

Tenova iMeltShop: the integrated process manager for the continual improvement of the whole melt shops production line

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Summary

In the present market situation, in order to meet the challenging demand of an ever increasing operating efficiency, effectiveness and flexibility, ORI Martin and Tenova collaborate for the optimization of the production line as a whole to obtain a careful management of quality, productivity and costs.

Tenova iMeltShop is the integrated process route manager that acts between the Process Control Systems of the single equipment (Levels 2) and the Manufacturing Execution Systems (MES, ERP, etc.). It's a real-time monitoring and dynamic control of the entire steel production flow with the aim of maximizing the availability of the production line and improving the overall performance.

To obtain the desired results according to all the specific requirements, the modular structure of the iMeltShop counts on the most advanced solutions for the process control supported by the integration of innovative sensors and actuators fully compliant with the concept of industry 4.0.

The coordination granted by Tenova iMeltShop enhances the continual improvement of ORI Martin's production process and promote the development of a new concept of smart factory in the steel industry.

Key Words

iMeltShop, process control system, automation, improvement, process, productivity, optimization, melt shop.

Introduction – background and concept

When the steel industry was running in the absence of process automation, plant operators have to personally monitor and control the performance values and the quality of outputs to define the best settings to operate the production equipment. The results in term of operational efficiency and safety are strictly related to the experience and elements of the involved people. Process automation made the task easier this with the help of sensors at thousands of spots around the plant that collect data on every significant parameter. The information is stored and analyzed at a basic level on a computer with the aim of monitoring the entire plant, while the single piece of production equipment can be monitored and controlled in the respective control rooms. So far, in the steel production, the development of process automation grew alongside the development of the single production equipment. The operative experience and the remarkable variety of production routes had an important weight to drive this kind of approach. The result is a huge variety of process control systems committed to gain the best performances from each of the single equipment being the guide for the operators. The coordination and management of melt shops is handled by one or more production managers, which rely on the experience of the shift foremen to reach the required productions volumes. While all the process stations have their own operation practice, there is not a true melt shop system

that can easily grant an overview of the plant as a whole with the information needed at all the different levels, from the operator to the melt shop manager. This present scenario calls for a process tool in order to coordinate the operation of working equipment with the steel production requests coming from ERP. Through the integration of the whole production line, Tenova iMeltShop is the answer.

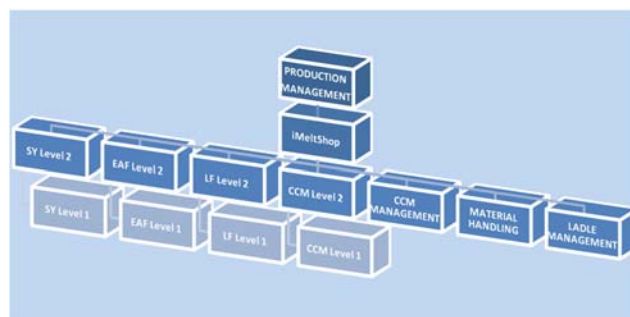


Figure 1: Tenova iMeltShop concept and interfaces.

Modular process optimization system

Tenova iMeltShop is designed and built with a modular structure which allows for easy configuration and incremental adaptability to future needs. Noteworthy, the operator interface of the iMeltShop, based on WEB technology, is available in form of webpages. It can be accessed from any network connected PC or portable device, by users with granted rights, simply through the most popular WEB browser.

