Stainless Steel Industry Awards 2025

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Introduction

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

Market Development Case Studies

Verteg Keg - Keg made of duplex

Member company

Acerinox Europa S.A.

The Challenge

Transport of beer has conventionally used Stainless Steel Kegs 304 which must withstand not only hygienic but also mechanical strength and endurance requirements. Reducing weight has benefits not only during transport but also on the amount consumption of material required, but this must not jeopardize the mechanical strength of the product.

Duplex stainless steel is well-known for achieving a reduction in material consumption and weight on industrial applications such as tubes and large tanks. These applications have less aggressive transformation processes than kegs and also generally use larger thickness of the metal. Duplex is also well known for their improved corrosion resistance to pitting compared to 304.

Nevertheless, there are several challenges on applying this material on kegs:

- Achieving successfully the deep drawing process for thin materials considering it is less ductile, controlling successfully the welding parameters and preparation on several areas of the product (chimes, neck and central welding)
- Anisotropy on the material plays also an important challenge on this kind of application
- Meeting a design adapted to achieve the correct balance between strength and weight with this new material to pass conventional endurance tests for kegs
- Understanding and applying pickling process parameters.

All-in-all, the project aims at applying taking all the benefits of an existing material on a completely new application: Kegs.

Why?

It was important to move forward on new ways of manufacturing traditional kegs and break the belief that to make a keg lighter it implies weaker and/or moving to plastic.

We bring something new to the market, with a traditional belief that there is not much change that could be done on kegs.

This improves the know-how on new applications of duplex materials and opens up new possibilities not only for kegs but for similar products that can benefit from the weight reduction, corrosion resistance benefits and strength.

Weight reduction could also be related to sustainability improvements due to lower consumption of material, lower weight during transport or optimizing the number of kegs to carry and weight limited loads.

Needed action

We have partnered on a I+D consortium with one of the largest stainless steel manufactures (ACERINOX) and 2 technological centers such as TECNALIA and AIMEN under the support of the CDTI funding.

THIELMANN Portinox Spain led this project and together we carried out investigations, including numerical analyses and experimental tests for welding and deep drawing, implementation of the knowledge on a new design, product validation and industrial application.

Project could be summarized on the

following phases:

- Selection of two reference cases with high volume on the market. In this case the 30L was one of them.
- Investigation and selection of alternative materials for kegs for further investigation
- Determination of key properties of the selected materials and their benefits and challenges with respect to welding, deep drawing, costs and strength
- Numerical and experimental analyses of the selected material on a laboratory scale. In this case the duplex AISI 2001 was one of the most suitable candidates
- Numerical and empirical application on prototypes of selected Keg design
- Product validation considering most common keg requirements tests for strength, beer contact and corrosion
- Application on an industrial environment

Action Review

Specific: The project focused on two initial test cases, whereas a selection to prioritize the 30L was concluded based on a market volume analysis and the highest probability of success on the new material application.

Most of the actions were focused on the selected material Dúplex AISI 2001 after the analyses of their advantages and also preliminary tests and simulations.

Measurable: The target of the project aimed at a weight reduction of up to 30%. For the specific case of the 30L standard keg, a reduction of 25% was achieved, passing the standard tests such as keg.

The project opens up for reduction of a higher level depending on the specific configurations which could be measured.

Achievable: The target to a reduction of 30% in weight is achievable, considering that even if it is ambitious, for the specific case of 30L a reduction of 25% was obtained.

Based on the test results, it is possible that a further reduction could be obtained reducing the thickness of the chimes.

Based on the know-how obtained, and considering variations on the design, volume of specific requirements for specific customers, it is possible that for certain products a 30% could be achieved by applying the duplex material.

Realistic: Deep drawing of the 30L keg domes: achieved successfully and without rupture after correct parameters were found.

Transformation of the chimes: was achieved without breaking on the manufacturing process

Chimes – Dome welding: was achieved passing the welding homologation tests

Neck-Dome welding: was achieved passing the welding homologation tests

Iron-pick up and metal migration tests: passed successfully

Drop tests: passed successfully

Neck impact and compression tests: was achieved successfully

Central welding with new parameters for duplex and specific thickness and shape: was achieved successfully

Time-bound: The project was planned for a duration of 2 years. The time plan was adjusted since some of the actions were subjected to CDTI funding, which was delayed. With that an extension was obtained and the project plan shifted to 3 years.

For the scope of the project, the results were obtained successfully on that time frame.

New actions and measures after the learnings with new scopes are set for additional development.

Horizontal expansion capability

Yes, some of the actions regarding the generation of prototypes, deep drawing and welding tests can be applied to other products in our company. For example, in the area of Industrial Containers and Pressure vessels.

Outcome

This product strengthens our brand, being the first in our sector to manage to engineer and produce a duplex keg. This has created a large interest in the market and customers about our products and our expertise.

Inside the area of Product Development, we have made great increases on our capabilities to develop additional products, improving on a large level our know-how.

In addition, there are benefits to the manufacturing plant, which pushes our skills to lighter materials and new ways for welding.

In the engineering department, it gives a sense of job satisfaction and enhances the innovation thinking for creating better products, even if they seem challenging or if there is no one who has done it before.

Lining on water release equipment of the Aso Tateno Dam

Member company

Nippon Steel

The Challenge

1. Due to climate change in recent years, the frequency and severity of natural disasters are increasing. In Japan in particular, localized torrential rainfalls known as "guerrilla rainstorms" are threatening the lives and livelihoods of local residents.

2. The Aso region in Kumamoto Prefecture boasts one of the highest rainfall volumes in Japan, and the Tateno district along the Shirakawa River has such a landform where rainfall is concentrated due to one of the world's largest calderas and other conditions.

3. In the Tateno district in the Aso region, a flood control dam called a "flood mitigation dam" has been constructed. This dam is structured to allow the river to pass straight through the dam bank without being stored at normal conditions. For this reason, this dam has the disadvantage of accelerated wear of the concrete structure due to gravel flowing from upstream.

4. To overcome this disadvantage, we figured out specifications for applying stainless steel lining to the concrete of water release pipes. As the lining material, we attempted to employ lean duplex stainless steel SUS821L1, which is both extremely strong and hard and also excellent in terms of processability.

Why?

1. Several flood control dams called "flood mitigation dams" have been constructed in Japan, and the concrete of water release

pipe is protected by abrasion-resistant steel plates in some cases.

2. Abrasion-resistant steel plates exhibit their effect in a dry environment, but in a humid environment where wear and corrosion simultaneously progress, the wear amount tends to be greater than expected and the plates cannot fully exert their effect.

3. Lean duplex stainless steel SUS821L1, which exhibits excellent corrosion resistance and abrasion resistance, is highly durable even in environments where wear and corrosion simultaneously progress, and a longer service life than that of abrasion-resistant steel plates can be expected.

4. Since lean duplex stainless steel SUS821L1 has excellent weldability and can be used to manufacture and weld ultrathick steel plates, we considered it as a replacement for conventional abrasion-resistant steel plates and therefore made this proposal.

