Specialised Technical Consulting Firm

# Steel Hub

Where Challenge
Meets Solution

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# Technical Evaluation of two Celsa Steel Plants in Europe for a Private Investment Company

## HIGHLIGHTS

*"Steel Hub has delivered some of the best pieces of work that I have experienced during my >20 years in top management consulting and private equity"*

**Petr Šlechta, Vice President M&A and Business Development**

### CELSA UK AND NORDIC PLANTS WERE VISITED

- **Port and Scrap Yard**
- **Melt Shop (SMS)**
- **Rolling Mill (Rod and section)**
- **Automation & Digitalisation**

### OUR APPROACH

01 **Status Quo Assessment**

02 **Future Capex Required**

03 **Adjusted Production Growth Forecasts**

## SITUATION

Sev.en Global Investments (7GI), a Czech private investment company, commissioned Steel Hub to conduct a technical due diligence on two steel plants in Northern and Central Europe. The goal was to validate the seller claims, identify undisclosed investment needs, review feasibility of future growth potential, and develop performance improvement ideas for future value capture.

## APPROACH

Steel Hub assembled a team of four seasoned technical and financial experts, each bringing over 20 years of experience in the steel industry. The team's assessment covered the melt shop and rolling mill operations, and included inspections of plant automation systems and ancillary assets. The baseline was first established by reviewing the technical specifications and performance data provided by the seller before on-site visit. The approach included:

- Evaluation of the technical conditions of the melt shop, rolling mills, automation and ancillary plants
- Compilation of a list of previously unknown capital expenditure (CAPEX) requirements, critical to sustaining and expanding production, which were earmarked as potential red flags to 7GI
- Preparation of an adjusted future production ramp-up plan to align the seller forecasts with the plants' technical capabilities

Steel Hub made capex investment trade-offs transparent and compiled questions for 7GI to submit to the Celsa management. At 7GI's request, our leadership joined board presentations, raising critical questions.

## RESULTS

- Comprehensive report detailing the technical assessment and summary of implications for seller CAPEX plans and adjustments to growth forecasts
- Identified potential CAPEX requirements:
  - Plant A: Up to ~€5 million
  - Plant B: Up to ~€40 million
- Introduced scenarios illustrating the sensitivity of ramp-up plans to major investments
- Findings helped 7GI adjust its bidding strategy and engage in more informed negotiations

## TESTIMONIALS

*"Steel Hub has delivered some of the best pieces of work that I have experienced during my >20 years in top management consulting and private equity. Throughout the project, we were impressed with both the competence of Steel Hub's technical specialists as well as the Steel Hub leadership's exceptional ability to meet and exceed our project requirements. In their reports and our consultations, Steel Hub managed to not only carve out the quantitative implications for adjusting our valuation models, but also made the underlying technical considerations transparent and easily accessible. We look forward to rehiring Steel Hub in the future".*

**Petr Šlechta, Vice President M&A and Business Development**

*"From start to finish, Steel Hub served us as a partner at eye level. The Steel Hub team demonstrated outstanding agility and responsiveness to our requests and project needs. Steel Hub's role in setting up the plant visit agendas was pivotal, and their participation in several plant board meetings proved invaluable in gathering critical information from the seller that informed our bidding strategy. We were impressed by the Steel Hub team's profound steel industry expertise and appreciated the collaborative spirit throughout the project. We will gladly build on Steel Hub's expertise to enhance the performance of the steel plants in our portfolio".*

**Jan Kraváček, Senior Associate**

# Optimising AOD Chemical Composition of Duplex Stainless Steel

## HIGHLIGHTS

**Argo Oxygen Decarburisation (AOD)** | **RESULTS** | **SAVINGS**

| | Current | | Steel Hub |
|---|---|---|---|
| $MoO_3$ : | 4,700 kg | → | *4,000 kg* |
| $CaO/CaF_2$: | 30kg CaO/7.5kg $CaF_2$ | → | *50kg CaO/10kg $CaF_2$* |
| S content : | 15ppm | → | *8ppm* |

Reduced raw material consumption of $MoO_3$ led to over ***$7000*** per heat in savings.

