

Turning knowledge into action for consistent strip quality and increased production efficiency

CMI, one of the leading suppliers of equipment for the processing of steel, has launched its latest, innovative servicing offer, OPEXSM, providing technical assistance based on process and operation expertise combined with easy-to-use software. This combination is designed to help customers bridge the knowing-doing gap (turning knowledge into action) when it comes to the processing of steel strip. In a first step, it focuses on single and dual processing lines.

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When faced with multiple challenges, choosing the right equipment or process can often prove complicated. To see a project through to a successful conclusion, steel producers need to find the optimum balance between the technical performance of their products and minimising costs. Then, to make the right decision, they need to be able to rely on sound, versatile technical and process skills.

CMI has gained world-renowned metallurgical, process and operation know-how by engineering and commissioning automotive galvanising lines globally. Today CMI's state-of-the-art strip processing lines feature the full spectrum of CMI's very latest process technologies: multistage cleaning section, vertical furnace (including L-Top math model and jet cooling system with energy recovery), zinc pot section and air-knife system, After-Pot-Cooling – APC Blowstab[®] cooling system, in-line skin pass mill and tension leveller, chemical and organic roll-coat post treatment, side trimmer and exit shear. This knowledge, coupled with intelligent software, is at the heart of CMI's OPEXSM (Operation, Process Expert System). It allows CMI to give the best possible advice and is an essential part of any manufacturing quality control strategy.

OPEXSM

Steelmakers' quality control systems are often set simply to monitor key variables, affecting the production process, in real time. Any deviation from the acceptable range will be indicative of quality issues, but the solution is not always at hand. This is where OPEXSM comes in – filling the gap between available data and the action to be performed by the operator, based on an analysis of all process and coil data to determine process and quality conditions and providing operational advice and guidance, both in the selection of suitable operational parameters and production processes



Fig 1 Furnace process section

As such OPEXSM provides the necessary customised assistance to make quality decisions. *Figures 1 and 2* illustrate two key areas – the heating furnace and the zinc pot – which are closely monitored by OPEXSM.

The proprietary software provides automatic coil grading (see *Figure 3*). The line model functions as a control chart that monitors process stability and gives signals when the charted parameters show unpredicted process drift. It condenses all process data on to a single wide screen which speeds up problem identification and intervention. This helps the steelmaker to determine whether a produced coil, even though not compliant with the criteria set for the specific production run during which it has been produced and thus related to a defined customer, still meets the criteria of another customer. This coil grading, automatically provided through the software, also considerably speeds up the coil validation process and drastically reduces the number of rejected coils, and thus cost.

The core of the software is the expert know-how that is linked on-line to the process control system. As such, data ▶



Fig 2 Zinc pot section

relating to quality coming from the line are recorded, stored and analysed, allowing for easy and visual best practice sharing, improved use of equipment, and eventually the reduction of scrap and increased yield, as well as speeding the pace of, for instance, automotive, certification and the implementation of new steel grades.

The display on the left-hand side is an overall view of the grading of all produced coils, using specific markers indicating whether the line status has met the required quality or not. A traffic light report helps the operator to visually identify anomalies by produced coil and process section (green = in-line/ orange = partially out-of-line/ red = out-of-line).

Additionally, the data that is mapped under the line model details the different process parameters within each of the process sections of the line. Thus, it helps identify where the data is out of the defined criteria settings, and exactly where the anomaly occurred. The criteria settings can be either of fixed criteria or tolerance ranges.

THE EXPERT SYSTEM

While operational indicators are provided via software, an expert system defines what action to take, as well as where and when to take it. Such advice is transmitted via a pop-up window that opens when the operator clicks on the process parameter that is out of range. All data and instructive guidance is displayed in form of either indication of corrective action to be taken, additional checks to be conducted, or a library of reference documents or similar events for comparison.

The individual pop-up windows are divided into three tabs: expert advice, data and actions. The expert advice indicates what the operator should do, helping him to understand the underlying process behaviour, as well as prioritise and select actions that he is to undertake to