Needed action

1. We introduced the characteristics of lean duplex stainless steel SUS821L1 to dam equipment designers and customers, and conducted promotional activities to inform that this steel is suitable for the lining of Aso Tateno Dam. Initially, SUS304 was also one of the candidate materials, but the Ministry of Land, Infrastructure, Transport and Tourism, the customer, understood that SUS821L1 is more advantageous even in terms of dam design because it is stronger than SUS304.

2. We summarized our track record of employing SUS821L1 in civil engineering

structures in Japan and explained to the customer that SUS821L1 has been used even in many pieces of dam-related equipment and has a sufficient track record.

3. By comparing the life cycle cost of employing SUS821L1 lining with that of employing other methods, we clarified the superiority of SUS821L1 lining and explained the rationale for employing SUS821L1.

Action review

Specific: As lean duplex stainless steel SUS821L1 is a strong material with excellent corrosion resistance, it is possible to achieve higher performance than abrasion-resistant steel plates in a corrosive environment.

Measurable: 1. As a past study report clarifies the relationship between cross section hardness and wear amount, we quantified the influence of the hardness distribution of SUS821L1 on the wear life by using that relationship.

2. By measuring and comparing the cross section hardness of SUS821L1 and that of other candidate steel types, we showed the superiority of SUS821L1.

Achievable: Welded structures that use SUS821L1 are constructed by common construction methods (fillet welding with flux-cored wire, full penetration welding, etc.), posing no big challenges at the time of construction.

Realistic: Welding tests using SUS821L1 have already been conducted by almost all gate fabricators, posing no challenges in construction.

Time-bound: We finished the proposal within the dam design period (April 2017 to March 2019).

Horizontal Expansion Capability

The construction of a flood control dam called "flood mitigation dam" is currently being discussed at several locations in Japan. As sedimentation affects the service life of dams, local government bodies are promoting the installation of bypass water release pipes for sediment discharge in dams that are nearing the end of service life. For the linings on those dams, employing SUS821L1 is being considered and as 1,400 tons of SUS821L1 were used in Tateno Dam, SUS821L1 demand is expected to increase by several hundred to 1,000 tons per location once it is employed.

Outcome

Construction of the Aso Tateno Dam was completed in April 2024. At the time of torrential rain in the Aso region immediately after the completion of the dam, the dam was able to lower the river water level in Kumamoto City located downstream and prevent damage to field crops due to flooding. According to estimates by the Ministry of Land, Infrastructure, Transport and Tourism, the economic benefits of preventing the damage amounted to several hundred million yen.

Safety grating with high strength stainless steel

Member company

POSCO

The Challenge

The hot and humid environment of the factory is a major cause of weakening the durability of materials. Safety grating, applied in various plants including steel mills, easily corrodes in such environments, threatening the safety of workers. In some workplaces, cheaper galvanized products are used instead of stainless steel due to cost increases, which accelerates corrosion and often increases replacement costs.

Why?

Safety grating made of stainless steel has excellent corrosion resistance, but many factories do not adopt it due to cost

increases. If stainless steel Safety grating can be supplied at a lower price, a new market can be secured to replace existing galvanized Safety grating and ensuring worker safety as well.

Needed action

The biggest obstacle to replacing widely used galvanized carbon steel with stainless steel safety gratings is cost. To solve the cost issue, Safety grating was manufactured using high-strength PossHN1 material which developed by POSCO. PossHN1 has higher strength compared to 304, making it possible to reduce the material thickness. Additionally, PossHN1 has corrosion resistance equivalent to 304 and ensures sufficient durability in hot and humid environments.

Action review

Specific: Safety grating easily corrodes due to the harsh environment in the steel manufacturing factory, leading to increased maintenance costs and threatening worker safety.

Measurable: By applying PossHN1 to safety grating, life cycle cost can be reduced (quantitative evaluation is currently being tested through prototype application).

Realistic: We verified cost reduction and durability improvement through prototype production and field application testing.

Time-bound: The prototype production and installation for the two sites in February and June 2024 were completed

as planned.

Horizontal Expansion Capability

By applying high-strength steel to applications requiring structural stability, such as safety grating, the thickness can be reduced, thereby reducing costs and creating new application.

Outcome

By using stainless steel with excellent corrosion resistance at a low cost, it is possible to reduce life cycle costs.

Technology Case Studies

Ultra grain-refined austenitic stainless steel with high strength and good corrosion resistance for battery case.

Member company

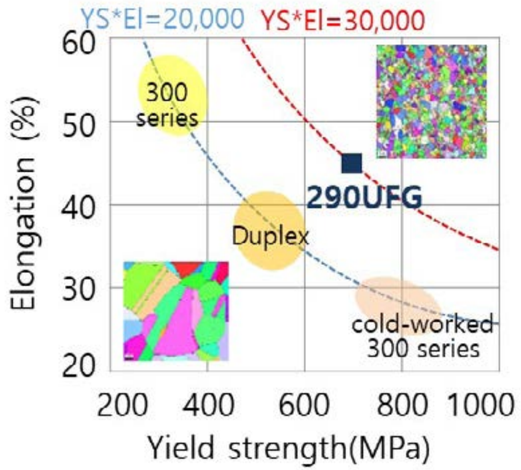
POSCO

The Challenge

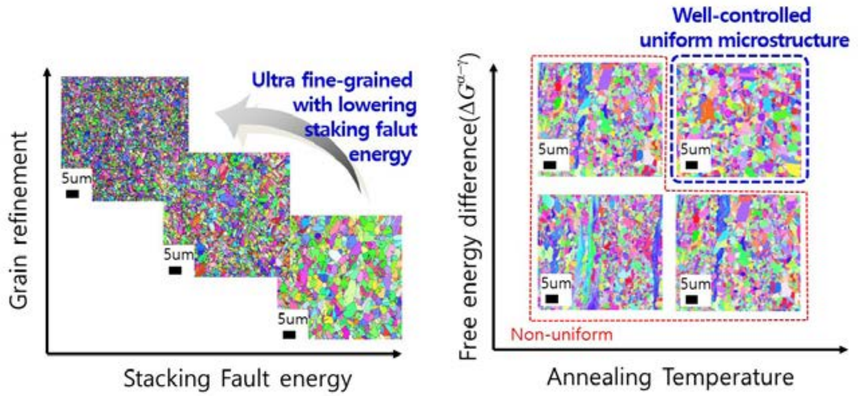
Austenitic stainless steel (STS) is a widely used structural material in construction and attracts attention as a material for electric vehicle battery parts due to its combination of strength, ductility, and good corrosion resistance. Lightweight STS with high strength and good corrosion resistance is advantageous for reducing weight and extending the product's life cycle. STS with high strength achieved through hard processes (additional cold-rolling and degreasing processes) also demonstrated good fire safety in battery components.

As competition in the electric vehicle market intensifies, there is a need to improve the price competitiveness of STS applied to electric vehicle components. Additionally, the required properties are gradually increasing due to the high capacity of batteries and their generational advancements. A new approach is needed to reduce raw material and replace high-priced hard processing for cost reduction while improving material properties. The Ni content, which accounts for the largest proportion of raw material costs, should be adjusted by replacing it with Mn, Cu, C, and N while maintaining corrosion resistance as 300 series STS. In order to obtain high strength, grain refinement is a powerful method and increases ductility, which is reduced by the hard process.