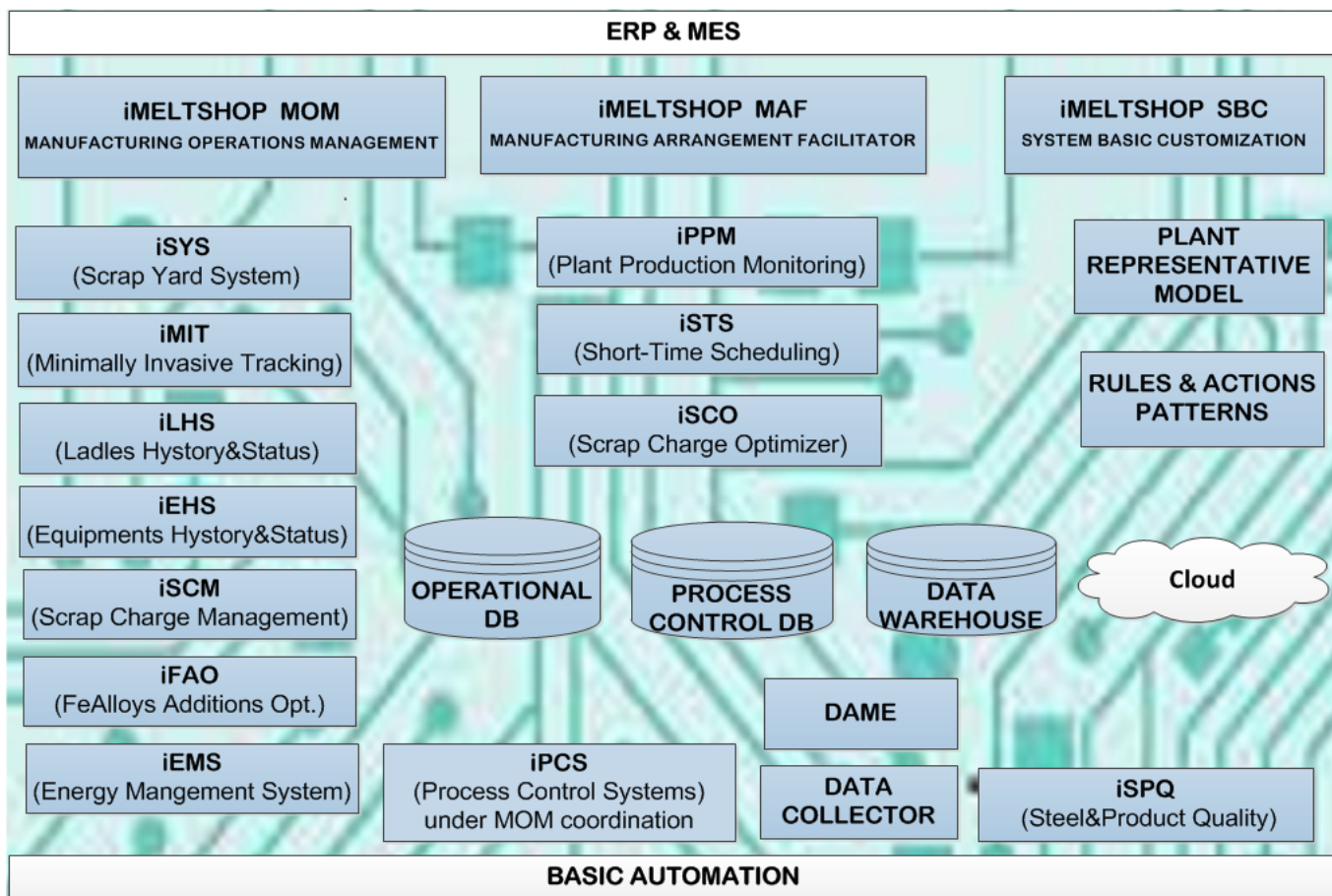


Figure 2: Tenova iMeltShop modular built and system structure.

iMeltShop MAF

The iMeltShop Manufacturing Arrangement Facilitator is the core of the system, for the coordination and efficiency improvement of the whole production line, according to what observed and recorded by the system during the operation. The real time management of the process route ensures the faster and most effective reaction in case of deviation from the standard practice, helping the production managers and operators to make the right adjustments and actions. The process control aims to improve the production follow-up leaning on a decision-making method, identifying and choosing alternatives based on the values and preferences given as targets. The iMeltShop proposes a selection of a belief or a course of action among several alternative operational possibilities to handle the unexpected production deviation and modification. The level of the action is in-between the equipment PCS and the ERP system. The result is a finest and dynamic coordination of the operation of the whole process route