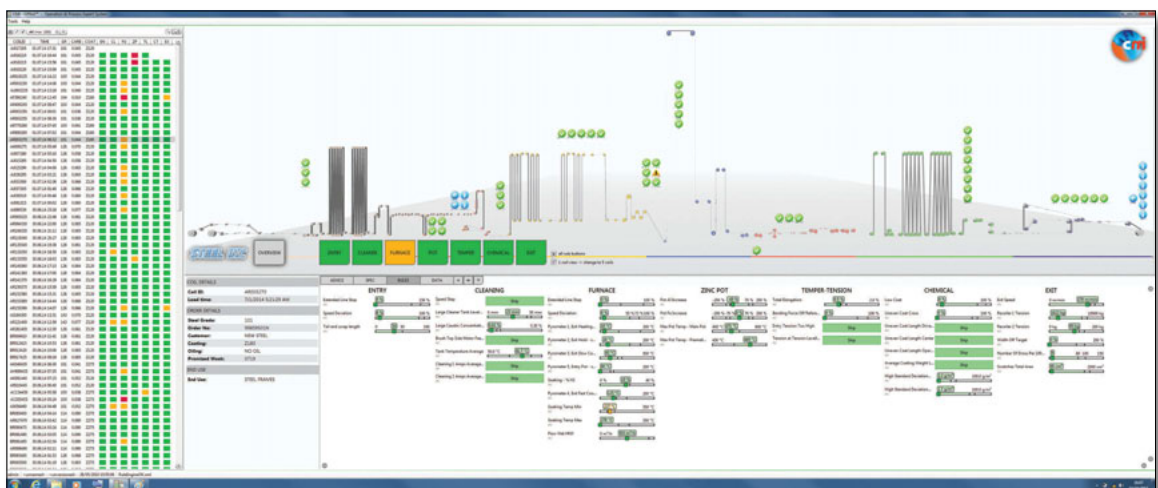


Fig 3 Model screen display example

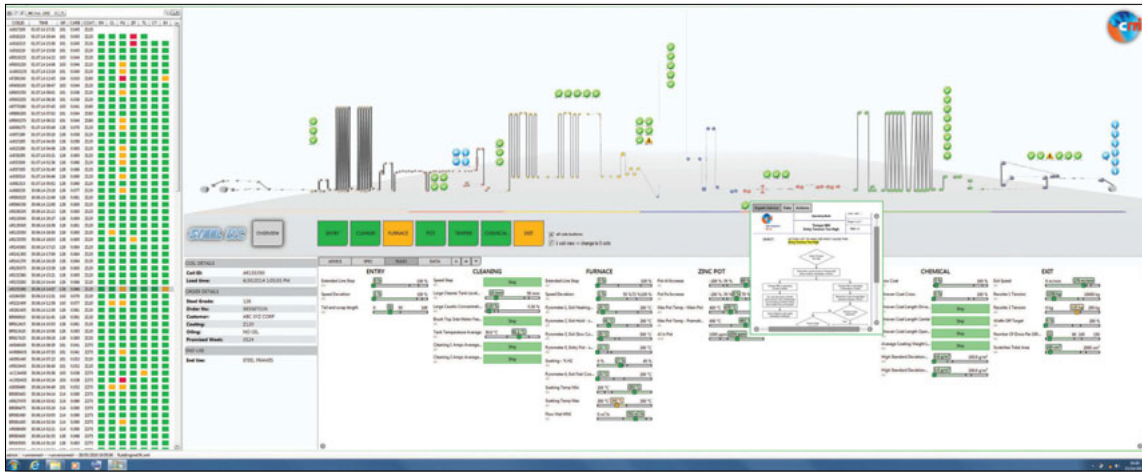


Fig 4 Example of expert advice display

restore the nominal quality of the line. It can be submitted in the form of a list of actions by equipment and/or a flow chart indicating the methodology to follow for troubleshooting and problem-solving (see Figure 4). It can also include supporting documents, such as 3D drawings, to help the operator better visualise specific equipment on which the problem has been detected, photos, eg, related to quality defects, or other instructive documents, eg, standard operating procedures.

Under the data tab detailed, recorded data related to the out-of-line parameter is given and under the action tab the operator formally acknowledges which actions have been taken. The software also provides a weekly analysis of suggested actions versus actions taken, and allows for an operator's input that can, or is requested to be entered, and that can be either observations or recommendations.

As the pop-up window and the related advice is available within minutes after the coil is produced, it guides operators most effectively in day to day operations. Additionally, the software allows for a direct link to the processing data coming from the line and can be accessed via the web to allow for a fast and customised intervention of external experts where needed.

STATISTICAL PROCESS CONTROL

Another important advantage the system provides is the correlation between recurrent defaults impacting quality. Such a correlation is vital to anticipate problems, and orange traffic lights, highlighting sections not fully in line with line parameters over a period of time, are a good indicator as to where to take corrective actions thus preventing anomalies. As such, OPEXs, also functions as an on-line statistical process control (SPC) system which, via continuous monitoring and process analysis, provides an important input for lean 'just-in-time' maintenance planning.

The recorded process parameters can be displayed by process section and are synchronised per running metre of coil, which helps to define when exactly a non-conformity occurred, and thus reduce the amount of strip to be eliminated, which is leading to decreased scrap and increased yield (see Figure 5).

COIL VALIDATION

Based on defined criteria, the system also helps to set the mechanical and chemical limits by product. During an involuntary slow-down of the line, due, for example, to problems either at the entry or the exit section, the system allows the definition of the exact slow-down percentage of the line-up to which compliance of the final strip with the given criteria is not affected.

OPEXs not only allows the line to be run under the criteria set by the CMI experts or the steelmaker himself, but it can also easily and quickly be updated to reflect any other specifications as, for example, those related to the final customer's (eg, car maker's) quality needs. It thus allows adjustment of the line's quality specifications, as well as its coil validation and adjustment based on various final customers' quality needs and the related grading rules. As such, the same processing line can produce product in accordance with the specifications and needs of various final customers.