In this development, a new austenitic stainless steel for electric vehicle battery parts was suggested. It was designed to be favorable for grain refinement, with each process newly optimized by considering its austenitic stability against martensitic transformation, the amount of cold-rolling, as well as controlling annealing temperature.



[290UFG positioning in strength & elongation relationship diagram]



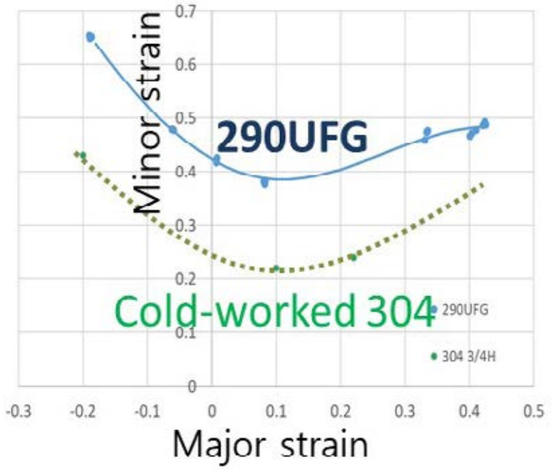
[Ultra grain refinement through optimizing the stacking fault energy and the free energy difference between the ferrite and austenite phases]

Why?

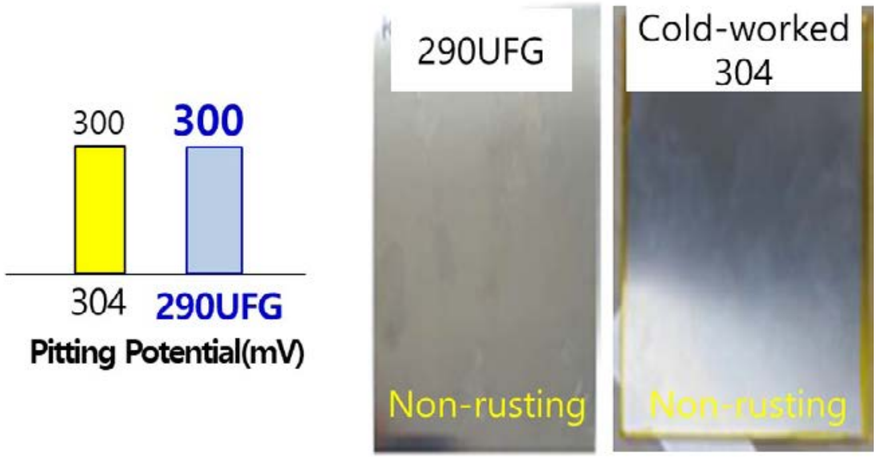
In accordance with changes in the electric vehicle market, it is important to have a good price competitiveness and develop materials with excellent properties, which is expected to be a key factor in overcoming the electric vehicle chasm. For this, it is necessary to develop an innovative high-strength stainless steel with a differentiated new concept. New types of ultra grain-refined STS have high strength and good corrosion resistance, as well as shorten the hardening process, which can contribute to enhance a material competitiveness in the electric vehicle industry.

Needed action:

The alloy composition in which the martensitic transformation occurs well for grain refinement was derived based on calculated stacking fault energy to evaluate austenite stability. The cold-rolling process is optimized to enhance transformation and flatness of high-strength flat sheets. Lastly, annealing temperature and time were optimized to control recrystallization and growth based on calculated thermal free energy.



[Forming limit diagram comparison between 290UFG and Cold-worked 304]



[Corrosion resistance comparison : Pitting potential and Cyclic corrosion test]

Action review

Specific: Fine-grained austenitic stainless steel 290UFG with high strength and good corrosion resistance can be applied as a battery module case.

Measurable: Tensile strength (MPa), Pitting Potential (mV), elongation (%)

Achievable: High strength and good corrosion resistance can be achieved in grain-refined stainless steel compared to the conventional one with hard processes

Realistic: The manufacturing process for grain-refined stainless steel was optimized, contributing to the achievement of high strength and good corrosion resistance.

Time-bound: From 2021 to 2024, POSCO succeeded in developing a new type of grain-refined stainless steel for battery component parts and met the customer requirements.

Horizontal expansion capability

Grain-refined austenitic stainless steel with high strength and corrosion resistance is expected to be used as a structural material in construction and other vehicle industries. It can also be applied to parts that require formability due to its good ductility properties.

Outcome

A new ultra grain-refined austenitic stainless steel, 290UFG, with high strength and corrosion resistance, can lower material costs and shorten the hardening process. It reduces weight, contributing to saving energy consumption, and is expected to extend the product's life cycle. It also improves the competitiveness of stainless steel in the electric vehicle industry with excellent properties, which are hoped to contribute to overcoming the electric vehicle chasm.

JAG Plate Heat Exchangers

Member company

Acerinox

The Challenge

Hexonic aimed to enhance heat exchange efficiency while ensuring durability and sustainability in demanding industrial applications. The primary challenge was to develop a heat exchanger capable of operating under extreme conditions, including high temperatures and aggressive environments, without compromising performance or longevity.

Why?

The demand for more efficient and corrosion-resistant heat exchangers has been increasing in various industries, including HVAC, chemical processing, and power generation.

Needed action

- Developed a proprietary corrugated plate design to maximize heat transfer efficiency.
- Utilized high-grade stainless steel (e.g., AISI 316L) for superior corrosion resistance.
- The application of the Finite Element Method (FEM Analysis) was intended to optimize the design in terms of durability, mainly by improving the stress distribution on cover plates and modifying fasteners, which led to expanding the scope of working parameters of the device.

Action review

Specific:

- Conducted in-depth market research to determine industry needs.
- Designed and prototyped JAG series exchangers with improved thermal performance.
- Partnered with key industry players to validate performance in real-world applications.

Measurable:

- Increased heat transfer efficiency
- Extended operational lifespan
- Reduced maintenance costs

Achievable:

- Successfully launched JAG exchangers in targeted markets, exceeding initial sales expectations.
- Met all industry certification requirements

Realistic:

- Designing an innovative heating plate
- Increasing sales of threaded

- Introducing an innovative product to the market

Time-bound: All actions related to the implementation of the JAG product were completed within the original time frame, according to the planned schedule.

