welding consumables. Due to the high strength of the newly developed stainless steel, the weight reduction of more than 30% is achieved and the working intensity of manual installation and removal is also greatly reduced. Furthermore, for the stainless steel bracket, paint maintenance is no longer needed, which avoids unfavourable effect on human body and the environment during painting. At present, the stainless steel bracket has been serving in good condition and the longest service has been 6 years (Figure 5), and the service life is expected to reach 30 years, which will significantly reduce the operating cost of users.

Action Review

Specific: A new Cr12-typed high-strength and tough stainless steel with ferrite and martensite dual-phase structure and with the yield strength higher than 460MPa was developed, and using which the long-life, lightweight and high precision roller and bracket for coal belt conveyor were produced.

Measurable: With the new developed stainless steel, the wall thickness roller pipe and the operation energy consumption of the belt conveyor are reduced, and the service life is prolonged; The weight of the bracket is reduced, which greatly reduces the work intensity and the operation and maintenance cost during manual disassembly and assembly.

Achievable: The products have been produced and applied in large scale, which helps to achieve the upgradation of the transmission lines and the low-carbon

operation in coal mining industry.

Realistic: Nearly 15,000 tons of the newly developed stainless steel products have been applied in the coal mining industry and they shows good performances.

Time-bound: The application of the newly developed stainless steel products in the coal mining industry will be extended even further.

Horizontal Expansion Capability

The newly developed stainless steel has high strength, good plasticity and toughness, and satisfying welding properties. It can be produced efficiently and cost-effectively utilizing conventional production facility and processes. The product can be used to replace carbon steel, weathering steel, coated steel, etc. in the atmosphere and weakly corrosive environment where the force and corrosion resistance are highly required, and it has a strong industrialization

promotion. At present, the product has been successfully applied in the coal belt conveyor, and has begun to be applied to the fields of iron ore, power station, and stockyard wharf belt conveying. The future market potential is extremely huge.

Outcome

The bottleneck of low strength of traditional Cr12 ferritic stainless steel is broken, and a new 460 MPa grade, low-cost, high strength and toughness stainless steel with ferrite and martensite dual-phase structure is developed. Through cooperation with the downstream

manufacturing enterprises such as tube and bracket factories, the technical problems during the welding of the new stainless steel are solved. The mass production of stainless steel rollers and brackets is realized, and the pain points on belt conveyor in the coal mining industry are eliminated, which not only improves the profitability of our company, but also contributes to the realization of low-carbon and green operation and the improvement in industrial competitiveness of coal enterprises. The main achievements are as follows:

1. The service life of stainless steel roller has more than doubled, which dramatically reduces the time and cost of operation and maintenance of belt conveyor for coal.
2. The stainless steel bracket loses more than 30% of the weight, which significantly decreases the working intensity of manual installation and removal. And the service life of the stainless steel bracket has tripled, which reduces the frequency of disassembly and assembly of belt conveyor for coal during production

process and shortens the working hours of the employees in the adverse environment.

3. The use of the belt conveyor consisted of stainless steel rollers and brackets leads to the decrease in overall energy consumption by more than 20% and the improvement in production efficiency by more than 10%. And the life-cycle cost of rollers and brackets reduces more than 38%, and the inventory levels decrease sharply.

“Hand tearable steel” -- Wide ultra-thin stainless steel precision strip

Member Company

TAIYUAN IRON & STEEL (GROUP) CO., LTD.

Category

Original concept for production of or application of stainless steels

The Challenge

The ultra-thin Stainless steel precision strip with a width of more than 450mm is a major breakthrough in the international precision steel industry. Its production process is complex and technically difficult, which is mainly reflected in the high requirements for steel purity, difficult control of rolling accuracy, plate shape and performance, and easy to cause problems such as belt breaking, belt drawing, roll collapse, surface defects and so on.

Why?

Ultra-thin stainless precision steel strip is a cutting-edge product of steel and an indispensable key material in 5G communication, aerospace safety devices, radiation protection clothing, new energy, high-end electronics and other high-tech emerging fields. In recent years, with the rapid development of consumer electronic products, there is an urgent demand for wide ultra-thin stainless steel precision strip.

Needed Action

TISCO adheres to independent innovation. Based on the combination of production, learning and research, TISCO has achieved major innovations in steel purity, precision controlled rolling, high-performance control and key equipment through thousands of tests in 10 years. The results are as follows:

1. High purity steel and fine inclusion

control technology: the refining technology of silicon reduction barium enhanced deoxidation + low alkalinity slag refining + weak calcium modification treatment is developed for the first time, which breaks through the problem of two-way regulation of low oxygen and high cleanliness purification of stainless steel and inclusion plasticity. The inclusion size in ultra-thin strip steel is less than 1 μm .

2. Wide ultra-thin and high-precision rolling model and core rolling technology: rolling shape control technologies such as compound multi curve taper roll system configuration and high-strength and tough titanium alloy roll have been developed, realizing the world's thinnest and widest 0.02 \times 640mm strip steel is rolled with high precision and stability, and the thickness accuracy reaches $\pm 1 \mu\text{m}$. Flatness of plate type is less than 0.1mm/m.

3. Ultra-thin strip fine structure and high-performance control technology: TISCO has developed high Si composition design + temperature controlled cold rolling and large deformation + low-temperature aging treatment technology of finished products for the first time, took the lead in developing high hardness and ultra-flat fine strip products with the highest hardness (above hv600) and 200000 fatigue life in the world, and developed multi rolling process + process flexible annealing + precision heat treatment technology of finished products to achieve 1 μM ultra-fine grain high plasticity soft ultra-thin fine belt production.

4. Design, integration and development of wide width ultra-thin strip production line and key equipment: the world's widest ultra-thin strip rolling, heat treatment and TA production line has been built, and a series of key technologies and equipment have

been developed. For the first time, the continuous, efficient and stable production of wide width high-performance ultra-thin precision strip has been realized, with a single coil length of more than 20000 meters.

