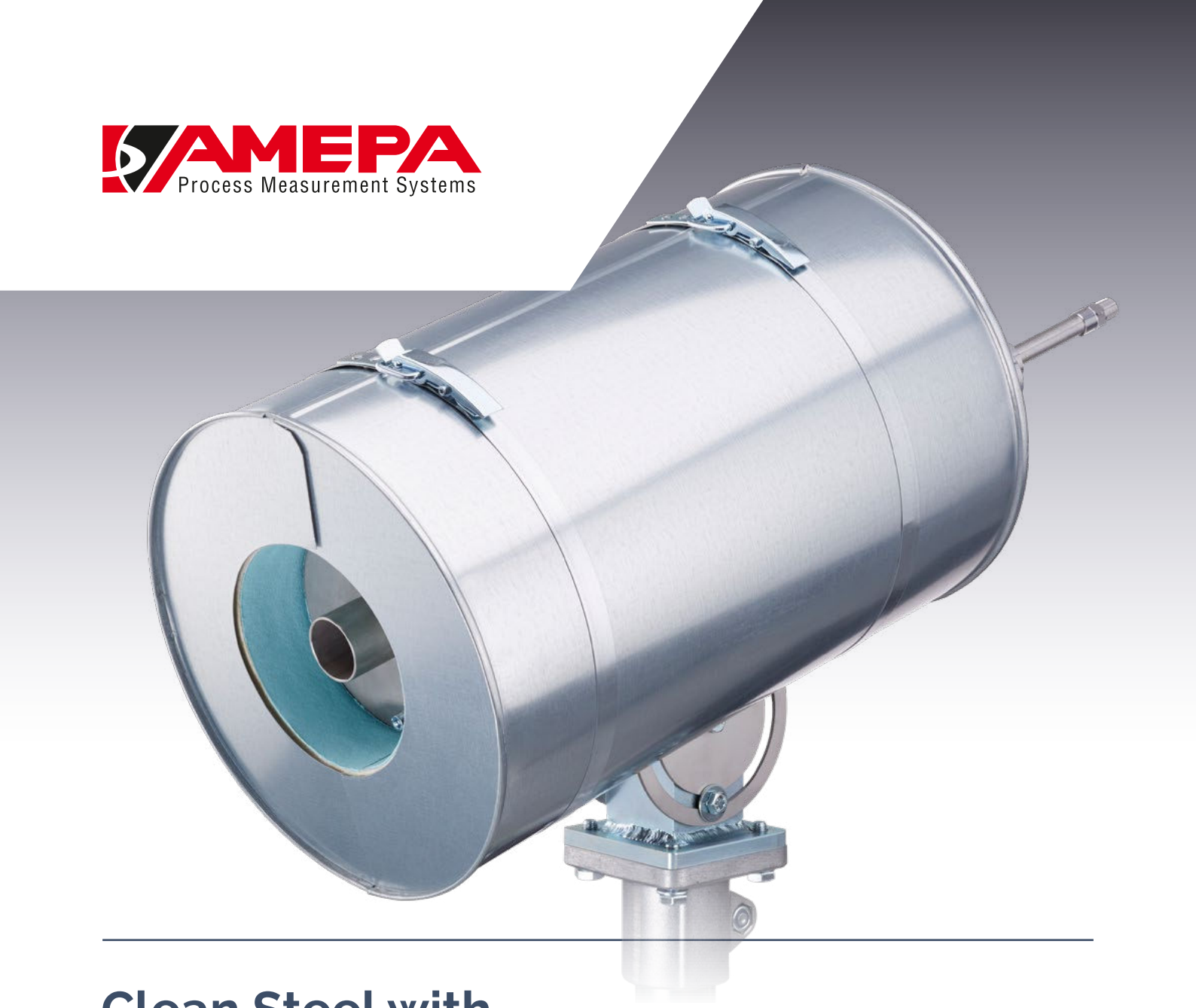
AMEPA
Process Measurement Systems



Clean Steel with Thermographic Slag Detection

TSD 2.0

Measure it. Control it.