Horizontal expansion capability

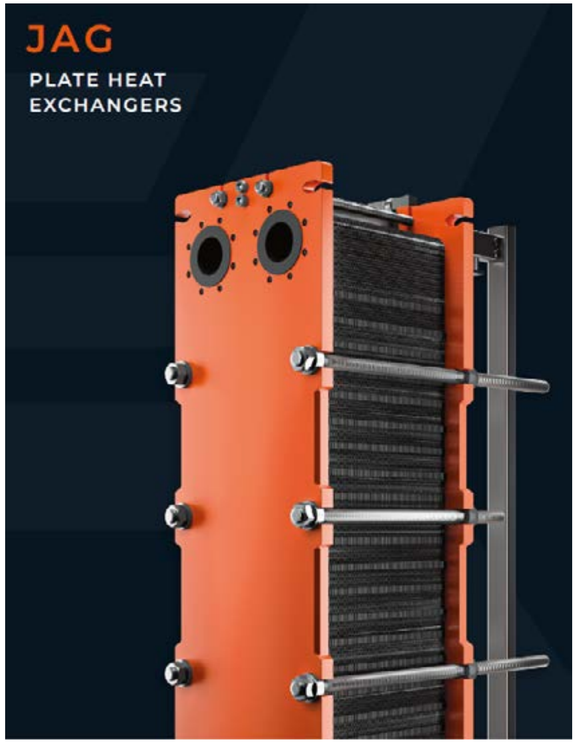
Yes, the modular design and advanced stainless steel processing techniques can be adapted for various industrial applications, including food processing, pharmaceuticals, and renewable energy sectors. The technology also serves as a foundation for further innovations in compact and high-efficiency heat exchangers.

Outcome

- Job Satisfaction: Acquiring new skills and learning innovative tools and work methods contribute to an increase in competence and self-confidence. Completing a project successfully, on time, and within budget, generates a sense of achievement. Employees who are proud of their goals tend to derive greater satisfaction from their work.
- Operational Efficiency: The ability to respond more quickly to market changes, better adapt to customer needs, and maintain competitiveness in the market.
- Cost Savings: The pursuit of cost savings involves optimizing processes, renegotiating contracts, automating tasks, and efficiently managing resources.
- Material Quality: High-quality materials ensure the durability, reliability, and aesthetics of the final product, while minimizing the risk of complaints and improving customer satisfaction.
- Sales Growth: Increased market penetration in Europe and North America

Other comments

The JAG series heat exchangers demonstrate the potential of stainless steel innovations in industrial applications. By combining superior material properties with advanced engineering, Hexonic continues to push the boundaries of efficiency and sustainability in heat exchange technology.



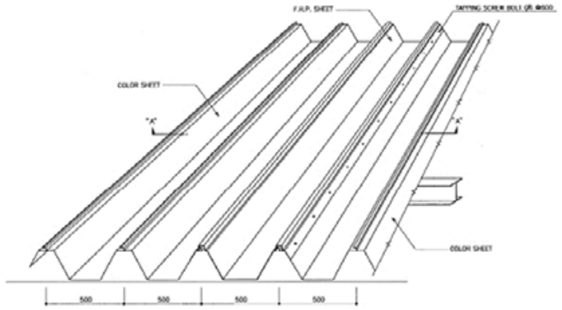
Lightweight roofing solution made from high-strength stainless steel for high temperature, high humidity and corrosion environments

Member Company

POSCO

The challenge

The slag yard plant in the steel mill area has a high temperature, high humidity, and high dust environment due to the discharged slag. As a result, the color steel roofing material made of coated carbon steel has serious problems such as the paint being damaged or the carbon steel being corroded after more than a year after installation. Since the roofing material requires installation work at high altitudes due to its nature, frequent roof replacement can cause safety hazards for workers and is expensive to replace. Additionally, roofing corrosion can cause leaks, which can lead to equipment downtime or create additional safety hazards.



Roofing shape : V500

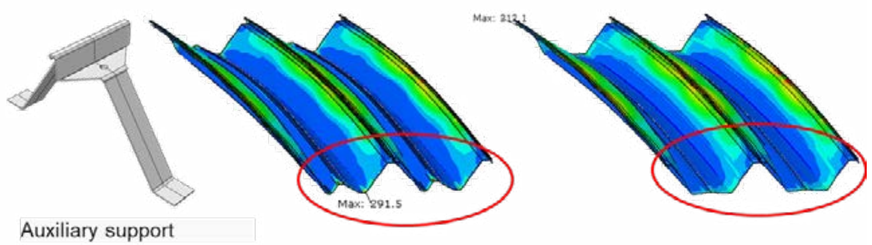
Why?

To solve these problems, it is necessary to select a roofing material that is resistant to high-corrosion environments and a lightweight solution for high-altitude workability.

Needed action

1. Selection of roofing materials that are resistant to external environmental factors such as snow and typhoons and highly corrosive internal environments

2. Lightweight solution to lower the initial cost of STS materials, which are more expensive than carbon steel, and to secure high-altitude workability



0.8t carbon steel roofing using previous auxiliary supports

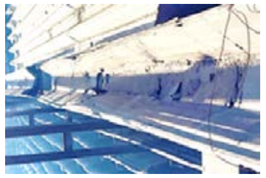
0.7t STS roofing using a new designed support

[1. Roofing lifting deformation : 10x deformation magnification]

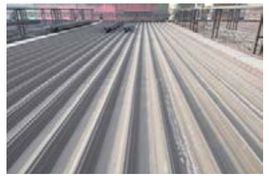
Action review

Specific: 1. The external environmental factors of roofing materials are snow and wind load. When it snows, the snow accumulated on the roof causes excessive sagging of the roofing material, and the wind load due to the typhoon lifts the roofing material and causes it to fall like a chain. For this, high-strength materials with high yield strength and high work hardening ability are required. In addition, the high-corrosion internal environmental factors of the factory with high temperature, high humidity, and high dust require STS roofing materials. For this, 304FG, a high-strength STS material developed by POSCO, is applied. 304FG is a fine-grained austenitic stainless steel that utilizes the recrystallization phenomenon

Slag removal operation



Carbon steel roofing



STS304FG roofing

[2. Roofing material installed in slag yard factory]

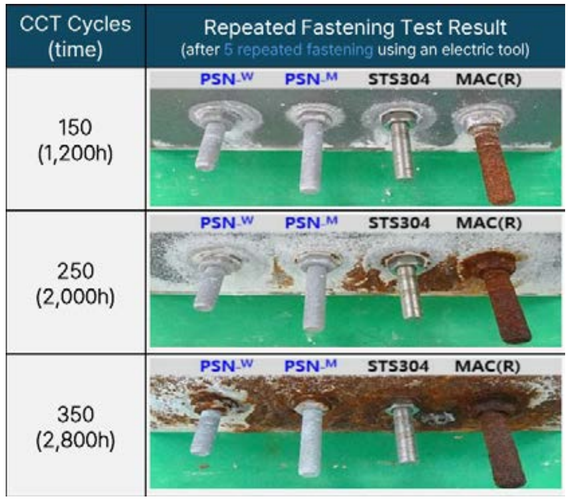
during annealing heat treatment. It has superior strength and corrosion resistance compared to standard 304 stainless steels.

2. When roll forming a complex-shaped roofing material using high-strength STS material, springback occurs due to the material's work hardening, so a roll gap setting technology that takes springback into account is applied for the roll forming process.