Action Review

Specific; The technology involves various processes and equipment of wide strip production such as smelting, rolling, heat treatment, performance control and key production lines.

Measurable; The inclusion size in ultra-thin strip steel is less than 1 μm . Thickness accuracy is $\pm 1 \mu\text{m}$. Flatness of plate type is less than 0.1mm/m.

Achievable; Wide width high-performance ultra-thin precision strip steel is produced continuously, efficiently and stably, with a single coil length of more than 20000 meters.

Realistic; This technology has achieved the world's thinnest and widest 0.02 \times 640mm strip steel rolling with high precision and stability.

Horizontal Expansion Capability

Wide ultra-thin stainless steel precision strip technology leads the development direction of ultra-thin stainless steel strip in the world, represents the cutting-edge manufacturing level of the iron and steel industry, and promotes the expansion

of stainless steel cold rolling products to thinner and wider direction.

Outcome

TISCO's wide ultra-thin precision strip is the pearl of the crown of the steel industry, amongst a series of stainless precision strip products. For the first time, TISCO has developed the thinnest, widest and best performing stainless precision strip in the world, and its technology and product quality have reached the world leading level. The products are used in radiation protection clothing, aerospace and military core components, folding screen mobile phones, sodium based saline energy storage battery electrodes,

precision pressure sensor diaphragms and shielding materials for nuclear power. Over the past three years, 71000 tons have been sold and the output value is 1.569 billion CNY. It provides key basic materials for high-end manufacturing fields such as high-end electronics, aerospace, military nuclear power, new energy and marine engineering, and promotes their upgrading and sustainable development. It provides a solid guarantee for the development of high-tech coating, coating and passivation industries, and provides a solid foundation for the healthy development of 5G coating, coating, coating and coating industries in the future.

Low Ni alloyed Austenitic Stainless Steel (Grade STS290) for LCD panel transport frame

Member Company

POSCO

Category

Original concept for production of or application of stainless steels

The Challenge

LCD transport frames are being used to transport products from LCD panel manufacturing plants to long-distance areas. These LCD panel transport frames are mainly manufactured by assembling STS304 square tubes. Recently, in order to reduce logistics costs of LCD panel due to high oil prices, it is required to reduce the weight of the LCD panel transport frame and improve the loading efficiency through structural improvement.

Why?

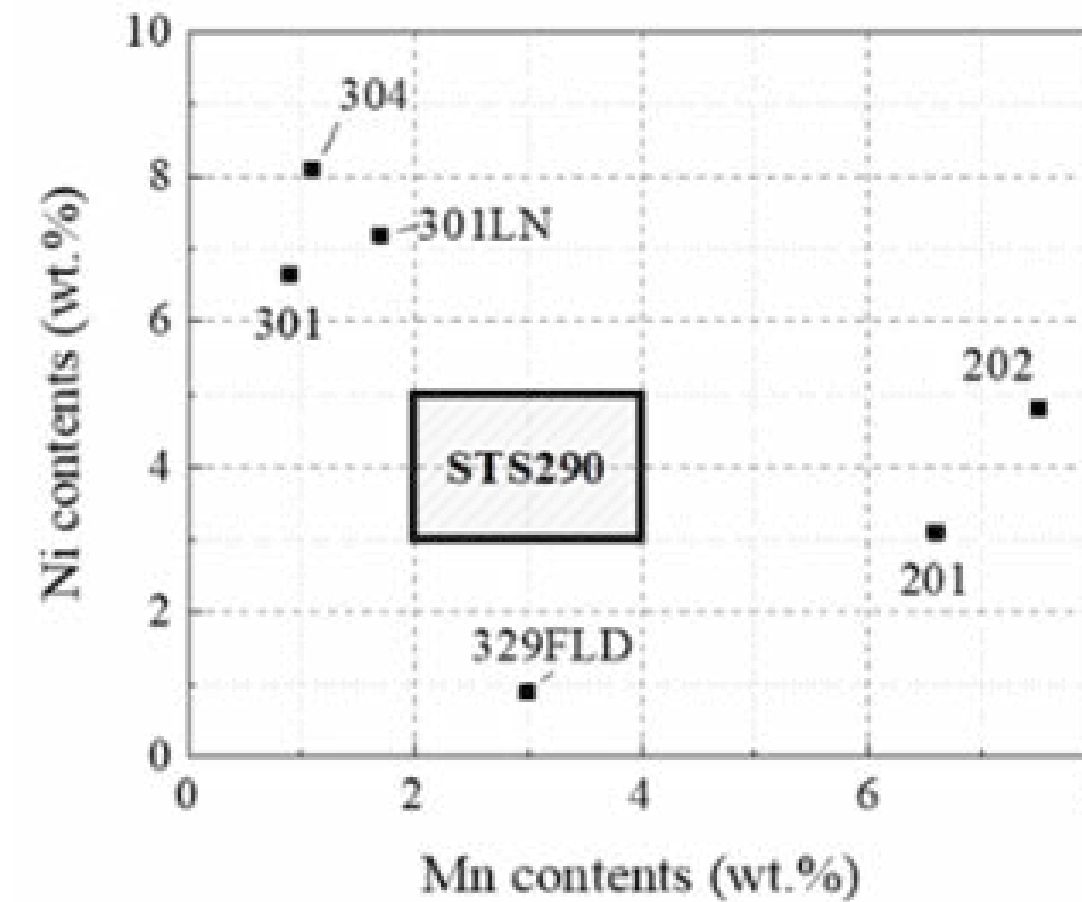
STS290 has enable a lightweight design of the LCD panel transport frame to improve loading efficiency.

Needed Action

POSCO developed STS290, a new steel grade with high corrosion resistance, high strength, and low cost, to lighten the material of the LCD panel transport frame. In addition, in consideration of the physical properties of the new steel type STS290, the structure of the LCD panel transport frame that can improve the loading efficiency was improved.