## SITUATION

A stainless steel producer in Southeast Asia faced product quality issues due to non-optimised chemical compositions in the final melt of duplex stainless steel grades S32205 and S32101. These sub-optimal compositions were causing frequent casting defects and compromising overall quality during production.

## CHALLENGE

- The key challenge was optimising the chemical composition to reduce defects ensuring consistent product quality.

## ACTIONS TAKEN

- Adjusted desulfurization and decarburization steps in the AOD converter.
- Proposed SOP modifications to adjust chemical additions in alignment with best practices.

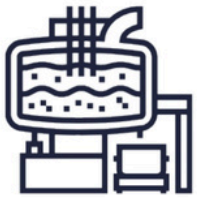
## RESULTS

- Desulphurisation Process Adjustments: Optimized CaO and CaF2 reduced steel sulfur from 15 to 7-8 ppm, improving casting outcomes.
- Nitrogen Injection Model: A custom model was created for Steel Hub's target composition, adjusting blowout ratios for duplex grades.
- Hydrogen Content Control: Controlled tapping procedure ensured an inert environment, reducing hydrogen content below 5 ppm.
- $MoO_3$ Consumption: A 13% reduction in consumption saved $7,000 per heat by adjusting $MoO_3$ and optimizing silicon content.
- Elimination of Nozzle Mushroom Defects: Modified oxygen injection to remelt the mushroom defect, improving production precision and operational efficiency.

# Optimising EAF Chromium oxide recovery and Oxygen Consumption for Duplex and Ferritic Stainless Steels

## HIGHLIGHTS

**ELECTRIC ARC FURNACE (EAF)** | **RESULTS** | **SAVINGS**



| | Current | | Steel Hub |
|---|---|---|---|
| $O_2$ : | *14 Nm³/tonne* | → | *3Nm³/tonne* |
| Al mixing reducing agent : | *1000kg/heat* | → | *0 kg/heat* |
| $Cr_2O_3$ : | *10%* | → | *3.5%* |

Reduced raw material consumption of $O_2$ and Al led to over ***$4000*** per heat in savings.

***$10,000*** in chromium metal value per heat

## SITUATION

A client in Asia had issues with high consumption of oxygen (>14 Nm³/tonne) and aluminium reducing agents in a 140 tonne EAF leading to high chromium oxide content in the slag and valuable alloying elements were lost in the slag. These elements could have remained in the stainless steel melt.

## CHALLENGE

Escalating operating costs driven by excessive raw material consumption (oxygen and aluminium) and process inefficiencies resulting in chromium losses to slag waste.

## ACTIONS TAKEN

- Conducted an in-depth review of EAF processes:
  - Oxygen injection
  - Scrap charge management
  - Alloy addition strategies.
  - Charge mix
  - Alloy addition strategies
  - Consumables/refractory
- Implemented optimisation strategies for reducing oxygen and aluminium consumption while maintaining quality requirements.

## RESULTS

- Reduced average oxygen consumption from 14 Nm³/tonne to 3 Nm³/tonne leading to chromium levels down to 6% without using any aluminium reducing agent.
- Chromium oxide in the slag fell below the 6% target, thus significantly reducing costs by saving at least 10,000 USD per heat in chromium metal value.
- The outcome of this work led to significant improvements on EAF process efficiency and decrease in operating costs resulting in higher throughput and improved production timelines.