3. When installing roofing materials, the thickness of the roofing material should be made light to facilitate high-altitude workability and reduce the initial cost of expensive STS materials compared to carbon steel.
In the case of lightweight roofing materials, the sagging and lifting of the roofing material should exist in the elastic deformation region, so the elastic deformation of the STS roofing material increases as the thickness decreases. This can be overcome by changing the shape of the roofing material. However, since roofing materials are standard products that follow legal regulations, it is very difficult to change the shape of roofing materials. Therefore, to overcome this, tight frame design technology is applied to change the shape of the tight frame, which is the auxiliary support of the roofing material, to suppress sagging and deformation of the roofing material and make it smaller than the thickness before weight reduction.

4. The steel frame of the factory supporting the roof is carbon steel such as H beam. The STS roofing material and the steel frame are connected by auxiliary support, but when fixing the auxiliary support and the roofing material, they is likely to be damaged by galvanic corrosion. To overcome this, the fixing bolts are coated with a coating technology that secures excellent corrosion resistance through the sacrificial method of Zn and Al flakes.

Measurable: Based on the snow load and wind load conditions calculated based on the Korean Building Structural Standard KDS41, the elastic deformation of the 0.8t carbon steel roofing material was compared with that of the 0.7t STS roofing material, and the deformation was reduced by more than 20%, and the stress generated in the roofing material was reduced by more than 23%. The proposed coated bolt showed a 400% improvement



[3. composite corrosion test results : PSN is out technology. It is shown that the corrosion of the joined parent material is significantly less than that of STS304]

in galvanic corrosion resistance compared to the hot-dip galvanized bolt in the composite corrosion test results.

Achievable: This technology was applied on a pilot basis to 20% of the roof area of the POSCO Pohang Steel Works Slag Yard Plant in December 2024, and no problems with corrosion or deformation have occurred after one year.

Realistic: Based on the results to date, we plan to additionally completely replace the remaining colored roofing materials of the slag yard factory with STS roofing materials.

Time-bound: completed within the original time frame.

Horizontal Expansion Capability

This technology could be extended to highly corrosive environments such as chemical plants. Additionally, the new bolt coating technology can be applied to all environments where STS materials and dissimilar materials experience galvanic corrosion.

Outcome

Based on the monitoring results to date, it is expected that the corrosion resistance of the roofing material will be five times higher than that of the existing colored steel plate, and the cost efficiency of not replacing the roofing material will be two to three times higher.

Other comments

1. Roofing lifting deformation

2. This is a comparison photo of actually installed colored steel sheet roofing material and STS roofing material.

3. Here are the results of a comparison of the corrosion resistance of bolts.

Safety Case Studies

Smart Fire Monitoring System

Member Company

POSCO

The challenge

We aimed to develop a system that could quickly detect fire incidents in the Coil Grinding Line, enabling early intervention to prevent the spread of fire and facilitate initial extinguishing efforts.

Why?

Frequent fires occur due to the mist of grinding oil used to cool the friction heat from the high-speed grinding belt on the stainless strip. This mist not only causes fires but also contaminates auxiliary equipment. Fires in the grinder body, dust collector, motor brake, welder, and other equipment are particularly challenging to extinguish once they spread, as they are oil fires exposed to flammable oil mist. Therefore, it is crucial to detect fire incidents quickly and extinguish them immediately in their early stages.

Needed action

To solve the problem of frequent fires during Coil Grinding and to undertake the development of a Smart Fire Monitoring System, the following actions were taken :

1. Assessment and Planning : Identified the need for a system to enable early detection and extinguishing of fires in the Coil Grinding Line due to the high risk posed by oil mist.

2. System Design :

- Designed a comprehensive monitoring system using intelligent CCTV technology to address the specific challenges of detecting and responding to fires in real-time.

- Integrated the sequence of fire occurrence into the system design :

heat generation smoke generation flame generation fire occurrence.

a) Temperature and Heat Sensors: Installed sensors capable of detecting temperatures up to 250 degrees Celsius to identify heat build-up.

b) AI-Based Smoke Detection: Implemented AI algorithms to accurately detect smoke, providing an early warning of potential fires.

c) AI-Based Flame and Fire Detection: Utilized AI to detect flames and fire occurrences, ensuring rapid response.

3. Installation :

a) Installed 16 CCTV cameras strategically around the Coil Grinding Line to cover all potential ignition sources and high-risk areas.

b) Set up a PC with a pre-trained fire monitor system in the control room for centralized monitoring and alert management.

4. Alert System Development : Developed a notification system with pop-up and voice alerts to inform workers of abnormal situations, enabling quick action without the need for constant manual monitoring.

5. Testing and Optimization :

a) Conducted thorough testing of the system to ensure reliability and accuracy in detecting fire-related incidents.

b) Optimized the system settings, such as temperature thresholds and alert sensitivity, to suit the specific conditions of

the Coil Grinding Line.

6. Implementation and Training

a) Implemented the system within the planned timeframe, ensuring it was fully operational.

b) Provided training to workers on how to respond to alerts and use the system effectively to enhance safety and prevent fire incidents.

| * Smart CCTV System

| * Installation

Action review

Specific: The system was specifically designed to address the need for early detection and extinguishing of fires in the Coil Grinding Line. The grinding oil mist, a by-product of the high-speed grinding process, increases fire risk and contaminates equipment. The system includes Smart CCTV with pop-up and voice alerts to monitor potential ignition sources, addressing the challenge of

| * Monitors in the control room

workers not being able to constantly watch screens.

Measurable: The system supports up to 16 cameras with a single PC. Over 30 months, it detected and extinguished 5 out of 7 incidents early, improving the initial fire extinguishing rate by 71%.

Achievable: The objective of early fire detection was achieved. The system provides visual and auditory alerts only during abnormal situations, allowing for quick response, which was a key goal given the impracticality of continuous manual monitoring.

Realistic: The sequence of fire occurrence is heat generation → smoke generation → flame generation → fire occurrence. To facilitate early detection and action, heat detection sensors were attached to the front of the cameras, and smoke, flame, and fire occurrences were detected by the PC with an AI program. It was improved to detect fires from welding sparks and motor brake overheating, allowing for early intervention.

The temperature values of specific parts of the equipment displayed on the monitor can be set differently at the pixel level,

allowing for more sensitive adjustments.

Since many CCTV monitors are installed in the control room, workers cannot constantly monitor them, so the system was improved to provide voice warnings and screen pop-ups only during abnormal situations, enabling early recognition and extinguishing of equipment fires, thereby preventing worker safety accidents.

Time-bound: The improvement work was completed within the planned time frame, and the performance is satisfactory - planned 3 months, installation 1 day, immediate operation

Horizontal Expansion Capability

Yes, the approach can be applied to any area where equipment fire risk is a concern, making it adaptable for expansion in any company.

Outcome

Since implementing the Smart Fire Monitoring System, we have observed a remarkable increase in the early fire extinguishing rate to 71%. This improvement has significantly enhanced employee satisfaction by ensuring a safer work environment and effectively preventing the spread of equipment fires, thereby yielding a high return on investment.

Over the two years of system operation, 5 out of 7 fire incidents were detected and extinguished early, despite the challenge of two incidents originating in enclosed equipment where camera installation was not feasible. The early intervention minimized equipment recovery time and financial losses, underscoring the system's value.