Action Review

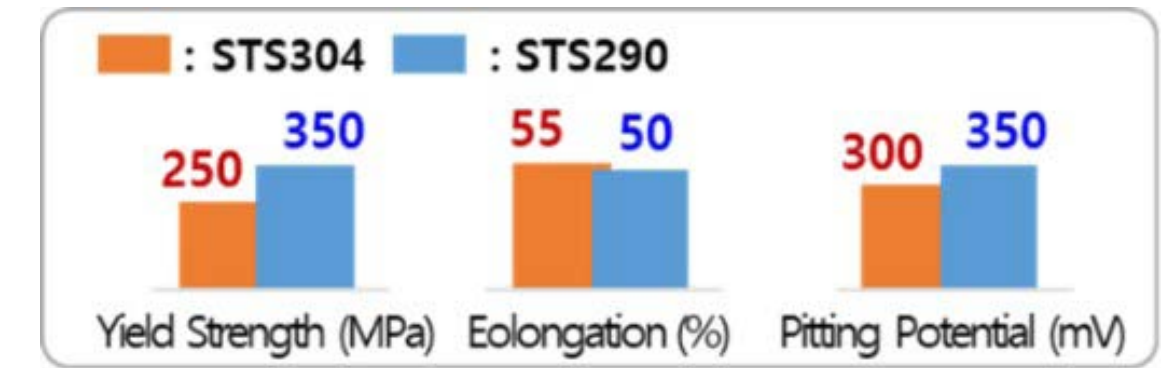
First of all, the yield strength of the new steel grade STS290 is over 350MPa, which is about 30% higher than that of the existing STS304 (YS: 280MPa). For this reason, when manufacturing an LCD panel transport frame by applying STS290, it was



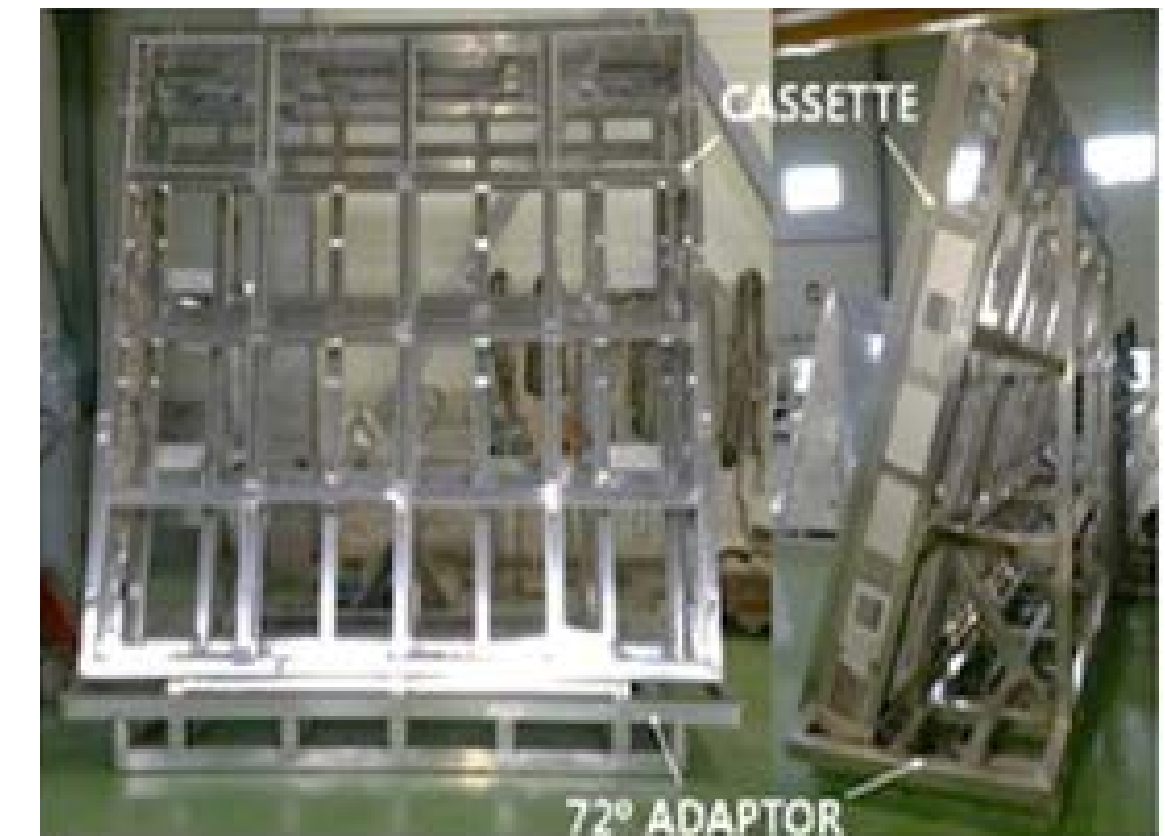
Mn and Ni content in stainless steels

possible to reduce the thickness by about 40% (1.7 to 2.4t) compared to the thickness (3.0 to 5.0t) of the existing STS304. In addition, as STS290 exhibits excellent elongation of 45% or more, corrosion resistance of STS304 level, and corrosion resistance of welded parts, it is possible to manufacture structures through square pipe forming and welding.