# Reducing Longitudinal Depression and Hot Cracking in Duplex Stainless Steel Slabs

## SITUATION

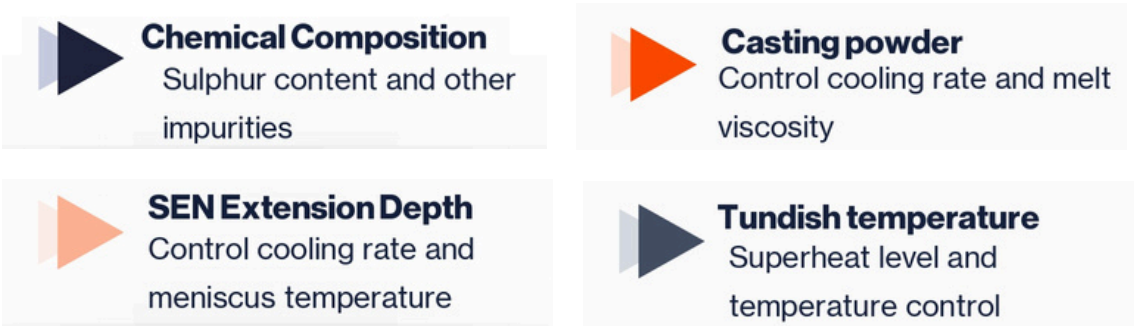
A stainless steel producer in Asia was facing issues with setting the casting parameters and the casting powder formulations for duplex stainless steel castings. The process settings were leading to the increased risk of longitudinal depression and hot cracks in the as-casted duplex stainless steel slabs.

## ACTIONS TAKEN

- Identifying the root causes of defects.
- Optimised continuous casting process settings and powder formulations to enhance slab quality.
- Provided hands-on training for operational staff to improve process consistency.

## CHALLENGE

- Multiple technical key levers needed contributing to defects
- Defects arising from casting were:
- Reducing material yield due to corrective procedures.
- Impairing operational flow across downstream processes.




## RESULTS

- Reduction in Grinding Loss: The extent of longitudinal depressions on slabs was significantly decreased, reducing grinding loss to below 5% of the slab material. This reduction in material loss contributed to increased production efficiency.
- Consistent Slab Yield: Improvements in slab quality ensured consistent slab yield post-grinding, supporting stable production output and reducing waste.
- Optimised Casting Process parameters: Submerged Entry Nozzle (SEN) Extension: Extended the SEN to optimise casting flow and prevent surface defects.

# Addressing Edge Crack Issues in Duplex Stainless Steel during Hot Rolling

## SITUATION

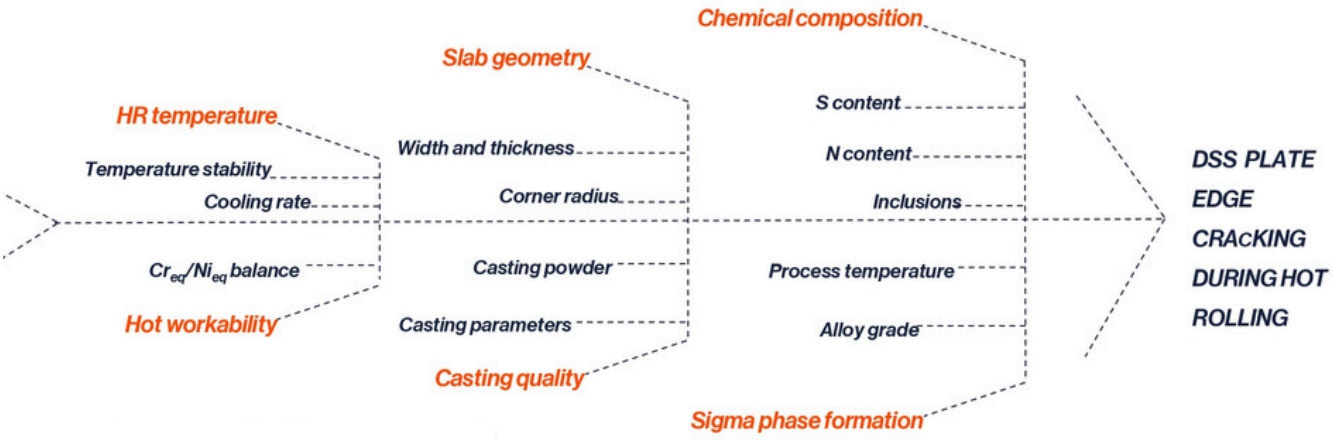
A duplex stainless steel (DSS) producer in India was experiencing significant edge cracking during the hot rolling of 300mm thick slabs, impacting both productivity and quality. The client approached Steel Hub for assistance in reducing the extent of edge cracks to enhance process efficiency and lower the defect rate.

