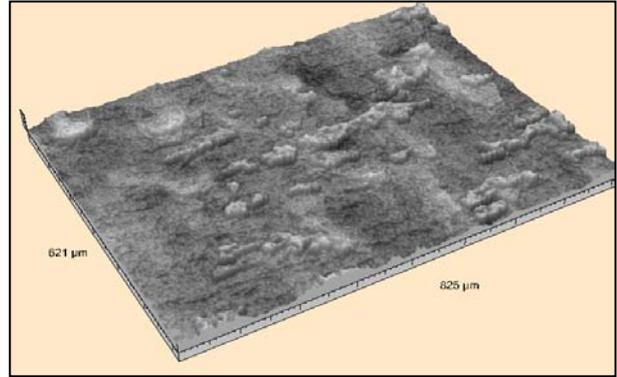


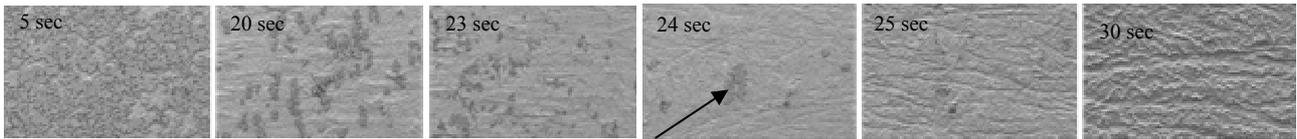
Optimising the pickling line capacity and surface quality with Detmaster MPG Pickling Grade Measurement System

In a pickling process, the residual scale, which is formed in the hot rolling process onto the strip surface, is removed to enable downstream processing of the coils. The residual scale is removed with a chemical reaction where the efficiency of the reaction is a function of several variables. The main variables are the acid concentration in the pickling tanks at the given time and the dipping time of each part of the strip. Different steel grades have different dipping time requirements. The target is to achieve the so called nominal pickling level and at the same time to maximize the production capacity. At nominal level the residual scale is removed, but the surface is not exposed to overpickling.



Picture 1 A microscope photograph of a hot rolled strip surface.

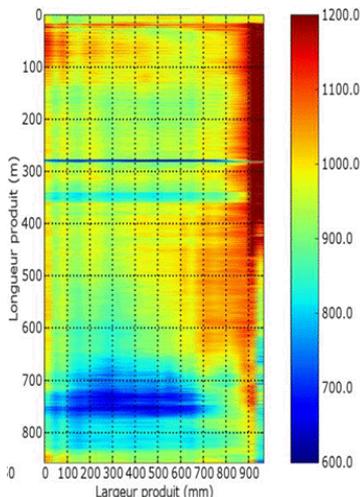
Below the series of microscopic images (0,25 x 0,4 mm) show the evolution of the strip surface in the pickling process, from 5 seconds dipping time to 30 seconds dipping time.



Picture 2 Microscope photographs show how the residual scale is removed. Small islands (10-30 µm) of residual scale are not visible with bare eye.

To run the line at nominal pickling level requires constant management of strip speed while simultaneously having the information on acid concentration in the tanks at a given time and steel grade specific nominal pickling level. Many optimising models have been developed to optimize the line speeds in order to ensure the removing of the residual scale and at the same time to maximize the line capacity and the surface quality. Underpickling should be totally eliminated. However, the turbulent production environment cannot always be taken into account by these models. On the other hand, with imaging technology (applied by automatic surface inspection systems) it is not possible to measure the remaining residual scale in absolute terms and with high enough accuracy due to the limited dynamic range (in grey scale) of CCD technology and missing calibration function.

Consequently, still today most pickling lines are run by the operator's subjective judgments on the pickling level. The operators view the surface from time to time and use safety margins in the processing. A safety margin takes place when an operator slightly overpickles the strip by running the strip in the pickling line with somewhat slower speed than he should in order to evoke the nominal pickling level of the strip. These safety margins result to unnecessary capacity restrictions.



Increasing the pickling line capacity and assuring pickling process output

SR-Instruments Oy has introduced a new, extremely sensitive and stable measuring technology, which is capable of measuring the remaining residual scale on strip surface. The measurement method comprises a high resolution continuous measurement covering the entire (100%) strip surface.