Through design review of the LCD panel



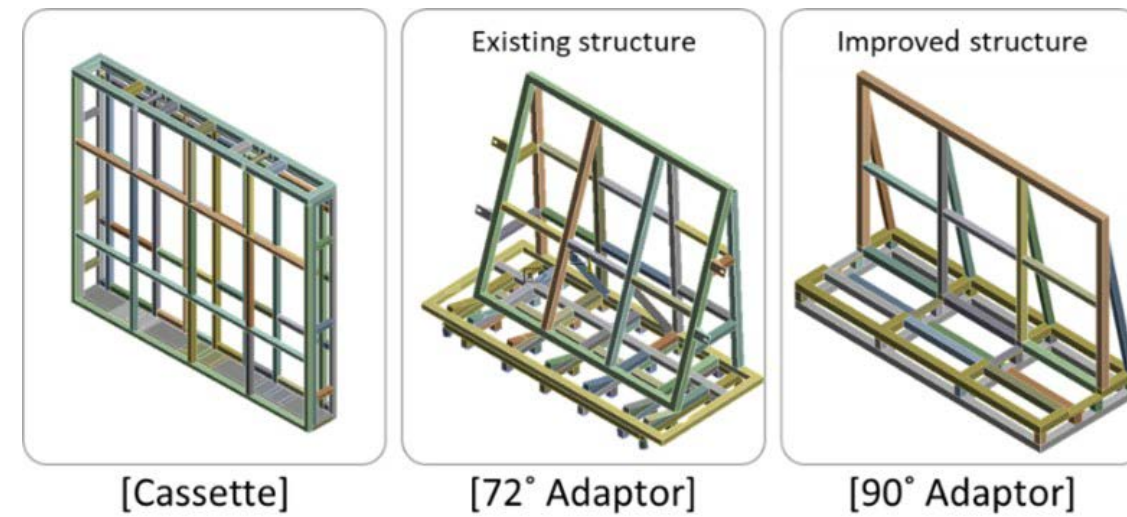
Characteristics of STS304 and STS290



LCD panel transport frame

transport frame (composed of adapter and cassette) considering the high-strength characteristics of STS290, the structure of the cassette was changed from 72 degrees to 90 degrees. By applying this design, the

number of LCD panel transport frames doubled compared to the existing one could be loaded in the same container space, and this made it possible to reduce logistics costs.



Horizontal Expansion Capability

Recently, it was promoted to apply STS290 as an alternative material to STS304 for anchor use in building structures. In this case, it was possible to reduce the thickness by about 40% compared to existing thickness, and as a result, it was possible to reduce the material cost by 15%. Because of these characteristics, many Korean construction companies are



| Anchor

expanding the application of STS290 for anchors. It has been proven that STS290 has great potential to be used for various purposes through high strength and high corrosion resistance, and its use will be expanded for various structural members in the fields of automobiles, railways, civil engineering/construction.

Outcome

From 2019, POSCO began to develop and apply a new LCD panel transport frame model using STS290 through collaboration with customers. The manufactured LCD panel transport frame is used very stably, and there is no particular problem in using it for a long time.

High Performance Ferritic Stainless Steel for Large-Scaled Washing Machines and Dryers

Member Company

POSCO

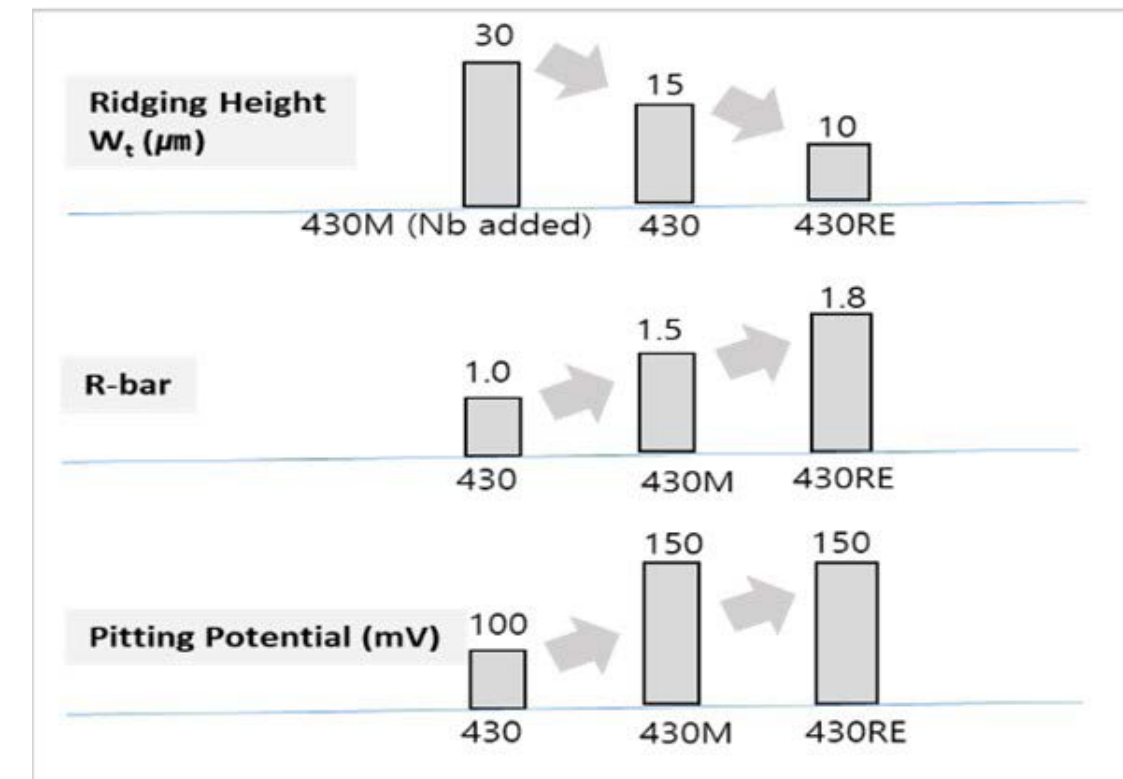
Category

Significant global market potential (>2.0m tons)

The Challenge

As washing machines and dryers become larger, consumers such as LG Electronics demand for us to make the material with excellent formability and good weldability with a competitive price.