iPPM – Plant Production Monitoring

The main scope of the Plant Monitoring is to present a fast and intuitive picture of the process route condition, combined with the evidence of the development of production on the time basis. All the information is

based on a real time screening and measurement of the production figures integrated by the analysis of the historical data. The module makes available the real-time updates of production flows and, by the dynamic analysis of the data, a predictive estimation of delays is performed for the calculation of the standard process times. The results are presented in different diagrams and patterns, as an intuitive real-time Gantt diagram of the whole process route or customizable “control charts” of the key parameters that can be seen wherever is required. Estimated times and performance indicators will be used as inputs for the other modules of the system to update the foreseen production schedule and to finalize possible corrective actions to be issued both downstream and upstream to manage the deviation from the standard practice.

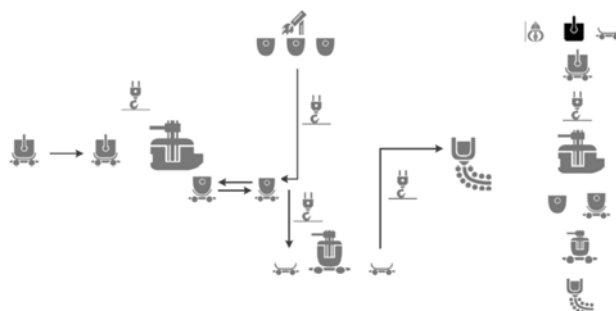


Figure 3: Plant Production Monitoring concept

iSTS – Short-Time Scheduling

The Production Short-Time Scheduling module is designed to provide support in the definition and management of the melt shop detailed production scheduling and operation planning with a typical time frame of 12-24 hours. The limited time horizon allows ignoring the time constraints: all the steel production requests have the same priority in the scheduling environment. The production request coming from the ERP system will be processed to generate the best heat sequence for casting equipment, taking in account the production targets and the production constraints. The generic request of liquid steel (melting order) is translated into one or more sequence of heats, considering generically applied limits and references and specific limits and references on the steel grade and semi-finished product. The module can work also as a stand-alone tool: in case of the absence of the ERP, the production request can be programmed directly within the iMeltShop.

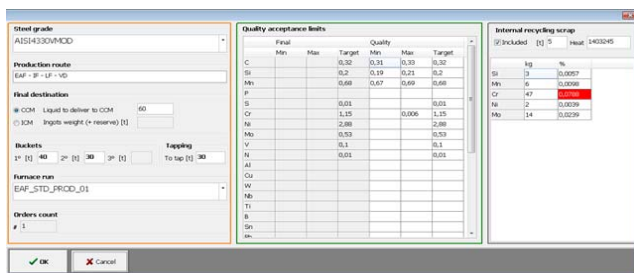


Figure 4: Short Time Scheduling. Steel grades definition and process routes assignment.

iSCO – Scrap Charge Optimizer

Once the production schedule and the heat sequences are generated by the Short-Time Scheduling, Tenova iMeltShop perform the charge optimization in order to minimize the production cost of the assigned melting. The model makes a dynamic evaluation taking in account both of the following main goals:

- the most cost effective composition of the charge considering the available materials;
 - the most efficient treatment in the process stations.
- Tenova iMeltShop charge optimizer takes in consideration metallic and non-metallic charge and the required ferroalloys additions into the tapping ladle to meet the quality targets of the final product.