In operation the system will measure and visualize the microscopic phenomena of the remaining residual scale to the operator via its user interface. Changes in the quantity of the residual scale of less than 2 % can be visualized with the system. The graphical real-time display and alarms indicate to the operator the nominal pickling grade and how far he is from it. Upper and lower thresholds with alarms are pre-set for all steel grades.

Picture 3 An example of graphical real-time reporting of pickling level.

Process development people have calculated that this new system increases the pickling line capacity in minimum by 5 %. For a 1 Mton pickling line this means 50.000 tons more productivity every year. The capacity increase has been verified during a three month on-line pilot installation on an ArcelorMittal pickling line. During the pilot installation period was recorded that the line speeds could be increased even by 30 % momentarily. The final capacity increase is a subject of plant specific issues and depends on the safety margins each operator is using. The concerned Detmaster MPG system is a stand alone system and no other investments are needed to increase the pickling line capacity.

What does it take to apply the Detmaster MPG system in the pickling line?

The Detmaster MPG system is installed on a pickling line immediately after the pickling baths and dryer section. At the measurement location the strip is recommended to be completely dry.

The system is placed below a free run strip in a place where the strip has no pass-line variation (bounce) and the strip tension is good. The strip should be planar at the measurement location. Approx. 1500 mm free space should be reserved between two supporting rolls. When placing the system below the strip the nominal distance between the measuring head of the system and the strip (84 mm) will always be the same, even if the strip thicknesses vary a great deal. For a double-sided installation strip thickness parameter needs to be sent to the system's data processing.

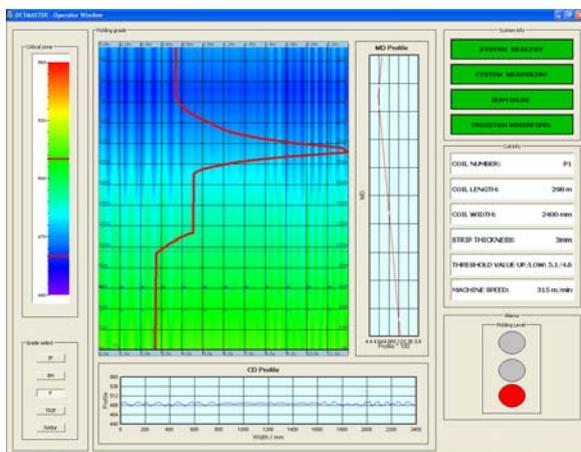


Picture 4 The Detmaster MPG system at the installation site.

The system is connected to level 3 automation with a TCP/IP connection. Through this two-way connection the system receives the coil specific information, including the steel grade, for the next coil. After receiving the coil change signal the system automatically starts to apply the correct threshold levels for guiding the line speed to the targeted nominal pickling level.

The system will utilise pre-defined “recepies” for every steel grade. Each grade to be processed should be defined in terms of pickling level. This is easily done by either running the new grade in different speeds through the line or more manually by collecting, say 5 samples from each steel grade with different pickling times; from under pickling through nominal pickling to over pickling. These samples are measured by SR-Instruments and the removal of the scale is mapped as a function of the remaining residual scale towards pickling time. After mapping of these curves the information is stored into the system and applied for the particular steel grades.

The operating principle of the Detmaster MPG system



Picture 5 An example for graphical real-time reporting of pickling level via Detmaster MPG system user interface.

The Detmaster MPG system operation and measurement principle has been verified by Arcelor Research. The measurement is based on reflection illumination measurement principle and applies the new multi-measurement principle of SR-Instruments. Furthermore, it has been verified that the roughness changes on strip surface don't influence to the scale measurement. Long life time LEDs are used as light sources and high sensitivity silicon sensors as detectors. An integrated temperature stabilization system eliminates the influence of the variations in ambient temperature. Automatic on-line/off-line position controls enable the moving of the entire system from the measuring position to the maintenance position. System's calibration function is automatic, and can be either time based or production volume (MD counts) based.