1. The reduction of defect rate in 'Drum Rear' part after press processing.
→ Excellent Formability (superior r-value as well as anti-ridging characteristics)
2. 'Drum Center' productivity must be improved by the change from 'Lock-Seaming' to 'Laser Welding'.
→ Good weldability with a competitive



Quality position

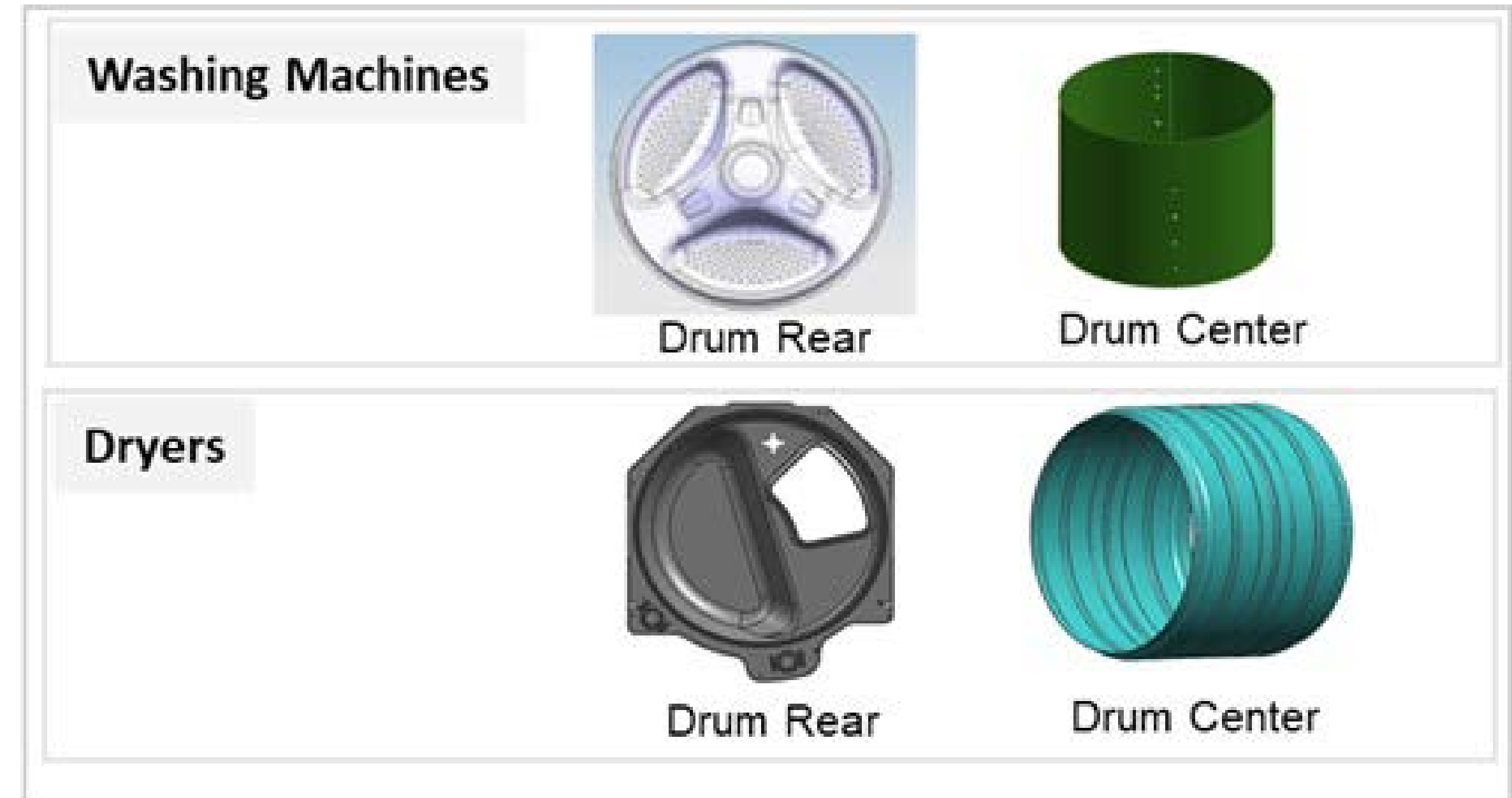
price.

Why?

In response to the increased demand for premium appliances (large-scaled washing machines & dryers), POSCO needs a customer lock-in for our development.

Needed Action

1. Competitive alloy design and process development (BAF (Batch Annealing Furnace) process omitted)



Application of 430RE

2. Optimization of hot-rolling as well as cold manufacturing conditions for improved formability and lowering ridging.

Action Review

Specific; 'Drum Rear' & 'Drum Center' of washers and dryers

Measurable; Ridging value (W_t), r-value (r-bar), elongation (%), corrosion resistance in fastened part

Achievable; 430RE (Ridging Endurance) product is launched and expanded sales

Realistic; LG Electronics has adopted 430RE product and has been constantly purchasing it

Time-bound; From 2018 to 2020, POSCO successfully satisfied the demands of LG Electronics.