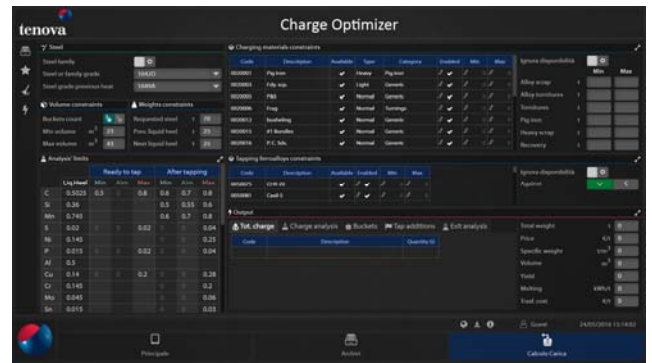


Figure 5: Scrap Charge Optimizer

iMeltShop MOM

The iMeltShop Manufacturing Operation Management is the ensemble of operative control tools dedicated to the optimization and integration of the process phases within the production line. It is the supervision and coordination system of the entire melt shop. Through continuous monitoring of ongoing activities and operating conditions, it determines, suggests and, if enabled, commands, in full autonomy, the most effective actions and interventions to face unforeseen events and deviations, chasing the best conditions of efficiency and coordination, even in the most critical situations. Through integration interfaces with the plant process control systems, it is able to intervene in real time on the whole line. It is the “digital shift foreman” that supports the department managers and the supervisors and simplifies the supervision and coordination activities.

iSYS – Intelligent Scrap Yard System

The module is conceived and structured to make the operational management of the scrap yard mainly automatic, with real-time updates of entrances / exits, activities in progress, position and operating status of equipment and equipment, storage status (volume, weight, quality) and with global coverage of data exchange with other systems with which it is appropriate / necessary to exchange information in real time (in particular, goods entry, ERP and MOM). It provides for the installation of sensors and special equipment to serve the individual functions of the system. In particular:

- radar systems for intercepting positions of cranes and trolleys;
- scanner systems for volumetric measurements in individual stalls;
- reliable weighing systems on cranes;
- WIFI coverage of the entire area;
- recording cameras for scrap loads and discharges.

iSYS is integrated with the “Manufacturing Operations Management” of iMeltShop, from which it receives the orders for preparing the buckets and the instructions

for the construction of the scrap bed on Consteel® and to which it transmits the results of the missions performed.



Figure 6: iSYS – Scrap yard manager tablet interface.

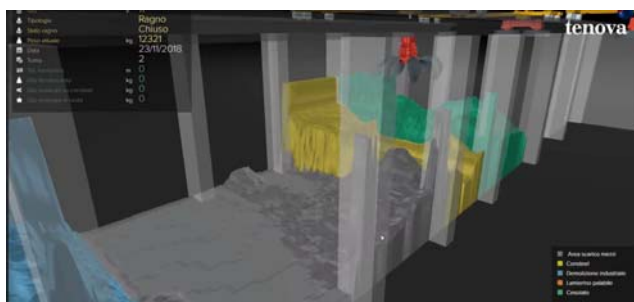


Figure 7: iSYS – 3D scan model of the scrap yard.

iMIT – Intelligent Minimally Invasive Tracking

With the most advanced technology, the Minimally Invasive Tracking System of Tenova iMeltShop permits the efficient management of the ladles inside the plant. Each ladle, equipped with identification tags, is constantly tracked and identified by the camera system, while moving from one working area to another. Basic elements of the Ladles Tracking System are:

- automatic detection of the ladle physical position;
- real time update of the ladle life history, by acquiring info and data of the running process

(steel grade, heat number, weights, power-on time, stirring gas times, ...), through connections with the Automation and Process Control systems;

- ladle life in-production monitoring, giving warnings when the refractory campaign reaches the predefined thresholds;
- standard ladle assembly form (freely configurable), for notifying the ladle refractory consumption when the lining is repaired or rebuilt;
- consumption components (e.g. porous plugs, plates, nozzles, ...) in-production monitoring, giving warning when the predefined thresholds are reached;
- identified components (like slide gates) in-production monitoring, giving warning when the predefined thresholds are reached. The Ladle Tracking System is informed each time an operation regarding an identified component is done (mount on ladle #xx, dismount, repair, ...).

The iMIT tracks how each ladle, with its current assembly, is used in the process. Main events are:

- drying / Heating begin and end;
- tapping begin and end, with assignment to a heat and weight;
- secondary Metallurgy treatment begin and end (LF, VD/VOD, ...) with stirring time, power on time, etc.;
- casting begin and end;
- overall Steel time for the heat with initial and final steel tons.