## CHALLENGE

- The main challenge was to identify the root cause of edge cracking of DSS plates
- Provide practical solutions to improve the reliability of the hot-rolled plates.

## ACTIONS TAKEN

- Steel Hub's expert team conducted a thorough analysis of the hot rolling processes, covering each stage from slab preheating to the finishing stands and coiling.
- Utilised fishbone diagrams to systematically identify factors contributing to edge cracking and other defects.
- Recommended specific adjustments and improvements across the hot rolling line to enhance product quality and minimise defect rates.

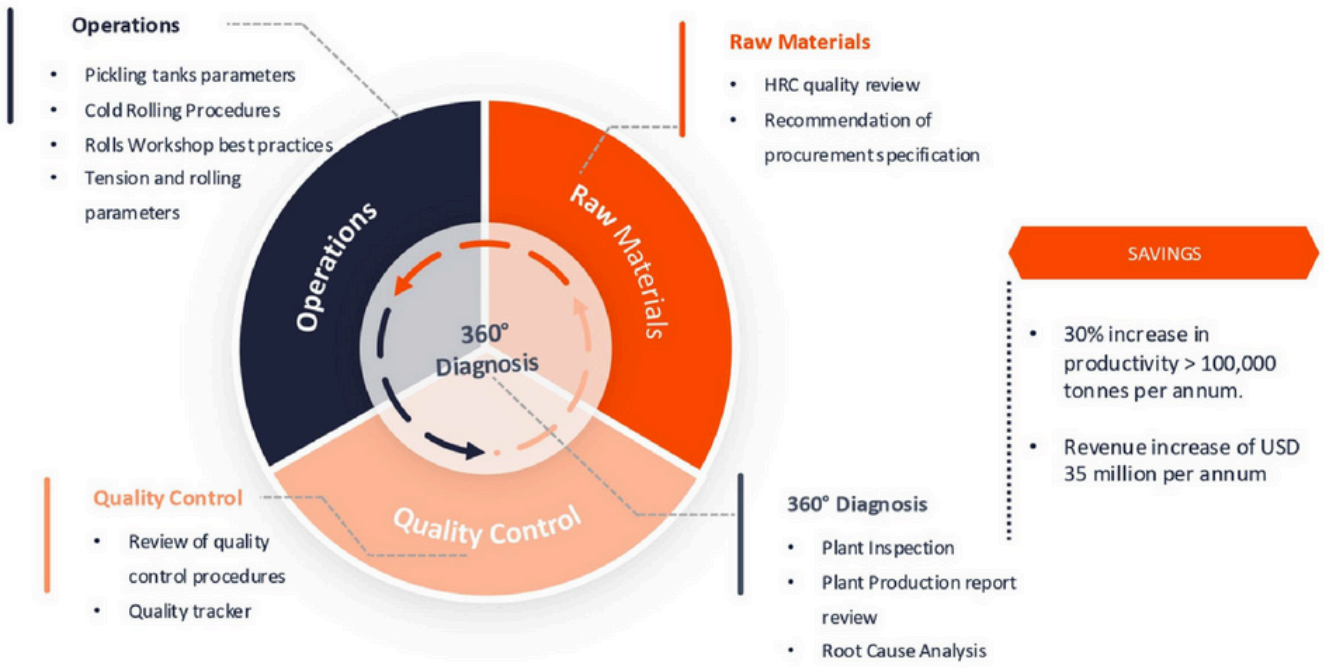



## RESULTS

- Enhanced Product Quality: Improved handling and processing techniques, such as slab edge chamfering, significantly reduced the incidence of edge cracks, thereby enhancing overall product quality.
- Optimized Chemical Composition: Achieved a balanced chemical composition between ferrite and austenite, improving the steel's hot workability.
- Controlled Cooling Procedures: Modified procedures to control the cooling rate of slabs during rolling, preventing the formation of brittle sigma phases that adversely affect the hot workability of the plates.