Horizontal Expansion Capability

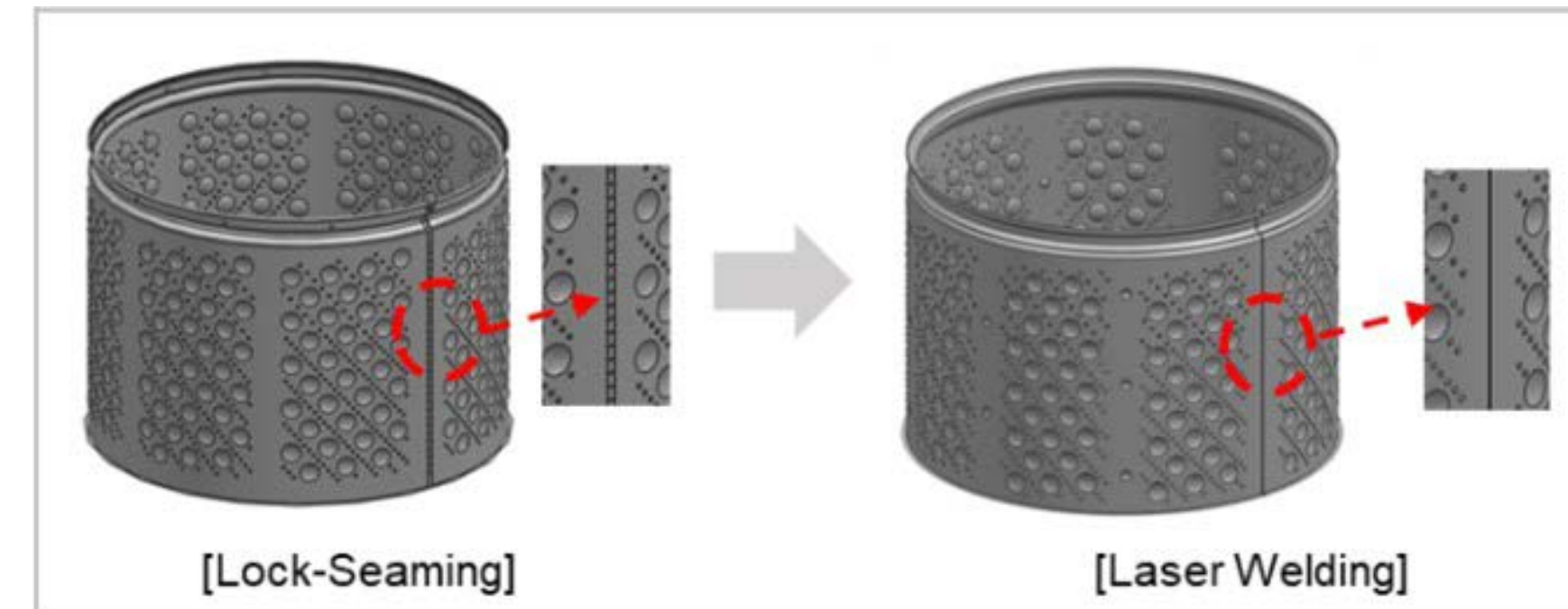
It can be applied to large scaled washing machines and dryers that require welding type.

It can be expanded into a global consumer electronics company.

Outcome

On the POSCO side, the development of BAF-processed omitted product has enabled process cost reduction and CO2 reduction.

On the LG Electronics side, 'Drum Center' productivity is improved by the change from 'Lock-Seaming' to 'Laser Welding' as well as reduction of defect rate in 'Drum Rear'.



| The change of joint method in Drum Center



| The appearance of joint in Drum Center after corrosion test

Technological development of heat and surface treatment

Member Company

SIJ Acroni d.o.o.

Category

Original concept for production of or application of stainless steels; Degree of contribution; Significant global market potential (>2.0m tons) or reduction in operational costs; Significant global market potential (>2.0m tons); Strong environmental improvement potential; GHG emissions reduction; Reduction in routine maintenance costs; Life-cycle costs (LCCs) lowest compared to competing materials

The Challenge

The solution is based on setting up a new technological route in the part which includes a change of heat treatment technology and subsequently beneficially affects the quality of the steel structure, which is closely linked to the final

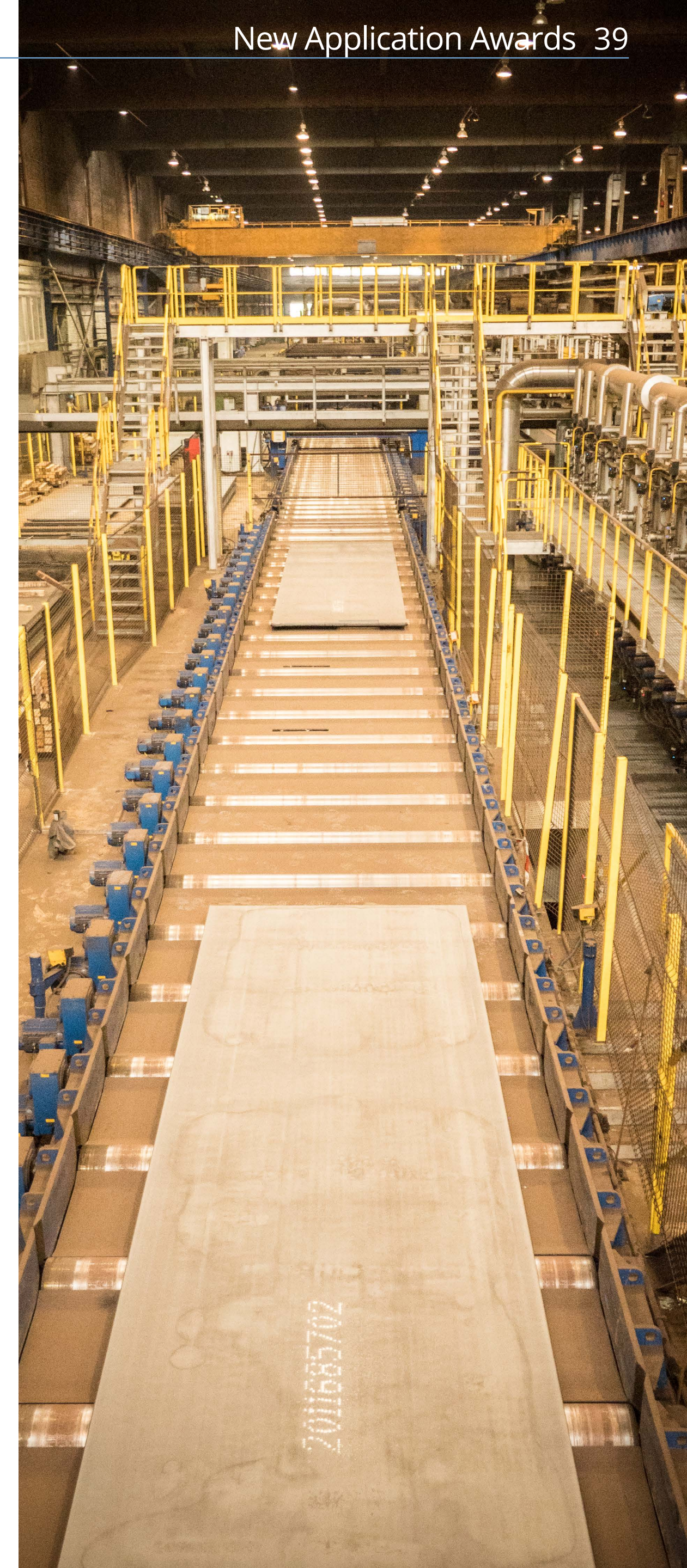
mechanical properties. The change of the heat treatment technology subsequently has very beneficial effect on the time and intensity of the surface treatment process or acid pickling to dissolve oxides from the plate surface. The solution was implemented in processing of all duplex X2CrNiMoN 22-5-3, W.Nr. 1.4462 and superduplex X2CrNiMoN 25-7-4 W.Nr. 1.4410 steel grades of our brand SINOXX 4462 and SINOXX 4410, which are part of SIJ Acroni's production programme.

