RFID as ‘Big Brother’ during tracking and tracing of batches and as guardian of the steel quality

Radio Frequency Identification (RFID) in the Foundry Industry

By employing radio frequency identification, a foundry has optimised the composition of the melting material: the transport containers for pig iron and steel scrap are outfitted with transponders, which are detected by an RFID UHF reader located at the electric induction furnace. Increased process safety, consistent metering accuracy and a complete tracking and tracing of the batches are the result.

Karl Casper GmbH & Co KG headquartered in Remchingen (in the German state of Baden-Württemberg) is a manufacturer of high-quality industrial and art castings. From top-grade pig iron and steel scrap, approximately 100 employees - in a two-shift operation - produce sophisticated components for machine tools and special machinery, plastic injection moulding machines and railway vehicles. The work pieces range from single parts to low-volume batches of up to 1,000 pieces - each piece weighing up to nine ton.

“For many years, the data pertaining to the composition of the melting material was entered manually into a PC, which made precise production planning and tracking and tracing difficult,” said technical manager Malte Lüking. “An efficient solution for just that now comes in the form of RFID - radio frequency identification - which enables the automatic recognition of the transport containers, the allocation of the batches and the software modeling of their relationships.” Lüking emphasises that a goal of the company management was to also incorporate the ideas of employees in the implementation of the new RFID application. “They are, after all, working with the program day in, day out - and know what is important,” he said.

The project team, consisting of Malte Lüking, Uwe Wilhelm - manager of maintenance at Casper - and Siegfried Schlaak - managing director of the consulting firm SSSsoft specialising in foundry technology - began roughly 18 months ago with the selection of the new hardware and the design of the software. One decision criterion was the lasting operational suitability: the RFID transponders had to survive the rough handling during loading and unloading, be unaffected by interference caused by strong electromagnets mounted to the crane, and withstand high furnace temperatures without damage despite continuous use. For the identification of the charge containers, the use of the low-cost, heat-resistant SIMATIC RF680T transponders by Siemens was suggested. The transponders are designed for operating temperatures up to 220°C and feature a rugged construction with IP68 degree of protection; they are thus ideal for applications in harsh industrial environments.

HIGHLY RESISTANT TO INTERFERENCE IN METALLIC ENVIRONMENTS

The radio signals are evaluated by a Simatic RF630R reader. “We chose Siemens products, since they best matched our ideas and requirements,” stresses Lüking. Due to limited space on the furnace platform, a reader with an external Simatic RF640A UHF antenna is employed. The unit operates in the ultra-high frequency (UHF) range and is unaffected by external influences such as dust or moisture. In addition, the unit is characterised by a high interference resistance in metallic environments - as found in the steel constructions around the furnace platform. For the communication and supply of power, the reader is connected to a PLC or a fieldbus communication module.

Prior to the introduction of the identification solution, it was time-
Radio Frequency Identification

Consuming for employees of the so-called charging plant to meter the contents of the charge containers in accordance with the recipes to achieve the called for product properties. Since then, ten charge containers equipped with transponders - for the transport of the melting material to the induction furnace - have been put into rotating operation at Casper. To feed the melting furnace, the crane operator of the charging plant selects an empty charging box and fills it with pig iron, steel scrap, stacks of sheet metal, etc. as specified by the production planning. As soon as the charge is complete, the crane operator sends the data to the control and monitoring software; the container is then ready for transport to the furnace platform.  

The requirements placed on the accuracy of the melting processes are very high and may deviate only slightly from the specifications. This highlights the advantage of the new RFID installation: the RFID reader/writer mounted to the furnace platform reads the transponder data of the charging box and forwards it to the control and monitoring system. During the melting process, a spectrometric and thermal determination of the alloying elements takes place. The software calculates the difference between reference and actual values, and informs the melter whether other additives (carbon, silicon, etc.) are needed on the basis of the recipe. Thanks to the batch tracking and tracing, what has been processed is precisely documented. At the end of the month, material quantities as well as the melting loss can thus be accurately accounted for.

Set-Up of an RFID-Based Casting Pattern Management

In the electric induction furnace, temperatures roughly reach 1,600°C. It takes about an hour for the raw materials and additives to liquefy into a homogenous iron melt. While the shift supervisor prepares for tapping the crucible holding the molten iron, employees in the light-flooded casting and moulding bays are already making arrangements for the next steps. After melting down and mixing all components, the melt flows into a treatment ladle by tilting the crucible, where it is adjusted to the desired quality using additional alloying elements. Afterwards, the ladle is transported to the casting bay, where experienced casters fill the iron melt into moulding boxes.

