Smart Line Management for Galvanizing:

End-to-End Quality Management Through Integrated Instrumentation, Robotics and Data-Driven Process Control

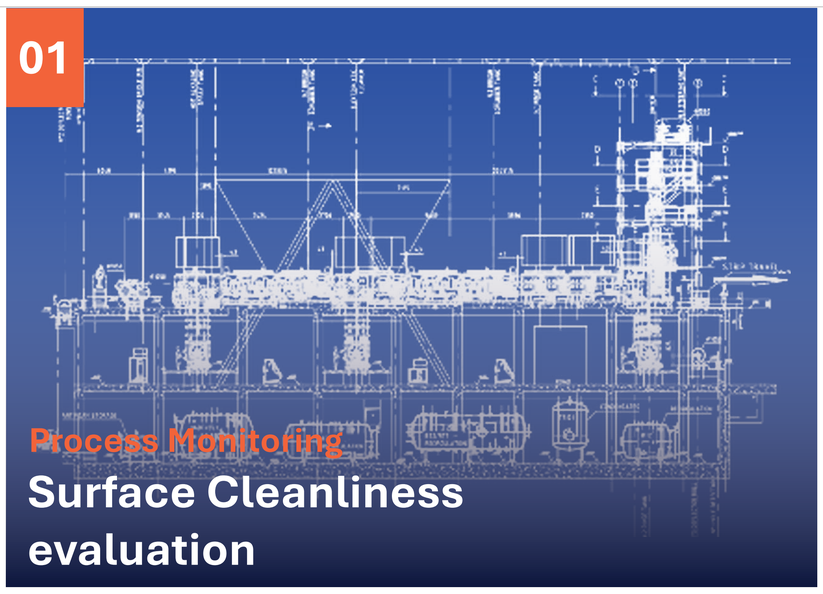
ABSTRACT

Achieving consistent metallurgical and surface quality in CGL requires an integrated “Smart Line” approach. CLECIM proposes advanced instrumentation, analytics, robotics, and process control in order to monitor steel quality and surface aspects in real time, all along the line and to adjust operations accordingly. Among all these solutions, three innovative ones are highlighted in this poster: an in-line surface cleanliness measurement tool supporting a better strip surface preparation, a dross-removal robot optimizing pot skimming, and a film-thickness measurement system to check roll-coating application at post-treatment. A case study in China demonstrates how this integrated, data-driven approach enables predictive quality control and process optimization.

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01



Process Monitoring

Surface Cleanliness evaluation

FROM PROCESS SIMULATION TO REAL-TIME CLEANING PERFORMANCE

CLEANING CHALLENGE

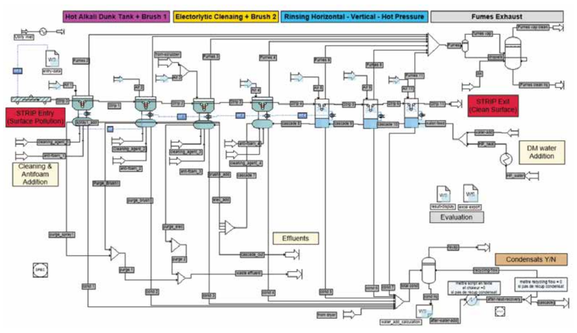
Surface preparation is a key step before galvanizing. The cleaning section must efficiently remove iron fines and oil from the strip surface after cold rolling or pickling. Contamination can reach up to 400 mg/m^2/side.

CLEANING SEQUENCE

The cleaning section combines several complementary steps:
Hot alkali dunk tank → Brush rolls → Electrolytic cleaning → Brush rolls → Horizontal + vertical rinsing + hot pressure spray → Drying
The overall cleaning performance depends not only on each individual step, but on the combined control of process parameters, fluid conditions and equipment performance.

FROM SIMULATION TO ACTUAL PERFORMANCE

Fluid simulations are used to predict the influence of key operating parameters, such as temperature, fluid concentration and line speed. These simulations provide a theoretical basis for defining and optimizing cleaning conditions.
However, simulation alone cannot fully describe the actual strip surface condition. An in-line surface cleanliness measurement system has therefore been installed on the CGL line to evaluate the strip surface directly during production.



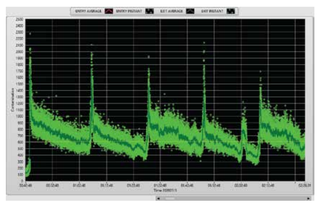
Example of Configuration Cleaning



MEASURE → COMPARE → OPTIMIZE

- Predict: Identify the expected cleaning performance through fluid simulation
- Measure: Evaluate actual surface cleanliness directly on the moving strip
- Compare: Assess the gap between simulation predictions and real strip performance
- Optimize: Adjust key cleaning parameters to improve cleaning efficiency and stability

In-line surface cleanliness measurement system



Pollution trend of coils surface showing typical cold mill contamination



HMI of line PLC – Contamination data & Process parameters in real time

OBJECTIVE

The next step is to establish a correlation between process parameters, simulated conditions and measured surface cleanliness, enabling more efficient process optimization and more consistent strip surface preparation before galvanizing.