From the beginning of development of duplex and superduplex steel grades up to 2017, when we began started with the implementation of the innovation process, heat treatment was done on three different heat treatment lines. Due to the broad dimension range (mostly thickness), the specifics of the steels under consideration, each heat treatment line had its technological limitations with regard to its position in the plant. Due to these limitations, the plates were

sorted based on the rolled thickness before heat treatment. The inconvenient position of the plate manipulator and the lengthy transport of the heated plates to the cooling beds caused undercooling which negatively impacted the structure of the cooled plates as well as the final mechanical properties. The input material was also heated in furnaces that used oxidative atmosphere, which accelerated the process of high-temperature oxidation and affected the thickness of scaling on the plate surface.

Why?

In accordance with the limitations on different heat treatment lines during regular production there were instances when duplex, and especially superduplex steels did not achieve the required structural properties. In the microstructure of plate samples, metallographic examinations showed some initials of intermetallic phases present in the steel





structure, mostly in the midsection of thicker plates. There were also cases when technological limitations on the line and subsequent excessive precipitation were the cause of poor mechanical properties (excessive precipitation of intermetallic phases in the steel has adverse effect on mechanical properties, mainly toughness), which resulted in re-heat treatment and, in the worst case, scrapping the product.

We wanted to eliminate these process problems and introduce into the market

steel with excellent mechanical properties which can be repeated and achieved in the shortest possible time.

Needed Action

The innovation is based on the optimization of heating and cooling the input material. As the high-temperature roller furnace HTF (HTF – heat treatment line) is composed of the pre-heating (max. 800 °C) and heating (max. 1100 °C) part, the technological challenge which we needed to conquer on the HTL line was in the pre-heating part of the HTF. The set temperature of the pre-heating furnace is constant during the process and does not vary. This is unfavourable for the presented type of steel due to the precipitation of intermetallic phases in the critical temperature range between 600 °C and 900 °C.

Within the framework of this challenge, based on the industrial tests, industrial

temperature measurements with a thermal barrier (obtaining a temperature profile ...), parallel laboratory sample examinations, and setting up suitable cooling conditions with appropriate water temperature intervals in l/m² * min in the industrial environment offered by the cooling device MFQ, we managed to set the conditions of solution annealing and cooling on the line, which enable stable production of heat treated duplex and superduplex heavy plates.

The second part of the technological process which follows is surface treatment or pickling. Thanks to the successful implementation of the technological process on the HTL line, we achieved extraordinary results in pickling the plate surface. The results have a favourable financial and ecological impact.

The first condition for achieving shorter pickling times is sandblasting or mechanical removal of oxide products

from the surface of hot-rolled steel plates, which is the first phase on the HTL line, before solution annealing. The efficiency of sandblasting was achieved with an appropriate speed through the sandblasting chamber between 1 m/min and 6 m/min and the type of sand.

The goals, we had to achieve:

- Ensuring temperature homogeneity in the process of solution annealing according to the applicable standards (ASTM, Norsok ...)
- Achieving a critical cooling rate during quenching, primarily to prevent the occurrence of intermetallic phases
- Achieving the prescribed flatness of the duplex and super duplex heavy steel plates after solution annealing and quenching
- Guaranteeing stability and repeatability of the prescribed mechanical properties

- Successfully passed pitting and corrosion test
- Acid pickling time optimization

Action Review

Specific; This is a very specific development and innovation, which is tied to the duplex and super duplex stainless steel segment. We have developed a new technological approach with the technological process of heavy plate heat treatment on the line which was originally made for heat treatment of wear-resistant steel. Along with developing excellent final mechanical properties and microstructure of the steel, we also improved the final surface quality of the plates.

Measurable; The results are measurable and comparable. The innovation's yearly contribution from the start amounted to:

- 8,061,354 EUR or 1.86 % of the total revenue of the company SIJ Acroni in

2018

- 8,335,218 EUR or 1.93 % of the total revenue of the company SIJ Acroni in 2019
- 11,233,333 EUR or 2.98% of the total revenue of the company SIJ Acroni in 2020
- 9,776,507 EUR or 2.15 % of the total revenue of the company SIJ Acroni in 2021

Achievable; The results are realistically achievable. In comparison to the period before introduction of the innovation, we improved the yield of the presented steel grades on an annual basis. The percentage of scrap heavy plates due to poor surface quality was reduced by 42.3 %.

Realistic; The technological development is realistic. The complete technological route of processing duplex and superduplex steel grades has directed through the newly developed heat treatment

technology for 3 years, with repeatable results regarding efficiency and quality.