AMEPA Slag Detection:
Optimized technology for "Clean Steel" with maximum yield

The increasing demands on the degree of purity of steels require a slag-free transfer of liquid steel from the oxygen steel converter or electric furnace to the ladle. A requirement for this is that impurities from slag to liquid steel are detected in a timely manner.

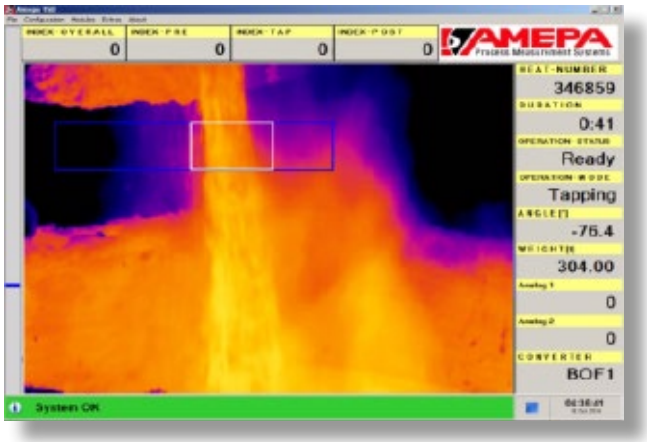
AMEPA's thermographic slag detection system TSD 2.0 detects the flow of slag during tapping by utilizing the distinct differences in emissivity between the melt and the slag. These differences are significantly more discernible in the far infrared range, as compared to visible light, even when both are at the same temperature.

Improvements achieved by our customers:

- **Reduction of the amount of transferred slag by up to 90%**
- **Reduction of the aluminium consumed by up to 5%**
- **Improved process control by an up to 40% reduction in phosphorus reversion**

Developed with 20 years of experience, the new generation of AMEPA's thermographic slag detection TSD 2.0 once again sets a new standard:

- Digital transmission and improved evaluation of the measured data increase the sensitivity and reliability of slag detection
- Second camera available to monitor the lip of the converter (Mouthcam) during tapping
  - Output alarm message when pouring over the lip of the converter (tap-over-lip)
- Raw data videos - enable the simulation of settings in offline operation for optimizing image evaluation and targeted process improvement
- Useful additional functions:
  - Slopping module to control converter ejection during refining
  - Automatic compensation for contamination of the protective window. Warning message when a contamination threshold is exceeded.
  - Display of the converter angle and the slag signal over time

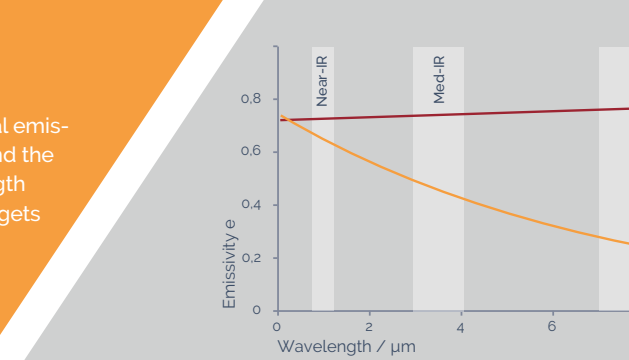


The tapping stream moves horizontally within the viewing window. Utilizing complex algorithms, the software automatically tracks the moving stream for optimal monitoring.

"We have been using AMEPA for over 20 years on a fully integrated steelworks to ensure compliance with thermographic slag detection. AMEPA's professional approach and also flexible attitude fits perfectly with our demanding manufacturing schedules. The TSD is a reliable, high performing measuring system with minimal maintenance and can be monitored remotely."

Glynn Hopkinson, Chief Engineer British Steel

Measurement principle:
The measurement principle of TSD 2.0 is based on the intensity difference of thermal emissions from steel and slag, which is influenced by the composition of the materials and the emission characteristics in the wavelength range being used. In the visible wavelength range, the differences in radiation are minimal, but they increase as the wavelength gets longer. Therefore, AMEPA employs infrared cameras as detectors, operating in the long wave infrared range for enhanced accuracy. Furthermore, the use of long wave infrared range has the added advantage of being less susceptible to interference from smoke and dust particles compared to the short-wave infrared range.



