The HMI displays each individual coil and the statuses of all plant components

Rule-based automation of a hot coil transfer system

Thyssenkrupp Steel has renewed its coil transfer system as part of a modernization of its No. 2 hot strip mill in Duisburg-Beeckerwerth, Germany. The existing material tracking and warehouse management system has been replaced by the rule-based solution TWMS/metals of 3tn. New functionalities have been added to the coil transfer system tailoring it to the specific requirements and conditions in the works.

The hot strip mill in Duisburg-Beeckerwerth is the biggest one of German number one steel producer Thyssenkrupp Steel Europe (TKSE). The plant has an annual capacity of around 6 million tons. In recent years, the hot strip mill has been modernized with focus on better capabilities to produce high strength steels. Within the scope of such modernization TKSE has revamped its coil handling management system.

The previous coil handling management system consisted of a material tracking and warehouse management system, whilst the input for the handling processes used to be supplied by a second system operating in parallel. TKSE was looking for a more modern solution that could combine both functions within one system. In February 2014, TKSE awarded 3tn the order for the supply of the new system. 3tn is a leading provider of warehouse management solutions for the metals industry. The company had already gathered experience with its rule-based TWMS/metals warehouse management system for slab and coil storage operations.

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Harmonize, simplify and automate the process

The request was that the new coil handling management system should cover the entire handling operations from the recoiler down to the hot coil store. TKSE wanted to avoid reprogramming in case any operating procedures or coil handling steps changed. Furthermore, the objective was to implement a solution that would allow the

production staff to adapt the system to current customer requirements without any involvement of IT staff. The aim was to harmonize, simplify and automate as much as possible the process of entering the coil handling instructions for the packing, marking, sampling and inspecting devices.

Because good experience with rule-based systems had been made in other works areas, the idea was born to also have a rule-based system installed for the management of the processes downstream of the hot strip mill. The advantage of such a system would be the possibility to customize the system via what is called the "technological editor" without having to change the source code of the software. It would be possible to freely define many of the rules and parameters by using a simple syntax, i.e. a simplified programming language.

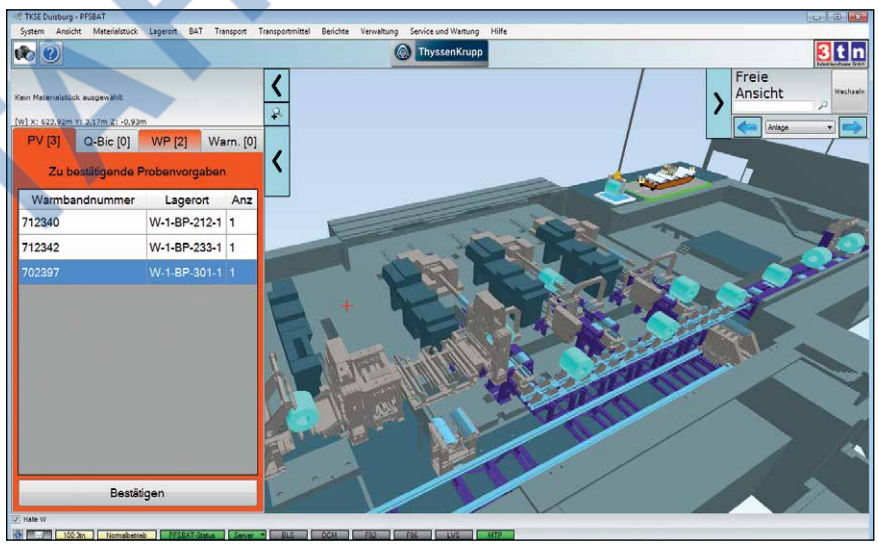
Rules automatically generate the handling data for each individual coil

The new automation system manages all coil handling processes downstream of the hot strip mill, starting as soon as a coil is being removed from the recoiler and continuing all the way down to when the coil is being deposited in the hot coil store. 3tn has implemented specific rule books for sampling, coil tying and coil weighing. Based on these rules and the characteristics of each coil, the process automation system decides which coil handling route has to be taken – for example, how it will be tied and marked. The system also determines whether a coil has to undergo an additional inspection, and if so which measures that inspection will have to include. In this way, the process automation system generates the input data for the subordinated systems, namely the tying and marking machines and the inspection line. The standard procedure is that the process automation system generates the input for the inspection and tying machines based on material data which the production control system extracts from its database. The programme thus relieves the operator from routine tasks. However, the operator may at any time intervene in the process via the 3D HMI and overwrite the data, for example, in the event of extraordinary operating conditions.

Helpful visualizations

The process automation system visualizes the handling operations between the recoiler and the hot coil store in 3D views. Additionally, all statuses of the subordinated systems, for example, the inspection equipment, are displayed on the control pulpit. The coil handling activities can be viewed from preset or freely selectable perspectives.