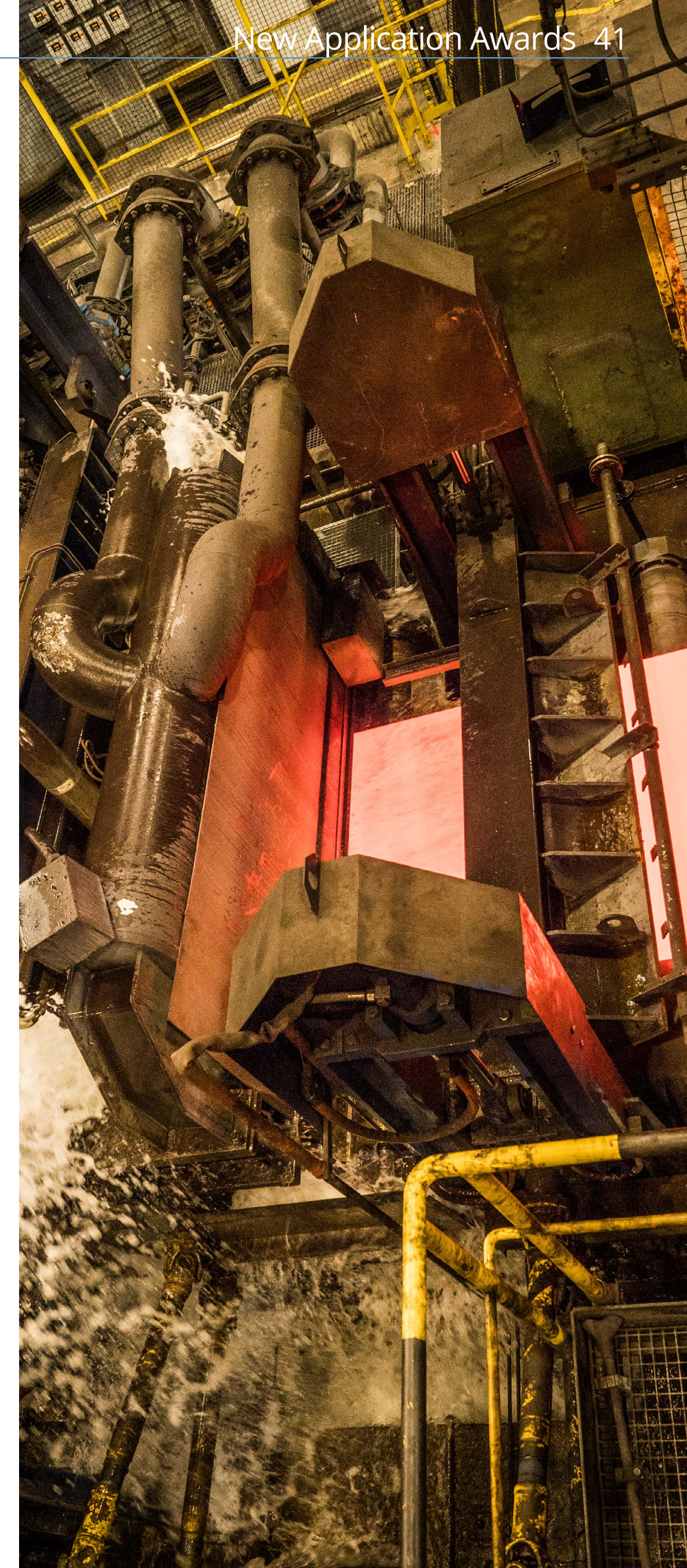
Time-bound; The development of this technology lasted 2 years.

Horizontal Expansion Capability

The process technology could be implemented into any production process globally or in companies with similar technological lines. The basic line was intended for heat treatment of special carbon steel grades. Our innovation with the change and upgrade of the line's technological process enables us to process the whole group of duplex stainless steels on the line. In this way we re-developed the process and upgraded the line for multifunctional use.

Outcome

The direct beneficiaries of this innovation are our customers for the whole group of duplex stainless steels. These steel grades





are mostly used in oil & gas industry. Some are also used in the aviation industry.

The direct beneficial effect of this innovation is firstly felt by the employees which are part of the production system, and in the work, which is related to heat treatment and surface treatment of duplex and superduplex steels. The physical labour is made significantly easier, and exposure to dangerous substances is minimized.

In the field of a wider range of users of duplex and superduplex heavy plates, the innovation has a very favourable impact in terms of final material quality and technological stability of production.

Regarding shortening pickling times, the innovation has an impact on the protection of the environment and the health of people, both employees and local communities. We are able to deliver quality steels to our customers with a better appearance and in a shorter period

of time.

The innovation's contribution amounted to 8,061,354 EUR or 1.86 % of the total revenue of the company SIJ Acroni in 2018. In 2019, the contribution slightly increased, and amounted to 8,335,218 EUR or 1.93 % of the total revenue of the company SIJ Acroni.

In 2020, the contribution rose to 11,233,333 EUR (2.98 %). In 2021, it lowered due to the changed market situation, and amounted to 9.776.507 EUR (2.15 %) of the total revenue of SIJ Acroni.

In comparison to the period before introduction of the innovation, we improved the yield of the presented steel grades on an annual basis. The percentage of scrap heavy plates due to poor surface quality was reduced by 42.3 %.

This innovation is very important to the company, as it increases the stability of duplex and superduplex steel processing

and ensures a faster delivery of final products with high added value to the customers. On the other hand, with the certification of the presented steels, which is currently underway for new customers, we are expanding sales to new markets in the marine, electrical and oil & gas industries.

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About worldstainless

worldstainless is a not-for-profit research and development association which was founded in 1996 as the International Stainless Steel Forum.

Its primary roles are to undertake stainless steel industry beneficial tasks that are better coordinated centrally in the fields of

- Promoting industry and material sustainability benefits
- Conserving resources and promoting the circular economy
- Providing economic and industry-leading statistics
- Support industry health & safety needs and developments
- Outlining market development and expansion opportunities
- Maintaining brand reputational positioning
- Materials education

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