Thermographic Slag Detection with the TSD 2.0

The challenge:

A slag detection system must be able to accurately and consistently detect the flow of slag, even in challenging operating conditions, to enhance process automation and ensure safety.

The robustness of the slag detection system hinges on its ability to accurately detect and compensate for various operating conditions, such as:

- varying tap temperatures and pouring stream diameters
- background thermal radiation from looking in the ladle
- fluctuations in dust and humidity levels in the surrounding environment

Ensuring that these conditions are reliably detected and accounted for is crucial in achieving high system reliability.

The system:

The TSD 2.0 application excels in its advanced capabilities to accurately recognize and analyze the unique radiation characteristics of the pouring stream, as well as transmission losses between the stream and the camera. These characteristics are effectively incorporated into its evaluation process through sophisticated corrective measures, enabling the system to dynamically adapt to evolving operational conditions, thereby ensuring consistently optimal slag detection performance.

Moreover, the system is equipped with a sophisticated stream detection system that utilizes advanced algorithms to accurately detect and account for alterations in the tapping stream position, even in the presence of high background emission levels. This ensures reliable slag detection performance, even in challenging operational scenarios.

/01

Adaptive

AMEPA's thermographic slag detection system is designed to seamlessly adapt to changing operational conditions, ensuring reliable slag detection performance even when there are variations in the tapping stream's position or high background emissions.

/02

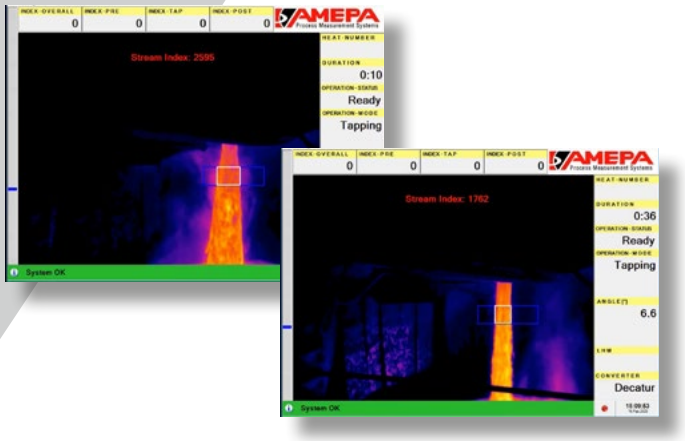
Reliable

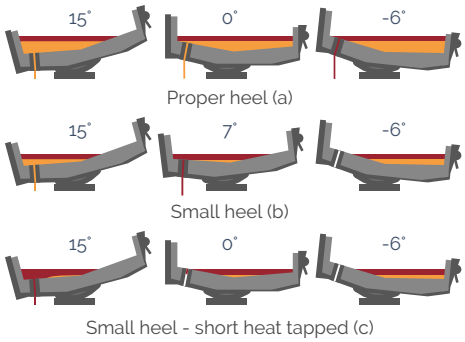
Independent of various process influences, including skull formations, changes in pouring stream geometry, temperature fluctuations, turbulence in the pouring stream, as well as effects from the addition of additives, such as flame formation

/03

Compatible

The TSD 2.0 system seamlessly integrates with a wide range of commonly used slag retention systems, including Dart, Ball, and others. This compatibility enables our customers to leverage the TSD 2.0 for fully automated control of their slag retention system, utilizing generated alarms as triggers for timely and efficient automatic closure actions.





"Liquid Heel Management"

Consistent process optimization on the electric arc furnace

Excessive slag-carry-over from the furnace to the ladle can significantly compromise the quality of steel production, leading to increased aluminum consumption, degassing difficulties, and higher costs.

The EBT furnace has been developed as a solution to this problem. Its operation is based on maintaining a constant liquid heel of residual steel in the furnace, which prevents the slag from entering the tapping channel and ultimately reduces slag carry-over.

When the EBT furnace tilts back after tapping, there is a critical angle at which the steel/slag interface reaches the tap hole, and slag starts to flow. A properly sized heel is illustrated in Figure (a), while Figure (b) shows a situation where the heel is too small, causing slag flow while the furnace is still tilted in the tap direction. In the worst-case scenario, shown in Figure (c), the heel is so small that slag flows while the furnace is still in the full tap position, resulting in tapping a short heat and excessive slag carry-over.