The visualization is extremely helpful for the operators as the modernized plant places the operators in the situation that some of the equipment has become somewhat concealed. In addition to fixed preset views optimized for specific workplaces, at other workplaces the views are freely configurable. While one view may show the inspection plant, another may focus on a coil-specific activity, for example, at the tying machine. 3tn has also incorporated status charts for the machines, indicating fault messages or the necessity to refill a tying machine. Also video images may be integrated. This feature allows the operator to compare the visualized processes on the monitor with video images taken from the video streams recorded by physical cameras installed in the plant.



Free view of the overall plant without status information

Clear view of activities

Whenever a strip is being recoiled, the material tracking and presetting system (MTP) sends the coil data to the process automation system. The latter sends the coil handling information to the individual machines via the MTP. The information may detail how the coil will have to be tied, whether it will have to be sent directly to the coil conveyor or whether it will first have to be transferred to the inspection plant by the cross transfer car.

The inspection plant receives all the information needed for the inspection of a specific coil. The samples for the visual surface inspection and for checking the strip shape will be automatically cut according to the information received. When all inspection activities have been completed, the cross transfer car will take the coil back to the coil conveyor and feed it into the material flow. The inspection results will be sent to the process automation system and displayed on the control monitor. In addition to the automatically transmitted results, the operator can enter further quality-relevant information outside the scope of the system such as complementary inspection data or photos.

Based on the received information, the process automation system also determines which activities have to be performed while the coil is on the conveyor. Then the process automation system sends the data to the marking robot. As the last step, the coils are transferred through a tunnel and taken to the hot coil store by a second conveyor.

As part of the modernization, TKSE also implemented a high-availability cluster together with a new operating system. 3tn installed the software in virtual machines which had been provided by TKSE in a pre-installed state. The client systems interacting with the operators consist of ThinClients

which, if necessary, can be exchanged in virtually no time.

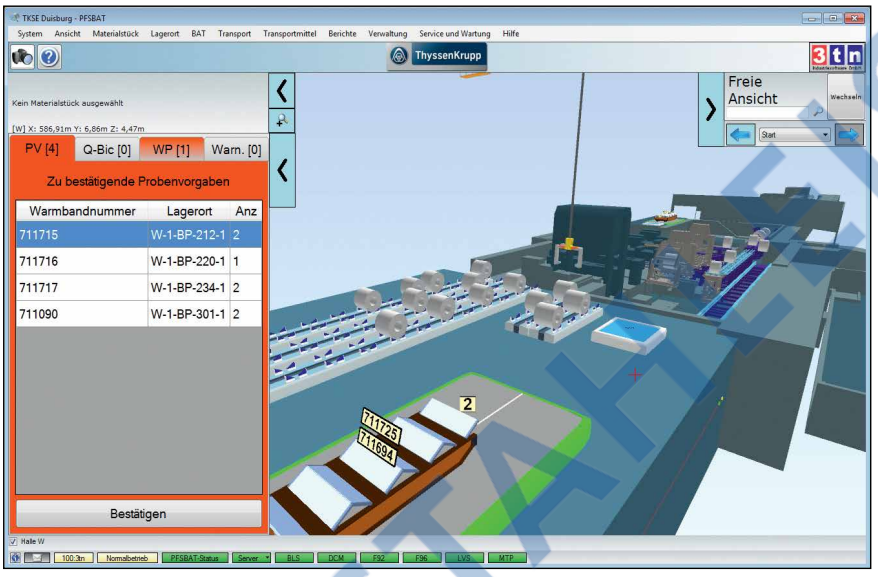
3tn also implemented a mobile solution for tablet PCs which may be used to enter inspection results or view storage and coil data.

The process automation system for the coil handling was installed and commissioned during a one-week stoppage of the hot strip mill. On the first day after the rolling mill had been restarted, the new system actively managed the marking and coil discharge operations. Nine days later, all functions of the process automation system were up and running. So far, there have not been any system failures or other unplanned downtimes.

High operator acceptance

The rule books have made the entry of coil data a largely automated process. This relieves operators from the need to handle each coil individually. In case of rules being modified, the production staff is able to do so without having the IT department involved.

From the beginning, acceptance amongst the operators has been very high. They appreciate that all coil handling operations are very realistically and clearly visualized, even those that cannot directly be seen due to the layout of the plant. Certain visualization elements of PFSBAT can also be controlled via PLT keys on the operator pulpit. This allows for simple commands, such as the switching between different views performed without a mouse or keyboard.



View of the handling area managed by the system

About TWMS/metals

The process automation system of the coil handling at the TKSE hot strip mill is a project-specific functional enhancement of the standard version of the technical warehouse management system – TWMS/metals – offered by 3tn. The standard programme manages and visualizes handling and storage activities in the metals industry from the continuous caster through to the dispatch of the finished products and optimizes the use of storage capacities across various warehouses.

TWMS/metals supports plant operators in optimizing the storage of slabs, billets, sheets or coils, while maximizing the utilization of the handling equipment, such as cranes or cross-transfer cars.

It was developed specifically for the metals industry. In one direction, the system communicates with enterprise resource planning system (ERP) and manufacturing execution system (MES) and, in the other direction, with the basic automation system and the sensor equipment. ■