02



Robotics & Automation

Dross Robot Efficient skimming

IMPROVING THE PERFORMANCE OF THE DROSS ROBOT IN THE GALVANIZING POT

GALVANIZING POT QUALITY

Galvanizing pot quality is directly linked to the final strip surface coating quality. Dross removal requires regular skimming operations, which are physically demanding and potentially dangerous for operators.

DROSS ROBOT FOR DROSSING ASSISTANCE

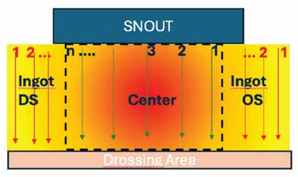
Dross Robot must be flexible and adapted to each pot & area configuration, including consideration of ingot feeding, instrumentation, equipped snout, air knives, etc. Specific dross robot sequences can start automatically or be launched by operator via HMI interface.



Picture on dross robot installed at HBIS Laoting – CGL2

CLEANING EFFICIENCY INCREASE THROUGH SIMULATIONS & SITE TESTS

- Tool design is also critical.
- Safety blocks are set up for all access areas, to avoid any contacts and enhance safety in the defined robot area.
- Theoretical model simulations accompanied and confirmed lately by online studies have been carried out to optimize all trajectories of dross robot arms for each sequence.
- Optimization of the sequences for racking, drossing and discharging step has been checked according to paths and trajectories: Tuning through adapted speeds, revised spacing for racking step (roughing and finishing), and optimized paths with controlled tool depth and adjusted positioning and distance.



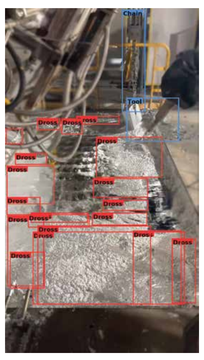
Example of the sequence for racking

ON-GOING INVESTIGATIONS FOR AI ASSISTANCE

Study of the AI images with analysis and supervised Learning practice to reach the targeted detection of polluted (dross) & cleaned areas on the zinc pot surface in real-time.

OBJECTIVE

The next step is to use the dross robot according to direct AI analysis feedbacks in order to launch adapted and specific cleaning on identified zones, increasing skimming efficiently. Operation is to be repeated until surface cleanliness is reached, enhancing overall drossing performances.



Example of AI image analysis on pot surface accessible by robot

03



Quality Measurement

Post-Treatment Film thickness continuous measurement

POST-TREATMENT – CONTINUOUS FILM THICKNESS MEASUREMENT TO ADJUST ROLL-COATING PROCESS

POST-TREATMENT / FINAL STEP OF CGL PROCESS

Deposition of thin organic or passivation film on the moving strip surfaces is depending on downstream product application. Application is done by roll coater machines. Standard means to measure deposited film thickness on collected samples in lab (RX). Investigation on real-time measurement solutions continuous film thickness is demanded.

MAIN TARGETS OF FILM THICKNESS EVALUATION

Deposition of thin organic or passivation film on the moving strip surfaces is depending on downstream product application. Film deposition is done by roll coater machines. Thickness & homogeneity of coatings depends on coat products, strip surface and on process parameters. Correlation between all factors must be determined and controlled for an even & continuous result.



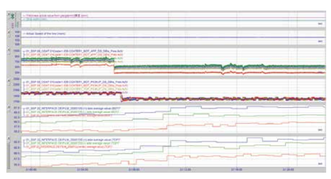
Picture of online Post-treatment Film measurement installation

ON SITE STUDY:

- Film thickness measurement sensor is installed after the Roll Coater equipment
- Evaluation of lab measurements is compared with online film thickness feedback.
- IBA data analysis is investigated to combined significant roll coater parameters with product information (film) using continuous film measurement results.



Trends for continuous signals on film thickness Bottom & Top sides



Process parameters IBA analysis to evaluate influence on film thickness

OBJECTIVE

The next step is to evaluate and consolidate a model through further data collection and analysis. Then, the Roll Coater management is to be enhanced thanks to possibility to tune in real-time the film deposition control and to directly assist operators.

CONCLUSION

Through the details of these three key original solutions and their contribution to end-to-end quality, modern production lines demonstrate the value of advanced tools for achieving the highest standards of surface and product quality.

CLECIM can propose this global line-management approach, combining high-tech instrumentation, advanced analytics, robotics, and process control to monitor intrinsic steel quality - including metallurgy and mechanical properties - as well as surface appearance in real time.

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