Figure 8: iMIT – Ladle status monitoring page.

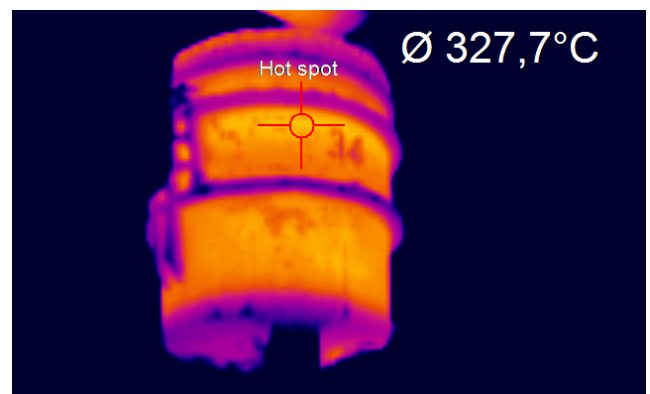


Figure 9: iMIT – Ladle thermal scan.

Data Mining and Reports

The overall goal of the module is the extraction and mining process of the data measured and recorded by the iMeltShop system and transforms it into understandable reports for further analysis and use. Data can be processed and relevant reports generated and customized according the managerial requirements. As a feature of this module, is made available the analysis of the deviation of the effective operation from the standard practice, to facilitate the continuous development of steel production process through incremental and breakthrough improvements. The Tenova's proprietary suite of iMeltShop in its entirety, is the strategic tool for the best melt shop management, from the quality, quantity and cost effectiveness point of view. Additional to the steelmaking operation, iMeltShop can be fully integrated with the iRecovery® system, the energy recovery system of Tenova, taking advantage to the opportunity of producing steel at the highest grade of energy efficiency and flexibility in every different environmental scenario.



Figure 10: Data Mining and Report. Tapping parameters trend and statistic.

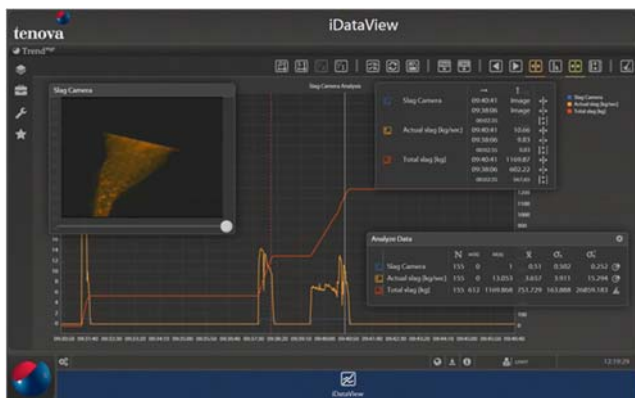


Figure 11: Data Mining and Report. Deslagging analysis and diagram.

Results and savings

In any different steel industry scenario, the implementation of Tenova iMeltShop guarantee an

effective and simple improvement of the operative conditions and process throughout the production line as a whole. The results with the installation of the system will be tangible in different spheres of the meltshop management that can be summarized in:

Efficiency and Flexibility

Logistics, production sequences and raw materials are optimized to reduce to a minimum the wastes and the yield losses, ensuring at the same time the highest level of flexibility and control, following any different scenarios of costs and production request. The production will be always uniform and consistent, improving workforce efficiency in each station.

Time and Productivity

Tenova iMeltShop will give the possibility to the meltshop managers to continuously develop and improve the operative practices of the whole line. Being able to optimize time losses and giving a real time estimation of the plant/equipment saturations will improve the coordination between stations, reducing bottlenecking and reducing the uncertainty and stand-by losses due to difficult plant coordination.

Availability and Reliability

The signals of improvement or weakening coming from the continuous monitoring and analysis of the plant condition will promote the implementation of improved maintenance practice to increase availability and reliability.