# Reducing Steel Breakages and production stoppages in a cold rolling mill plant

## HIGHLIGHTS




## SITUATION

A client operating a cold complex plant in Bangladesh faced frequent production stoppages and strip breakages in their cold rolling mill, impacting operational efficiency. The client engaged Steel Hub to conduct a comprehensive 360° diagnosis to uncover the root causes of these issues. This assessment led to a series of targeted implementation projects aimed at delivering operational excellence.

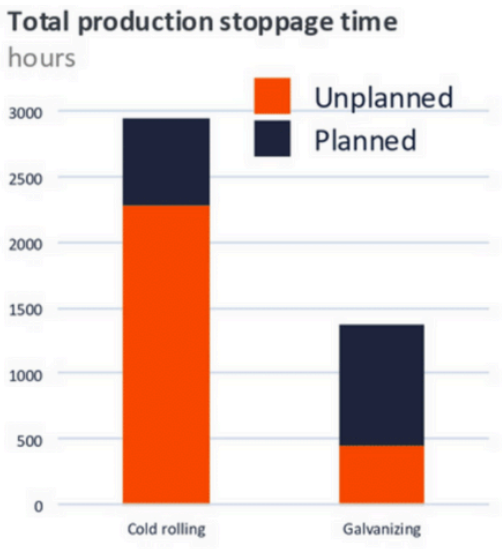
## CHALLENGE

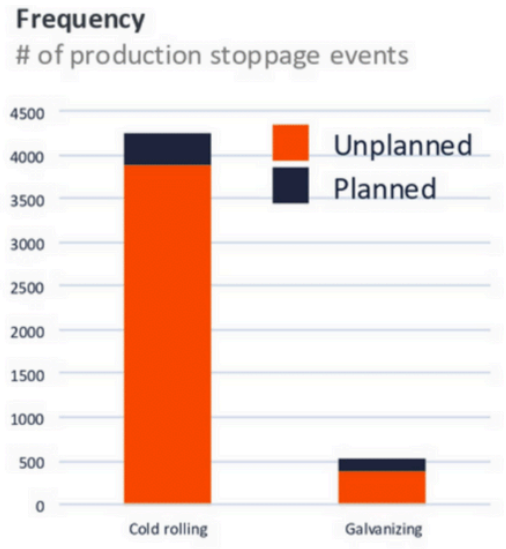
- Frequent strip breakages and mill stoppages were causing significant productivity losses and impacting customer delivery schedules.
- Addressing this complex, multi-faceted issue required a comprehensive 360° diagnosis of the entire cold rolling mill operation, including operator practices and procurement processes.

## ACTIONS TAKEN

- Diagnose the root causes of frequent steel breakages and stoppages in the 20-Hi and 6-Hi rolling mills, and implemented customised solutions to improve their productivity and reliability.
- Conducted a deep-dive analysis of quality and production reports to segment areas with the highest occurrence of production stoppages and steel breakages.

## HIGHLIGHTS




## RESULTS

- **Delivered New Specification for Sourcing Hot Rolled Coil (HRC):** HRC SAE1006 IF for coils under 0.2 mm and HRC SAE1006 MODIFY for coils over 0.2 mm.

- **Cold Roll Procedure:** Introduced a model for calibrating tension parameters and rolling patterns for target thickness. Inspected and modified lubrication procedures to reduce breakages. Organised training for staff and directors, including workshops and a site tour of a world-class plant in Italy to demonstrate best-practices.

- **Modified Roll Specifications:** New hardness and roughness specifications for work rolls, intermediate rolls and back up rolls, leading to improved wear performance. Developed a plan to source alternative rolls for the 6-HI and 20-HI mills.