To mitigate these issues, the TSD Systems Liquid Heel Management module proactively monitors the heel size and alerts operators to build up the heel whenever necessary. This approach eliminates the risk of short heats and excessive slag carry-over, ensuring consistent steel production quality.

/04

Low maintenance

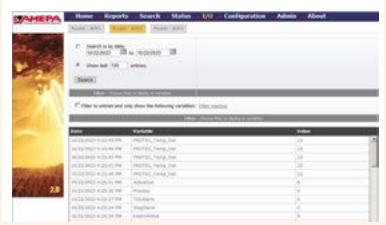
The TSD 2.0 system eliminates the need for sensors or similar installations on the vessel, resulting in minimal maintenance and servicing requirements for the user.

/05

Informative

In addition to storing process data and system information, the AMEPA TSD 2.0 system also captures and retains videos of the slag detection processes.
This valuable feature allows for in-depth analysis at a later point in time, providing insights into the slag flow dynamics and other process variables.

TSD reports

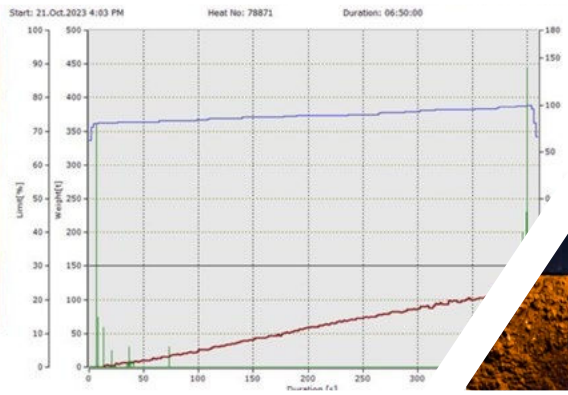


The web interface of the TSD 2.0 system provides a comprehensive report view that allows data records of individual taps to be displayed in a clear and organized tabular form. To enhance the user's understanding and ease of analysis, the generated data records are initially summarized by year, month, and day, providing a consolidated overview. Users can then further filter and sort the data according to their specific needs, including by user and evaluation criteria.

Maintenance reports

The AMEPA web interface goes beyond just providing real-time monitoring, as it also offers the capability to save and visualize all input and output signals transmitted via the data interface. This comprehensive data logging includes critical information such as temperature monitoring, process start and stop signals, alarms, alarm limits, and other system values. Additionally, any changes made to the configuration of the TSD system are logged, ensuring a complete audit trail.

These detailed reports serve as a valuable basis for maintenance and service work, enabling users to accurately track and analyze system performance over time.



Detailed data recording

The TSD 2.0 system goes beyond just recording steelworks-specific data such as melt number, date, time, and tapping duration. For each tap, the system generates a video that is stored in the data logger, allowing for visual documentation of the process. Additionally, the TSD system captures the current status of the system, changes in settings, and other system data, providing a comprehensive record of the slag detection process.