For instance, early fire extinguishing costs are reduced by approximately 99% compared to late fire extinguishing. Typically, 24 CO2 fire extinguishing cylinders are discharged per fire incident, costing about 7,080,000 KRW. In contrast, an early fire can be extinguished with a simple portable 2.3 kg fire extinguisher, which costs about 75,000 KRW per unit, reducing the cost to 1/100. Most importantly, early fire detection results in no productivity loss.

Overall, the system has proven invaluable in safeguarding employee health and wellbeing, improving job satisfaction, and optimizing business operations by reducing costs and maintaining material quality.

Other comments

For equipment with recurring fire incidents or areas where fires are expected to occur, we recommend the Smart Fire Monitoring System using fixed cameras as described above. For maintenance work areas involving welding or cutting due to equipment failure, we recommend a portable Smart Fire Monitoring System. The portable system, equipped with an internal battery, can be installed anywhere on-site where hot work is performed. After maintenance work is completed, it can be left in place to detect smouldering fires that may arise from oil or dust, sending text messages and photos of the fire site to registered workers' mobile phones in the event of a fire. By establishing both fixed and portable Smart fire monitoring systems, we can improve the early extinguishing of fire incidents in industrial settings, creating a safer stainless steel production environment.

New developments in Psychosocial management for a steel plant

Member company

ACERINOX EUROPA S.A.U.

The challenge

300 million people in the world suffer from depression, a disorder that is the main cause of disability. Mental problems such as anxiety and work stress represent the second cause of absenteeism at work, causing a loss of 12 billion working days in organizations and in society in general.The trend in the steel industry is similar.

Why?

Taking into account the figures discussed in the previous section, it is a priority that action on psychosocial risk factors be integrated into the overall risk prevention management process in the company, in order to minimise their impact and achieve a healthy work environment both physically and psychologically, since safe and healthy work environments are not only a fundamental right, but are also more likely to minimise tension and conflict in this area and improve staff loyalty, as well as work performance and productivity.

Needed action

Acerinox Europa has designed a program that allows us to monitor the psychosocial indicators that we obtain through a survey integrated into the health examination and named Psicomet, assess the need to carry out Psychosocial Risk Assessments, and monitor the action plans that are being implemented.

Action review

Specific: Prior to the use of this new system, another method was being used, more general and not so focused on the activity of our sector.

Prior to the use of this new system, another method was being used, more general and not so focused on the activity of our sector.

This new procedure includes:

- The creation of a Psychosocial Management and Mental Health Working Group. Made up of 5 people with previous training in the use of these tools. This group will hold monthly follow-up sessions where the Psicomet summary, action plans, etc. will be reviewed to give dynamism to the continuous improvement program.
- The methodology Psicomet is applied to each worker taking advantage of the annual medical examination. Psicomet is a tool designed to assess the psychosocial health status of workers. Its objective is to identify factors related to emotional and psychosocial well-being in the work environment, allowing the detection of possible areas of improvement that benefit both the worker and the organization. The procedure is simple and is integrated into the medical examinations. It consists of 4 levels (see diagram below).
- The first level consists in a test of 10 questions in order to know about the psychosocial health at work.
- If a worker needs to be evaluated in a second level, then:
- A specific questionnaire named Mentally PRO will be completed that

will help to obtain a broader view of the general condition of the workers.

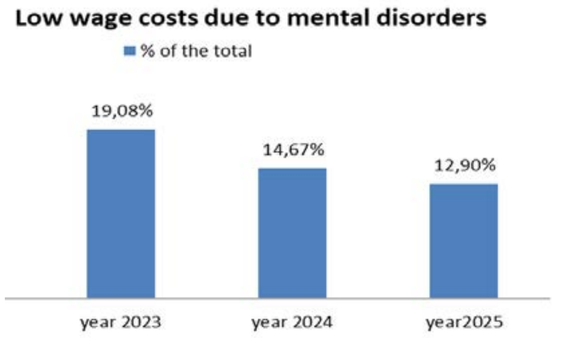
MentallyPRO activation in those analysis units with participation greater than 25% and moderate impact > 3 factors (10QFRP scale). Psychosocial assessment tool in compliance with complementary ISO standards. The MentallyPRO instrument updates psychosocial assessment instruments, using more modern psychometric design techniques and identifying biases related to sociodemographic variables and their correction. It also includes new psychosocial risk factors such as conciliation, mental load, the importance of work teams, change management, leadership style, social reward, etc.

The factors that are evaluated are:

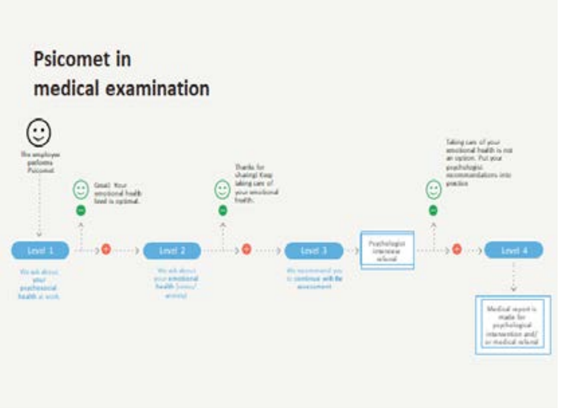
1. Work content
2. Workload and pace
3. Work time
4. Participation and control
5. Performance of functions and responsibility
6. Professional development
7. Interpersonal relationships
8. Work teams
9. Mental load
10. Conciliation
11. Leadership style
12. Change management
13. Social reward
14. Information and transparency

The results will be reviewed in a personalized and confidential manner by the health surveillance team and, if any situation is identified that requires it, specific actions will be proposed to support the worker (Sessions with a clinical psychologist provided by the company): third and fourth levels.

The following graph shows the evolution of the indicator "Wage cost of sick leave due to mental disorders" expressed as a percentage of total expenses due to illness in the mill:



Flowchart for using Psicomet:



Achievable: The company's objective is to implement a personalized health itinerary adapted to the workers in our workforce, seeking not only to improve the health and well-being of employees, but also to optimize the company's investment and promote an organizational culture of care and support on an ongoing basis. In

this sense the objective is achieved.

Likewise, as can be seen in the graph above the trend in salary costs (absenteeism) due to mental illnesses is downwards. Therefore, the objective is also achieved

Realistic: The actions have been possible to carry out and have been very well received by workers and union representatives.

Time-bound: Initially was a project for two years however given the good results for workers and the company, the Psicomet project will continue to be carried out.

Horizontal Expansion Capability

Yes. In fact, the program is already being implemented in other Acerinox Europa work centers.

The need to establish means to anticipate preventive interventions in the event of situations of deviation from occupational health and safety standards is common to the entire industrial sector.

Outcome

The implementation of this type of measures will continue to be carried out since it improves the rapid detection of any psychological or emotional disorder, so that in this way we can anticipate and provide the worker with adequate therapy that improves their prompt recovery and in turn provide a healthy work environment from a holistic point of view; being a benefit for workers from the point of view of health, wellbeing and job satisfaction. The absenteeism indicator (KPI) due to psychological or emotional disorders has decreased. Therefore, the cost due to absenteeism has also decreased.