- **Improved Pickling Line Procedure:** Reviewed and improved acid bath chemistry and operating temperature. Delivered an advanced coil quality tracker to monitor HRC condition before and after pickling.

- **Outcome:** Increased daily production by 500 tonnes, boosting productivity by 30% (from 500,000 to 620,000 tonnes annually), equating to USD 35 million annual revenue increase. Approved three modified SOPs, ensuring lasting operational impact.

# Adjusting Reduction and Tension Patterns of Cold Rolled Steel

## SITUATION

The client, based in South East Asia, was experiencing frequent steel breakages and, with a yearly average of 8 breakages per day higher than acceptable benchmark standards (5 breakages per day). This issue was leading to a reduced throughput, increased maintenance and operational costs.

## CHALLENGE

The primary challenge was to optimise the reduction and tension patterns, tailored to the specific equipment in use and the desired product properties, to enhance process stability and product quality.

## ACTIONS TAKEN

- Our expert team conducted a 360° diagnosis of the cold rolling plant, focusing on quality and process parameters.
- Determined that reduction patterns and tension settings contributed to high strip tension and steel breakages.
- Developed and implemented a trial plan to validate adjustments in reduction and tension patterns, aligning with best practices and client requirements.

***"By precisely controlling reduction and tension settings, we transformed process stability, boosted product quality, and achieved substantial cost savings."***

## RESULTS

- We initiated a rolling pattern strategy framework, determining the client's customer final thickness requirements and developed a tension model for rolling. A tension curve was created, modelling specific tension (kg/mm²) as a function of incremental target thickness, with computations for entry and exit sides of each rolling pass.
- New parameters were test trailed onsite, which resulted in improved cold roll quality, reduced operation stoppages, and enhanced process stability, significantly lowering steel breakages.
- A robust model for varying reduction increments and final target thicknesses was developed, enabling accurate calculation of tension setup requirements for each pass, thereby improving reliability and efficiency.
- The client experienced notable improvements in product quality, decreased maintenance costs, and an increase in the utilisation index of the plant from 72% to 85%.

# Reducing Dross Formation and Zinc Consumption in Galvanising Line

## SITUATION

The client, based in Southeast Asia, reported a primary issue of excessive dross formation and an increased rate of unplanned stoppages to remove bottom dross, resulting in higher zinc consumption and poor utilisation equipment. These issues elevated operational costs and reduced product quality.

## CHALLENGE

Insufficient control over dross formation was leading to excessive zinc consumption and required line stoppages. The challenge was to reduce these inefficiencies while maintaining product quality and avoiding major changes to the existing setups.

## ACTIONS TAKEN

• **Comprehensive Analysis:** A complete diagnosis of the galvanising process, including remote and on-site assessments of key areas, such as the zinc bath chemistry, temperature control, strip cleanliness, zinc bath level control, additions strategy and physical drossing methods.
• **Process Optimisation:** Adjustments were made to the operating parameters, inclusive of modifying the temperature profile and zinc bath chemistry control to reduce dross formation. New drossing techniques were introduced to reduce the amount of zinc loss in the bath. Optimised procedures for zinc and aluminum additions to the zinc bath that contributed to high dross formation
• **Material Handling Improvement:** Implemented improved handling and storage procedures for carbon steel coils from the cold rolling mill to minimise iron fines and oil contamination on the strip surface.

## RESULTS

- **Increased Line Productivity:** Galvanising line productivity was raised by 5-10%, reducing unplanned stoppages by approximately 2.5 hours daily due to improved zinc bath management across the numerous galvanising lines.
- **Optimised Bath Composition and Procedures:** High dross formation, previously caused by poor aluminium control and temperature fluctuations in the bath were addressed by setting target aluminum and control limits (~0.2% +/- 0.01) and implementing strict maintenance protocols.
- **Enhanced Bath Temperature Control:** A Zn-leveling monitor was designed to maintain consistent bath levels, while burner settings were optimised to hold bath temperatures within ±2°C. Additionally, strip temperatures were increased to prevent cooling of the zinc bath.
- **Air-Knife Quality Improvement:** Sourcing OEM parts for air-knives optimised their performance, reducing excessive zinc consumption and improving zinc application consistency.
- **Throughput and Revenue Growth:** These combined measures led to a 7% increase in galvanised product throughput, adding 35,000 tons per year and generating an estimated USD 17 million in additional annual revenue.