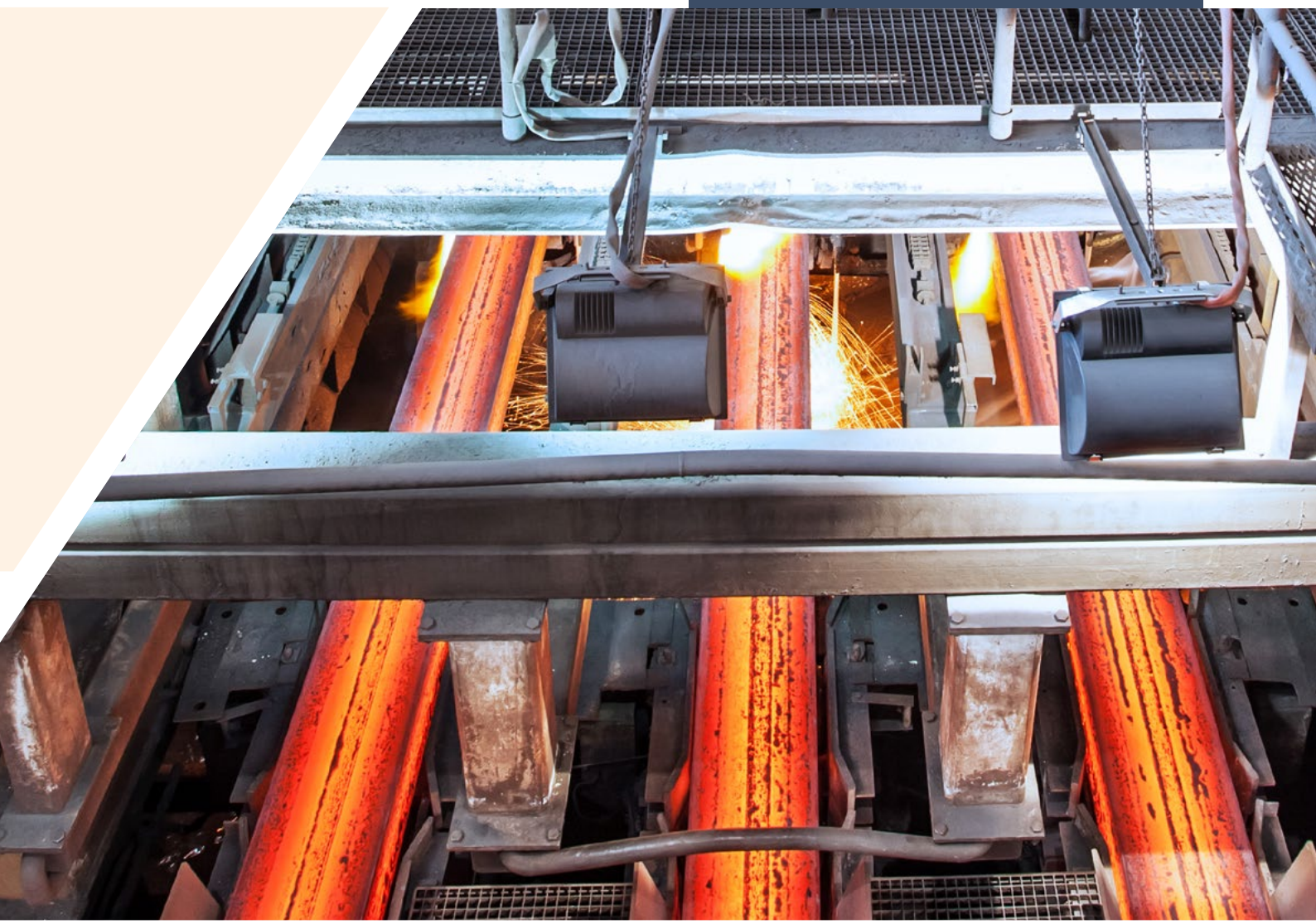
The AMEPA data concentrator is a powerful tool that allows for central access and consolidation of data from multiple TSD systems, with the capability to handle up to 4 TSD systems.

Overall this provides a secure and convenient solution for recording, accessing, and analyzing slag detection data, facilitating efficient maintenance, reporting, and analysis in steelworks operations.

Secure analysis - fast knowledge

The AMEPA web interface serves as a user-friendly display tool for accessing the recordings from the TSD data logger. It allows for easy viewing of measured values and videos from any workstation integrated into the plant network, without the need for additional software installations.

The search function and integrated filter function further enhance data access and evaluation capabilities, enabling efficient data analysis and retrieval of specific measurement results.