An expansion of the identification solution to provide an RFID-based casting pattern management is planned. The modern high-bay warehouse of the foundry holds patterns made of laminated wood, synthetic resins or polystyrene foam for repeat orders, pattern changes or pattern adjustments. “We are warehousing roughly 8,000 casting patterns, of which about 4,000 are recurring shapes,” describes Lüking. In the future, every pattern plate will receive an RFID tag, on which component and job data, attached parts, storage location, materials and other information are noted. “Employees can then read out the data with a handheld scanner. The uniform and always up-to-date information greatly facilitates the identification of the patterns. Lengthy searches thus become a thing of the past.”

Casper not only makes high-quality products, but also is pursuing the goal of a clean environment - the company calls itself ‘weiße Gießerei im Grünen’ - meaning an ecological foundry preserving the environment. Among these measures is a newly installed co-generation plant that generates power and heat in an environmentally friendly manner and significantly lowers the operating costs. To further optimise the energy consumption, the company management has tackled the project of energy management; in particular the high power consumption of the electric melting furnaces which represents an enormous cost factor for foundries. However, other areas of the facility have also been considered, for example, the production hall cooling and ventilation, moulding plants, shakers, sandblasters and sand preparation – in all these areas considerable energy savings can be realised.

In a first step, the technicians have started...
to install Sentron PAC4200 power meters by Siemens in the control cabinets of the various production areas, and consolidated the measured data in CSV files. The next step will involve the Sentron units being integrated into the automation and energy management software ‘powermanager’, which conveniently visualises all measured data. The solution will then clearly depict the current status of the plants and the power grid quality; and by more efficiently utilising the systems, the energy use and costs are lowered. The real-time display of connected consumers enables a weak point analysis and thus a quick power reduction at individual production plants.

FAULT ANALYSIS: CONVENIENTLY WITH NOTEBOOK AND SMARTPHONE

To comprehensively automate the production operation, the foundry management decided to install the production monitoring system DCAS (Data by Concentration and Analysis System) by SSSoft. It monitors, amongst other things, the pass-through rotary mixers, the sand regeneration, the electric furnace and the air compressors. The signal parameters are tapped at the Simatic controllers by means of Profinet and forwarded to the software. A visualisation computer prepares the data and provides it in real-time for the monitoring and control of the plants. If, for example, a fault occurs, the employee can immediately locate the problem and initiate the proper steps. A location-independent, secured system access via the Internet using a notebook, iPad or smartphone is also possible, e.g. to remotely control processes and avoid interruptions through early intervention.

The diverse automation tasks at Casper have been carried out by Simatic controllers for years. The Simatic S5 controllers used so far are now being replaced by new Simatic S7-300 modular controllers. In this context, the process visualisation is also advanced to allow processes to be controlled and monitored from different operator control and monitoring stations. As distributed, I/O modules, signal and function modules as well as Simatic ET200S communication processors are employed for the user-specific automation tasks of the S7-300 controllers, which greatly simplifies the wiring and commissioning.

Casper is a compelling example of a successful implementation of an integrated automation philosophy. Thanks to its complete product portfolio of totally integrated automation (TIA), with which Siemens denotes the transparency and interoperability of its systems, the individual automation components are always matched to each other. From medium-voltage transformer to drive and control technology to sensors and visualisation, the foundry solely utilises standard components from the same vendor.

The integrated TIA Portal engineering environment for PLC, HMI and network provided great flexibility during the system development, which considerably reduced the time required for the integration. According to the project team, the development and commissioning times were greatly shortened and the requirements optimally met with the TIA Portal software, unlike with other solution approaches.

SUMMARY

“The production of high-quality casting alloys requires a lot of experience, the mastery of all production processes and an optimal composition of the source materials. RFID is the right solution here. In the six months since its commissioning, it has truly proven itself and been running trouble-free,” enthuses Lüking. Thanks to the transponders, the loading of the charging boxes with pig iron and steel scrap can be accomplished in a precise manner, which helps in putting together the melt with minimised use of resources. Compared to the manual entry of data, sometimes during frantic operations, the paperless storing of the raw materials data ensures that nothing is ever lost. “Together with the analysis values, the data forms a comprehensive batch profile, which provides information about the respective metallic composition. A complete history is generated that makes a gapless tracking and tracing of the process progression and certified quality management easy,” concludes Malte Lüking.