

# INSPECTION AT THE EXIT OF A COUPLED PICKLING TANDEM COLD MILL<sup>1</sup>

*Olivier Deschamps<sup>2</sup>*

The new Siemens VAI PLTCM installed at Corus (Ijmuiden, Netherlands) has been provided with a SIROLL SIAS surface inspection system installed at the exit of the rolling mill. The challenge was to ensure a perfect surface inspection in the tough environmental conditions at the exit of a PLTCM. The article describes the solutions implemented and the results obtained.

**Key words:** Surface inspection; Flat strip; Tandem mill; SIAS.

<sup>1</sup> *Technical contribution to the 47<sup>th</sup> Rolling Seminar – Processes, Rolled and Coated Products, October, 26<sup>th</sup>-29<sup>th</sup>, 2010, Belo Horizonte, MG, Brazil.*

<sup>2</sup> Siemens VAI MT SAS

## 1 INTRODUCTION

Automated Surface Inspection systems have become standard tools for the manufacturing of steel products. They are used at various steps of the manufacturing process: starting at the hot-rolling mill to detect and remove defective material from the process, until finishing lines for quality control before shipment to the customer. The benefit of using automated surface inspection is two-fold as it allows monitoring both the quality of the product and the process. This results in value for the systems users through process improvements and increased productivity.

SIAS, the Siemens VAI solution for surface inspection, has been developed to ensure that these two goals are met. The SIAS solution brings unequalled performance recognized by the most prestigious steel suppliers with unique functions. The paper presents the range of applications of SIAS and the benefits it brings in each case, as well as the tools that have been developed to pull the most out of the surface inspection system from the perspective of the maintenance, quality and production teams. The new Siemens VAI PLTCM installed at Corus (Ijmuiden, Netherlands) has been provided with a SIROLL SIAS surface inspection system installed at the exit of the rolling mill.

## 2 METODOLOGY

For its new KW22 Tandem Cold Mill at Ijmuiden (Netherlands), Corus Strip Products requested the latest state-of-the-art technology to be incorporated:

- 4 Power 6Hi stands
- Tandem mill designed for both rolling and skin passing
- Surface inspection at the exit of the mill



Figure 1. PLTCM Corus Ijmuiden (NL).

An automatic surface inspection system on a tandem mill provides substantial benefits both in terms of quality and productivity. The main target is to detect the roll marks, which are the main defects that occur in the tandem mill. Without SIROLL SIAS, such marks are found only on the downstream lines and downgrade the product quality. Rejections detected at a later stage in downstream lines are costly since more value has been added to the strip. In addition, the defects are then sometimes harder to detect because of the applied coating, change in roughness.

The SIROLL SIAS Surface inspection consists of (for each side):

- two linear cameras
- one LED light bar for a long life duration.
- one data processing cabinet

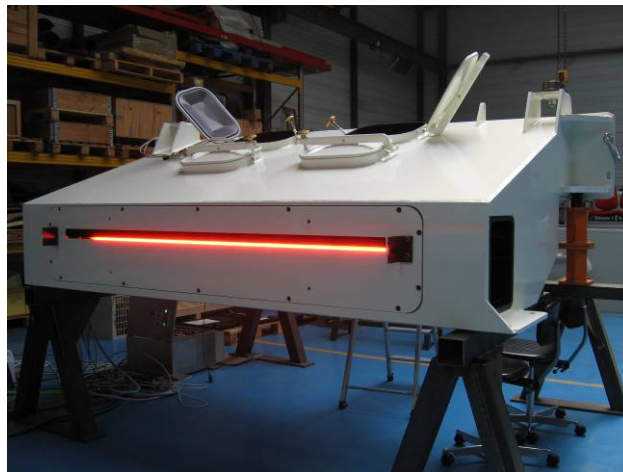
The challenge of the installation at the exit of a tandem mill had to be considered taking into account:

- the environment (emulsion, vapor)
- a number of machines within a tight space (shear, flatness roll, thickness gauge...)
- the speed of the mill (up to 20 m/s)