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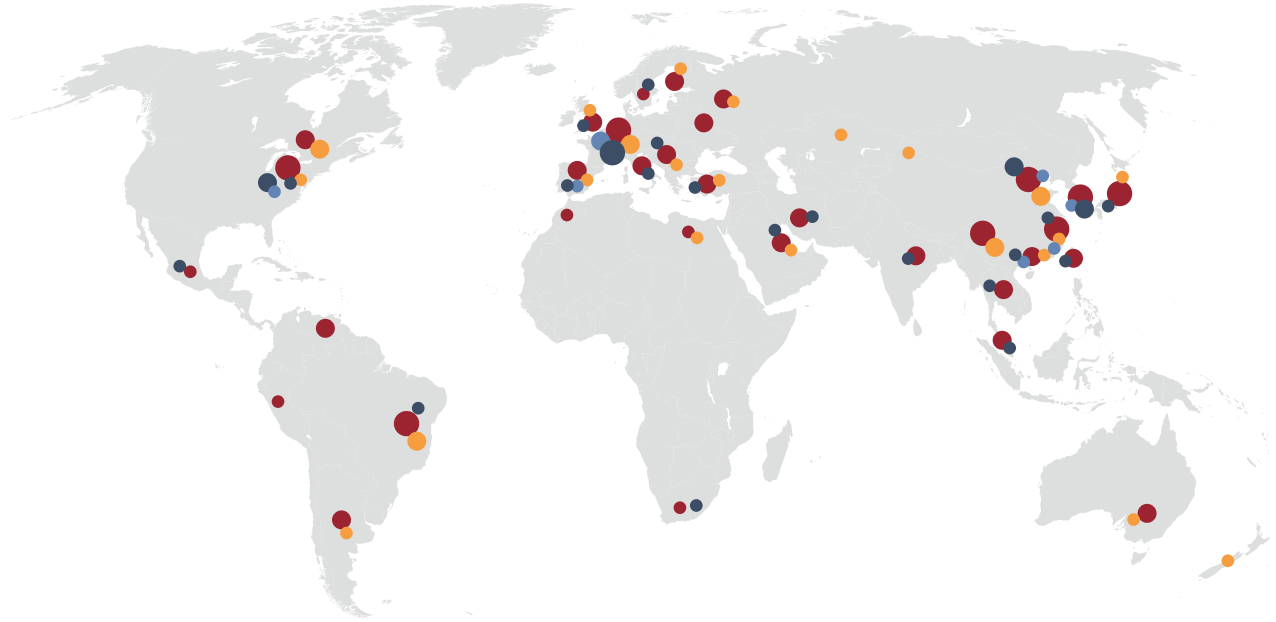
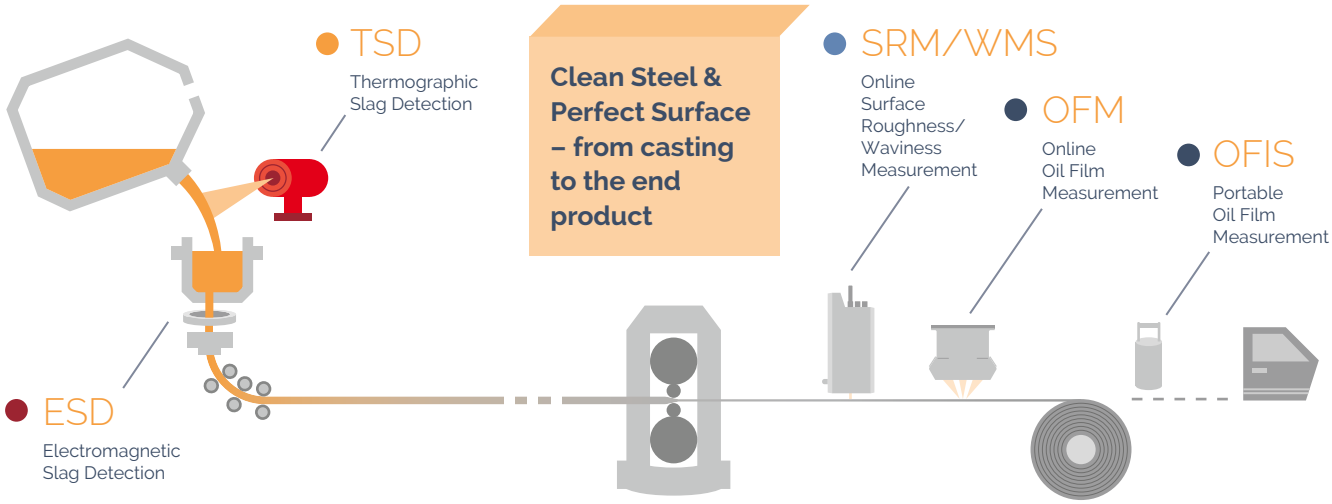
Worldwide successful





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