The system offer also has the following benefits:

- Translation of characteristics of a final product into process and product parameters, as well as process steps and tolerances (see Figure 6).
- Including trial runs when deviating from the process and production path defined by the CMI experts, due, for example, if the necessary steel grade is not produced by the steelmaker.

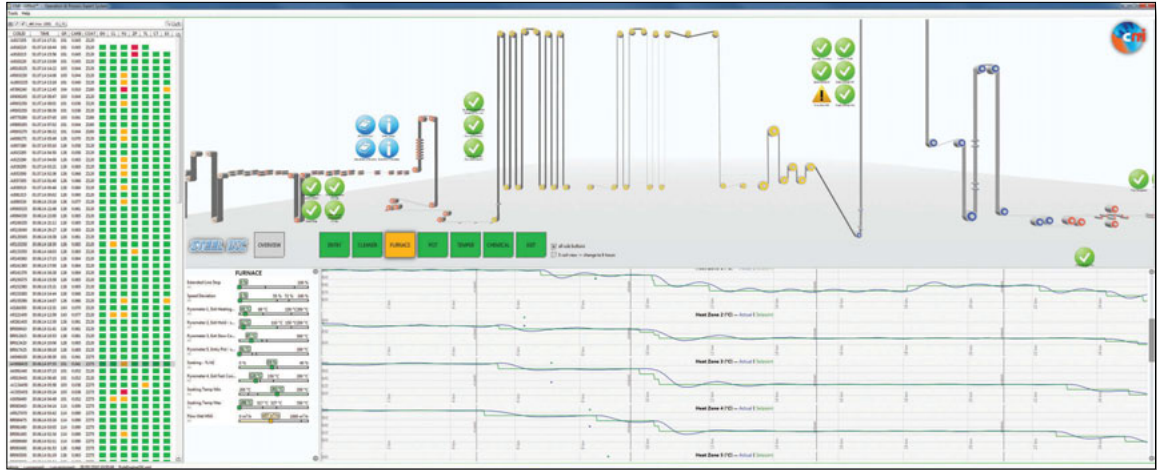


Fig 5 Example of recorded process parameters

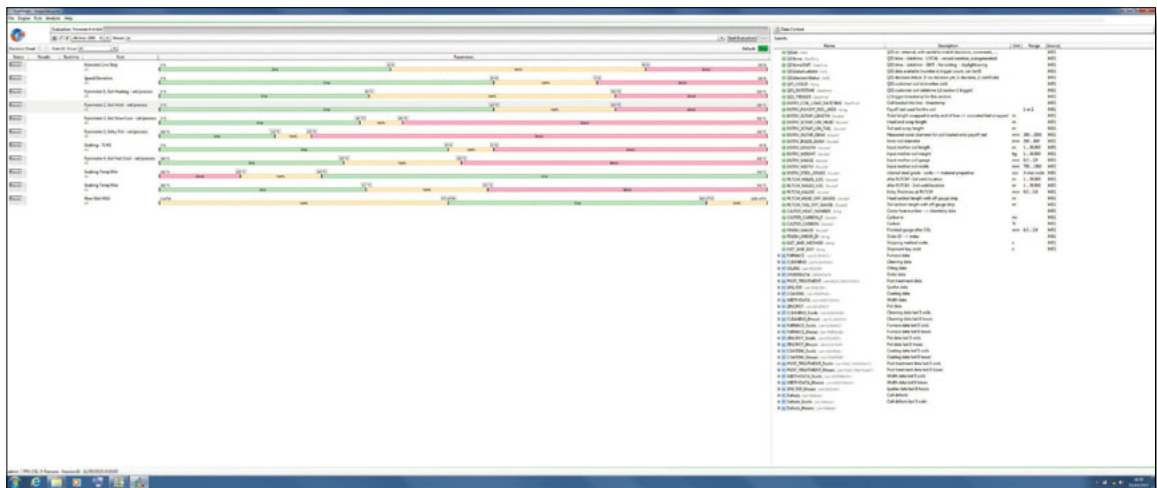


Fig 6 Typical process evaluation screen

CONCLUSIONS

- OPEXSM allows optimisation of the line settings based on analysis of data coming from processed coils, as well as upstream data analysis end event reporting.
- It provides line operators with context information as to the customer's processing specifications as well as those set by final customers. The corrective or preventive action to be taken is identified based on this analysis and available minutes after the coil has been processed.
- Markers indicate the origin of the problem to be solved, as well as specifying the required manual intervention when needed. Additionally, the system displays similar events for comparison.
- The system has the capacity to 'learn', thus continually updating its database with the acquired knowledge from the daily strip processing.
- Provides a display of similar cases for comparison and

on-site know-how assistance, the necessary expertise and support to secure audits and certifications, including automotive related certification.

- Is not only relevant and easy to implement for single processing lines, but also for lines combining several processes, like pickling and galvanising or annealing and galvanising, where it helps with the management of complex processes and as such helps steelmakers increase their production flexibility and produce products according to market requirements implying the lowest possible capital expenditure. **MS**

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