Figure 12: iMeltShop results.

As a result, the continual improvement approach leads to the reduction of the transformation cost for the production of steel which is the main driver of the steelmakers, especially in a challenging period such as these years.

Ongoing development

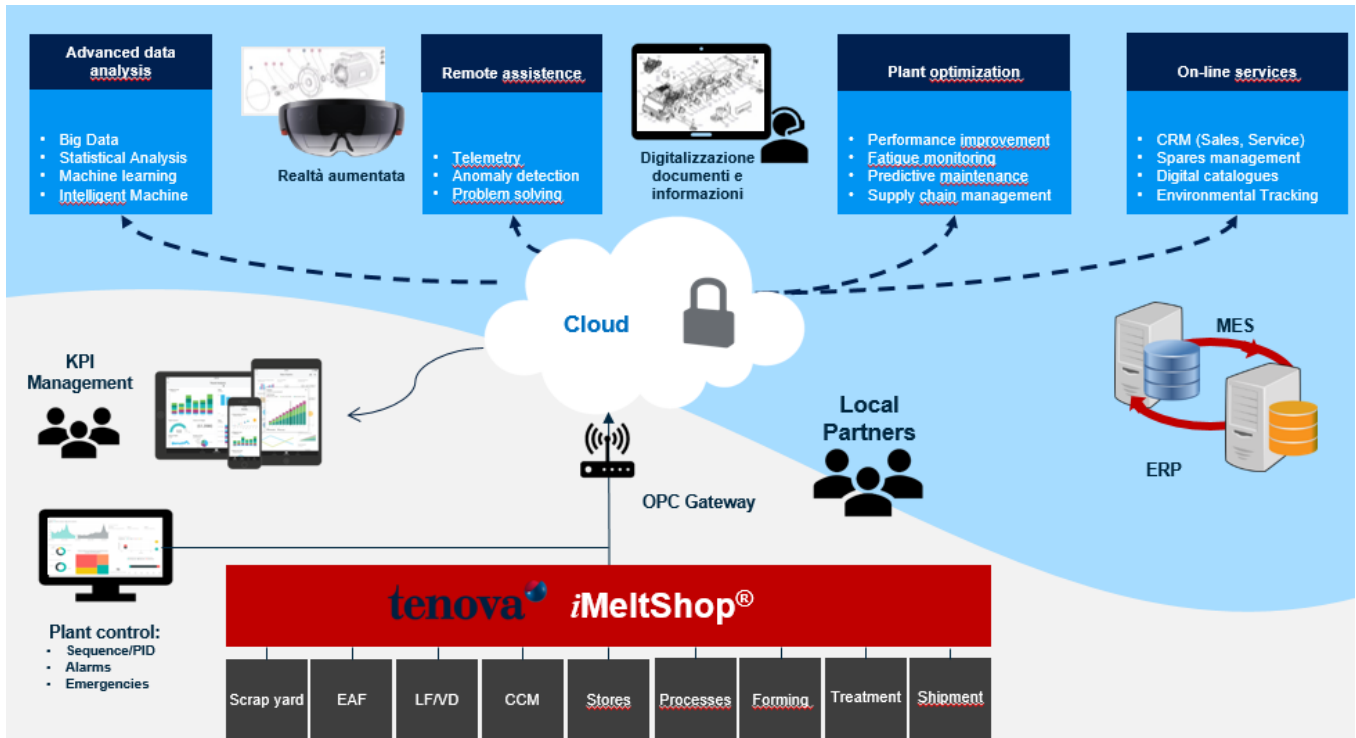


Figure 13: iMeltShop ongoing development in the approach of Industry 4.0.

Tenova iMeltShop is fully compliant with the concept of Industry 4.0 and continuously under development to guarantee the best integration with the innovative digital approach and products of Tenova portfolio. The ongoing development of the iMeltShop is leading to making the most of the potential of a network of collaborative systems, to guarantee even more integration with the production process in all its executive phases.

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