Caster Area Stopper Arm

Member company

North American Stainless

The challenge

A new Caster Stopper Rod Arm design that will prevent the stopper rod from opening when the tundish is raised in the cast position.

Why?

This new design will prevent the stopper rod from opening up when the tundish is raised, either in an emergency situation or if someone was unable to remove the rod before the tundish is raised. On 6/6/24 the slab caster had an incident where the tundish overflowed out of the front of the tundish. Due to the steel coming over the front of the tundish, operators were unable to remove the stopper rod arm. When the tundish was raised, the old style stopper rod arm hit the overhead beam on the tundish car causing the stopper rod to go full open and pour steel into the mold itself, the mold cover and the floor, putting all operators in danger. Cleanup and machine repair, cost the shop approximately 10 hours of downtime not to mention the cost of the equipment that had to be replaced that was destroyed in the incident.

Needed action

Area team have worked with a contractor to come up with a working prototype and a final version of a new stopper area that has been in service without issue since 9/12/2024. Currently have two spare stopper rod arms in storage. The contractor has a copy of our blueprints and can have a new one ready within two weeks.

Action review

Specific: The area team worked with a contractor to develop a prototype stopper arm and then a final version based on feedback on prototype.

Measurable: Zero incidents in ~6 months since installation.

Achievable: Final solution was achieved and has operated without incident since installation.

Realistic: All team members are happy with the final results of the project and feel this design will take human and/or machine error out of the equation making it a safer work environment.

Time-bound: The project was completed in less than 3 months.

Horizontal Expansion Capability

Could be spread to other areas within Acerinox.

Outcome

No incidents since the implementation of the new design. Work team members are happy with final results and believe human and/or machine error out of the task.

Sustainability Case Studies

Application of duplex stainless steel to the cargo hold of general cargo ship Toshinmaru

Member company

Nippon Steel Corporation

The Challenge

1. In Japan, coastal shipping accounts for approx. 40% of domestic freight transportation (approx. 80% of industrial basic substances) and serves as a core transportation infrastructure that supports the domestic economy and people's livelihood. In the face of the worldwide movement toward carbon neutrality in recent years, coastal shipping exhibits excellent eco-friendly characteristics, including its CO2 emissions being approx. one-sixth that of trucks when freight of the same weight is transported. Coastal shipping will continue to serve as a vital means of transportation.
2. General cargo ships in coastal shipping transport a wide variety of cargo, not just a specific type, and are designed to transport metals, crops, and other materials. As the wall and floor surfaces of cargo holds are generally made of carbon steel applied with anti-rust coating, there is a concern that the coating may peel off due to contact with the cargo and then get mixed in. Therefore, repair work of portions from which the coating has been peeled off needs to be periodically carried out by the ship's crew to avoid those portions from rusting, and a large-scale repair, including overall recoating, is needed to counter the aging.

Why?

1. In the Japanese shipping industry today, there is a shortage of labor, which is reducing the number of workers available to carry out operations and maintenance, and there are concerns that this will lead to a vicious circle in which the workload per each crew member increases, further accelerating labor shortages. Therefore, measures such as improving the working conditions of crew members will be necessary. The shortage of labor is a major issue for the coastal shipping industry in terms of maintaining and providing stable and quality transportation services and improving the crew's working conditions is recognized as a pressing issue. Tackling

cost increases due to inflation and environmental protection are also important issues, and it is necessary to reduce costs and environmental impacts in the mid to long term.

2. Employing stainless steel or stainless clad steel as the cargo hold design material is being considered to reduce the maintenance load and cost that continuously occur and to significantly reduce the opportunity losses due to repair work. We feel that the efforts to solve these challenges will contribute to the stable operation of coastal shipping and create demand for stainless steel plates.

Needed action

1. Corrosion-resistant coating has conventionally been applied to carbon steel, but large-scale repairs have been a major challenge due to the heavy burden of repair work. To address this challenge, we have tried to reduce the load and cost of maintenance and the environmental impact attributable to coating by employing SUS304 and eliminating coating.
2. This time, by employing duplex stainless steel plates and stainless clad steel plates consisting of duplex stainless steel and carbon steel, which exhibit a corrosion resistance equivalent to or greater than that of SUS304, high strength, and excellent wear resistance, we tried to extend the service life and reduce the life cycle cost.
3. Duplex stainless steel, to which the addition of rare metal is reduced, is an eco-friendly material and exhibits high price stability. By selectively employing stainless steel clad plates that contain carbon steel in some portions, we tried to further reduce the life cycle cost from that which employs SUS304.

Action review

Specific:

1. To maintain the strength characteristics and the durability of wall surfaces and the floor surface (corrosion resistance, wear resistance, etc.) that are required for the cargo hold of general cargo ships, a material with a high strength and a high corrosion resistance was required. To meet these requirements,

we employed duplex stainless steel plates.

2. In order to further reduce the cost while guaranteeing the strength of the ship body structure, we selectively employed stainless steel clad plates consisting of duplex stainless steel and carbon steel in some portions.

Measurable: On the cargo hold (40.0 m long × 9.5 m wide × 6.3 m high) of the newly-constructed general cargo ship Toshinmaru (G/T: 499), approx. 50 tons of duplex stainless steel (NSSC 2120™(KSUS821L1)) plates and approx. 30 tons of stainless clad steel plates consisting of duplex stainless steel (NSSC 2120™ (KSUS821L1)) and carbon steel are used to replace the steel material while maintaining the existing capacity of the cargo hold.

Achievable: By employing stainless steel on all of the cargo hold's wall and floor surfaces, the antirust coating that had been applied to all surfaces could be omitted, and it became unnecessary to conduct periodical repair work in association with coating damage and large-scale repair due to aging. Thus, we achieved a reduction in maintenance load and costs and avoided opportunity losses during the maintenance period.

Realistic: The application was completed in 2023, and the ship was launched.

Time-bound: As originally planned, the ship was launched in June 2023, and started service in August of the same year.

Horizontal Expansion Capability

The application of duplex stainless steel and stainless clad steel consisting of duplex stainless steel and carbon steel to the cargo hold of the general cargo ship Toshinmaru we made this time is very useful as a case example of countermeasures for challenges that the coastal shipping industry faces these days, and its horizontal expansion to other general cargo ships is expected.

Outcome

It has been verified that duplex stainless steel plates and stainless clad steel plates consisting of duplex stainless steel and carbon steel are appropriate as steel materials for cargo holds of general cargo ships and they bring many sustainable benefits for the various challenges that the coastal shipping industry faces. We also feel that as employing stainless steel reduces the load of regular maintenance, those materials have also contributed to reducing the workload of the workers.

Other comments

In selecting the type of steel to be employed, employing alloy-saving duplex stainless steel among stainless steel types brought advantages of excellent corrosion resistance, high strength, and high wear resistance, exhibited eco-friendliness due to using fewer rare metals, and made its high price stability highly appreciated. Selective employment of stainless clad steel consisting of stainless steel and carbon steel in some portions achieved further cost reductions.

Decanting and recovery plant for industrial oils

Member company

ACERINOX EUROPA S.A.U.