### 3 RESULTS AND DISCUSSIONS

#### 3.1 Equipment Installation

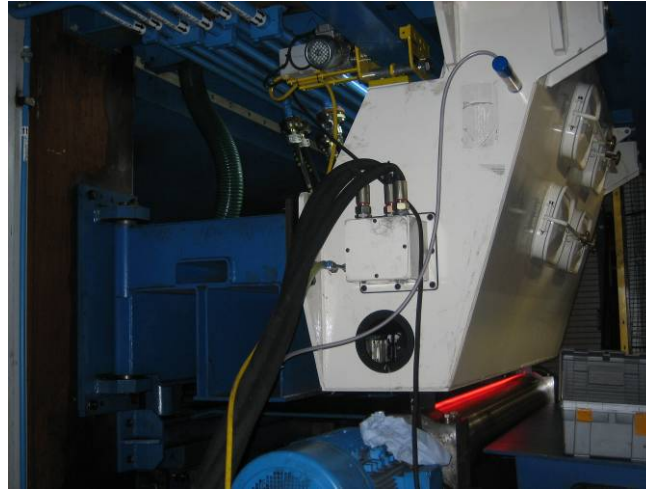
To address this challenge, Siemens VAI incorporated the lighting system and cameras into a compact pressurized box, further named “caisson”.



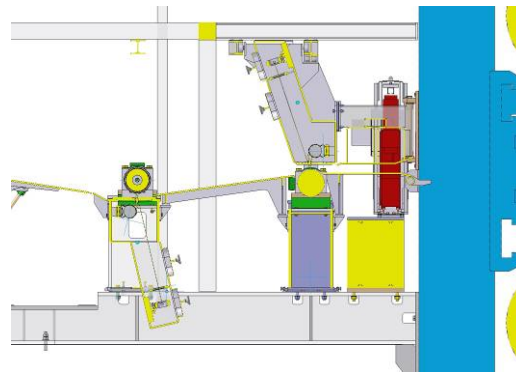
**Figure 2.** View of one “caisson” containing the lighting system and cameras.



**Figure 3.** The lighting system is mounted on rails to be quickly extracted & checked.



**Figure 4.** View of the top side “caisson” installed on the line

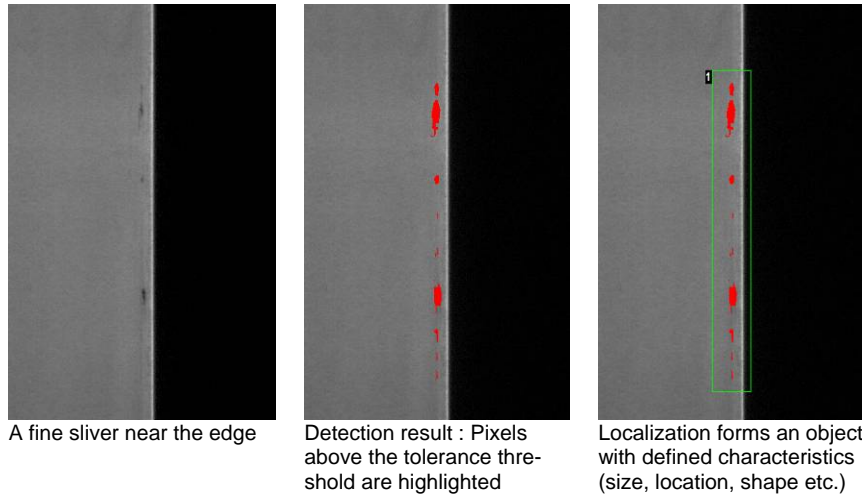


**Figure 5.** View of the arrangement at the exit of the last stand

### 3.2 Acquisition Principle

As it is being acquired, the image is “normalized” to eliminate the negative impact of both sensor-related (e.g. electronic noise) and product-related (e.g. product aspect variations) phenomena. Consequently, image processing is consistent and leads to an image that is free from external disturbances.