# Controlling Spangle Formation During Galvanising process

## SITUATION

Our client in Bangladesh produced galvanised coils with inconsistent spangle formation leading to high operating costs and customer complaints.

## CHALLENGE

The challenge was to maintain the desired spangle size, appearance, and brightness while reducing dependency on costly bath additives such as tin and antinomy. This required precise control over the galvanising process parameters, including bath chemistry, cooling rates and substrate standards. The additional cost of tin as an additive further compounded operational expenses.

## ACTIONS TAKEN

- The expert team analysed the zinc bath chemistry to identify factors affecting spangle formation, including the concentrations of alloying elements such as lead, tin and antimony.
- Modifications were made to the cooling rate by increasing the strip temperature and line speed from the zinc bath help promote uniform spangle formation.
- Reviewed cold rolled substrate standards such as surface roughness and cleanliness.

***"By fine-tuning bath chemistry and cooling rates, we achieved consistent quality and saved $700,000 annually—without any high CAPEX investment."***

## RESULTS

- **Improved Quality Control:** Developed a quality tracker and improved strip handling procedures to reduce surface residues, ensuring consistent and even spangle formation across products.
- **Optimised Temperature Management:** Adjusted burners in the DFF exit to maintain a minimum strip temperature of 500°C, a critical factor in controlling spangle formation during the zinc coating process.
- **Elimination of Unnecessary Tin Additions:** Identified that over 53 metric tons of tin added annually to seven galvanising lines were unnecessary due to sufficient levels of lead and antimony in the zinc bath. This adjustment saved the client approximately USD 700,000 per year without requiring any capital investment.

# Optimising Pickling Line Conditions to Increase Efficiency

## SITUATION

A cold rolling mill in Southeast Asia faced issues with the pickling process, a critical step between hot rolling and cold rolling. Inconsistent performance led to suboptimal pickling, resulting in surface defects like mill scale and staining, which affected product quality and operational costs due to rework and scrap.

## CHALLENGE

The primary challenges were to optimise the process to ensure consistent and thorough pickling of the steel surface, minimising defects, and improve overall process efficiency, including acid consumption —all without incurring significant capital investment.

## ACTIONS TAKEN

- Conducted a detailed analysis of pickling line operations to address inconsistencies causing surface defects.
- Proposed a target composition for the baths based on European steel plant benchmarks and implemented solutions to maintain chloride levels below 4 ppm/m³ through regulated injections of clean water and fresh HCl.
- Trained staff on new procedures and introduced a quality tracker to monitor steel conditions before and after pickling.

## RESULTS

- **Enhanced Pickling Consistency:** Addressed inconsistent pickling performance, which caused stoppages due to surface quality defects. Process adjustments reduced deviation in pickling parameters from over 25% to a maximum of 10%, ensuring a stable pickling process.
- **Optimised Chemical Composition pickling reservoir:** Discovered elevated iron levels and low pH in the HCl acid bath, leading to over-pickling. Set target compositions for the acid and rinse tanks and maintained chloride content below 4 ppm/m³, stabilising HCl, iron, and pH levels with regular monitoring.
- **Temperature Control:** Identified and corrected temperature fluctuations in the pickling bath, further enhancing the process efficiency and quality by reducing material inconsistencies prior to the cold rolling process.
- **Outcome:** Reduction in coil breakages and Pickling-related defects. Previously the second-highest cause of steel breakages in the cold mill related to pickling issues and accounted for about 25% of total breakages (170 per quarter). After process optimisation, breakages linked to pickling decreased by 50%, from 170 to 87 per quarter.

## DISCLAIMER



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