The challenge

Acerinox Europa Mill uses a large volume of industrial oils in its facilities. Some of these oils, such as hydraulic oils, can become contaminated with water or other lighter oils in the event of leaks, equipment cleaning, spills, etc. In these cases, the hydraulic oil and others lighter oils cannot be reused and must be managed as waste, with the consequent cost of replacement and waste management itself.

Why?

Acerinox Europe's sustainability strategy requires finding solutions that avoid waste generation.

Needed action

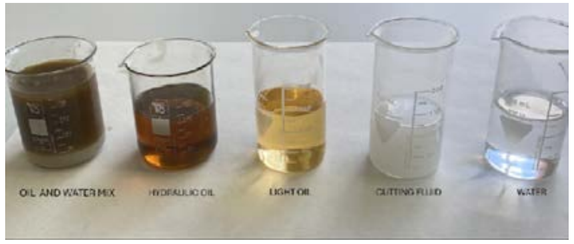
Separate the different phases that, when mixed, form a waste, to obtain different valuable products: hydraulic oil, light oils, water.

Action review

Specific.

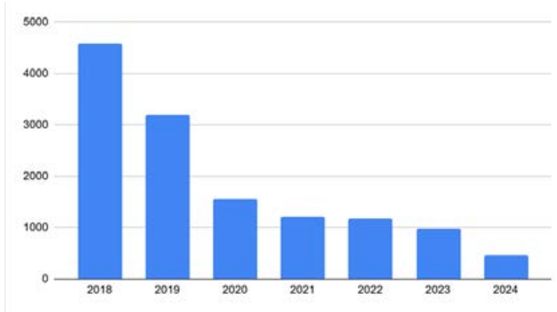
Decanting plant

- Employing the principle of density differentials between various oils, encompassing hydraulic fluids and lighter varieties, alongside water present within a composite mixture, the decantation methodology is to be implemented for the purpose of achieving phase segregation.
- A set consisting of the main decanting tank and 5 auxiliary storage tanks, as well as a feeding system to the tanks (gravity and pumping), form what we call an oil decanting and recovery plant. The tanks used come from an old, decommissioned facility.
- By letting this mixture rest in the tank, the different qualities of oils are separated according to their different densities, as well as the water.



Ideal separation of different phases.

Measurable: The following graphs show the evolution of the oil mix generated as waste (mT/year).



Realistic: The following premises were taken: the investment had to be low, using tanks and mechanical parts of old installations out of order, technically simple, quick to implement, and separation methods that did not involve chemicals and/or energy consumption had to be avoided; so that it was as sustainable as possible.

Time-bound: As can be seen in the graphs above, the response to the actions was very fast.

Horizontal Expansion Capability

Yes. This type of plant can be easily implemented in other factories of the group and other companies.

Outcome

With the oil decantation plant, we have managed to recover oil and reduce the generation of oily sludge (waste to landfill), improving the KPIs related to the circular economy. This is an important step to improve our waste management and plant efficiency. In addition, we have achieved very significant economic savings.

Other comments

It is demonstrated that the initiative carried out, as well as the coordination between the work areas involved, have allowed the initially proposed objectives to be achieved, contributing to significant benefits for the company, a direct result of the team's dedication to continuous improvement in reducing waste generation.

Environmental Improvement and Efficiency Enhancement in Slab Penetrant Testing Work

Member company

Nippon Yakin Kogyo

The challenge

Slabs transported from the steelmaking plant undergo a penetrant testing process (hereafter referred to as "color check") to inspect surface quality. The color check process involves the following manual steps:

1. Slab placement
2. Application of penetrant
3. Penetration
4. Cleaning
5. Drying
6. Application of developer
7. Development (i.e. waiting time for penetrant to bleed out and reveal indications)
8. Inspection
9. Slab flipping
10. Application of penetrant (reverse side)
11. Drying
12. Cleaning
13. Drying
14. Application of developer
15. Development
16. Inspection

Slab placement is done using a crane, while slab flipping is performed by manually attaching a chain and lifting with the crane. Since most of the work is manual, the working environment was extremely harsh.

| Before the improvement

Why?

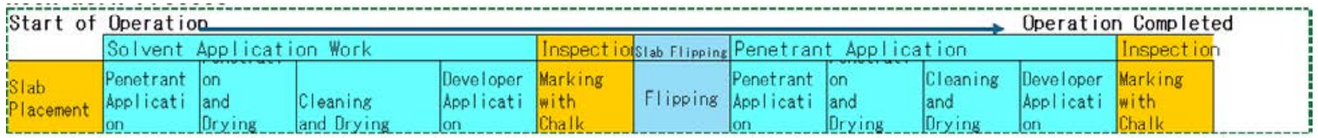
This harsh environment resulted in a low retention rate of operators over the long term. Additionally, the work performance varied depending on individual capabilities, as many steps required manual labor.

Needed action

Below are the main work activities:

1. Application work: Operators wear protective equipment to prevent contact with the penetrant during application of developper and cleaning process.
2. Slab flipping work: To inspect the underside of the slab, a 20 kg chain must be manually passed under the slab and connected.

We sought to change these manual tasks to mechanized operations.



| Color check work progress

Action review

Specific: With the installation of the equipment for the color check process, operations became feasible with only an operator to control the machine and an inspector to conduct checkings.

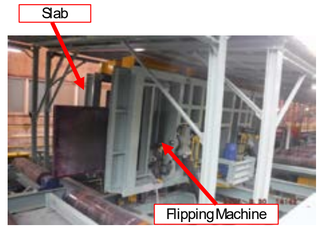
Measurable: Thanks to the equipment installation, the number of required workers was reduced by half. Moreover, eliminating variation in work performance led to a 1.7 times increase in the number of slabs processed. Additionally, the amount of penetrant used was reduced by 14%, contributing to the reduction of liquid waste.

Achievable: Automating operations under harsh conditions is expected to improve operator retention. Furthermore, reducing dependence on manual labor resolved the issue of performance variation based on operator skills.

After the improvement

Automated solvent application

Automated slab flipping



Realistic: We believe that the automation and streamlining of such operations through equipment installation is realistically possible and should be actively promoted.

Horizontal Expansion Capability

It is applicable to other member companies as well.

Outcome

By automating work in harsh environments, not only was the labor environment improved, but work efficiency also increased. As a result, we were able to address labor shortage issues and achieve labor-saving operations through automation of operations, both essential to advancing sustainability initiatives.

No	Process Steps	Before	After
1	Slab Placement	Crane	Crane
2	Penetrant Applicati	Manual	Equipment Operation
3	Penetration and Dryin	–	
4	Cleaning	Manual	
5	Drying	–	
6	DeveloperApplicatio	Manual	
7	Development (Drying	–	
8	Inspection	Manual	Manual
9	Flipping	Manual &Crane	Equipment Operation
10	Penetrant Applicati	Manual	
11	Penetration and Dryin	–	
12	Cleaning	Manual	
13	Drying	–	
14	DeveloperApplicatio	Manual	
15	Development (Drying	–	
16	Inspection	Manual	Manual

Comparison of Process Steps – Before and After Improvement

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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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