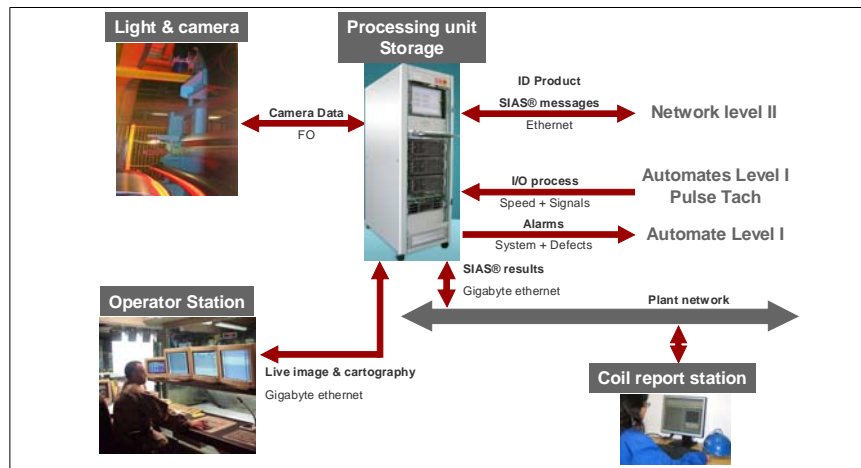
On the image, detection algorithms are applied: each pixel is analyzed to determine whether it is “suspect”. The algorithms consist of a combination of filtering and thresholds in real time and here again the system sensitivity is programmable and depends on product type.



**Figure 6.** Strip Online Analysis

Furthermore, auto-adaptive algorithms have been introduced to cope with the increased variability observed in the surface texture within the same incoming steel grade, automatically adjusting the sensitivity to background noise, thus accelerating and simplifying the on-site tuning.

Each object image is then analyzed by software to identify which defect category it belongs to. This phase which consists in identifying detected objects is called classification. The SIROLL SIAS exclusive, patented classification method is a multi-stage approach for streamlined operation and maximum efficiency. It is fully traceable and highly accurate. Classification basically consists in comparing the newly detected flaw with a “knowledge base”, i.e. a defect library, a group of defect images assembled by Quality people that is typical of what can be seen on the line.



**Figure 7.** System Architecture

Siemens SIROLL SIAS system provides total traceability and monitoring of the inspection process, which is key to both high confidence in the results and Quality management (e.g. ISO) of the measurement.

### 3.2 Results

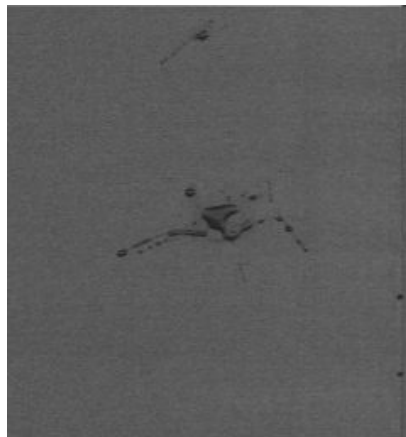
Within a few weeks, the preliminary results went beyond expectations. The image quality allows the critical defects in a tandem mill to be addressed (ie roll marks). Last



but not least, the system automatically indicates which stands generated the roll mark, analyzing the defect period.



**Figure 8** A fine roll mark detected



**Figure 9.** Perfect Image quality: view of an emulsion drip-down

The SIROLL SIAS system is used for quality evaluation, and is also giving a feedback on the process. Slight edge waviness around 2-3 cm (not seen by the flatness roll) is seen by the operator on the live image display for immediate adjustment of the flatness actuators. Also emulsion drip on the strip can be seen for immediate corrective action.

#### **4 CONCLUSION**

Surface inspection at the exit of a tandem mill is a new Siemens VAI innovation. Thanks to an appropriate installation, the image quality remains unequalled. The results go beyond initial expectations: not only the expected defects are detected and classified (like roll marks) but also process parameters can be seen like edge wave (not seen by the flatness roll) or residual lubricants on the strip.

The defect detection at each stage of the process route is important as it allows minimizing money losses induced by defects through immediate action rather than downstream on a higher value product.

Siemens VAI has developed a network of SIROLL SIAS systems along the process route which can ensure their customers a full tracking of defects leading to an optimization of the quality control.

