In steelmaking, advanced digitalized processes enable vastly more efficient production methods. Condition monitoring, sophisticated automation technologies, and ecological solutions contribute to greener and more future-proof plant operation.
Melt Expert is a state-of-the-art electrode-control system that Primetals Technologies has designed to ensure optimal operation of electric arc furnaces. It retrieves production data from a variety of furnace-related components and continually analyzes this information in order to obtain a complete picture of the state and history of the melting process. Based on its findings, Melt Expert regulates the activity of the electric arc furnace, and changes set points and controller gains in reaction to the actual process conditions. Operators can inspect the overall melting process on a selection of interfaces—even current-generation smartphones are an option.

Melt Expert’s auto-adaptive algorithms make a significant contribution toward a reduction in furnace energy requirements. It increases melting efficiency and productivity with its automatic melting profiles and dynamic adjustment of production-process parameters. Another key benefit is the increase in both furnace reliability and operational safety. Of course, Melt Expert’s core objective is to safeguard process quality at the steelmaking stage so that any unexpected fluctuations that would influence the production facility’s end products can be ruled out. Since Melt Expert yields substantial energy savings, the system pays for itself within a nine-month time frame.

**MAIN BENEFITS**

- State-of-the-art furnace control
- Increased furnace reliability
- Reduced energy consumption
- Highly developed safety functions
- Reduced need for maintenance
- Integrated system health checks
- Universally accessible interface
- KPI and benchmark reporting

Melt Expert features a universally accessible furnace control interface.
Primetals Technologies has continually worked on perfecting the automated scrap material flow for steel plants that are based on electric arc furnaces (EAFs). Depending on the customer’s requirements and the targeted scope of automation, various configurations are possible. In principle, the automated scrap material flow comprises the automated scrap bucket loading at the scrap yard and the automated charging of scrap into the EAF.

The basis of the fully automated scrap yard is Primetals Technologies’ EAF Chargeopt solution. This is a scrap-charging system that can operate largely without human interaction, and comprises patented scrap-bucket detection as well as a charging-crane positioning system, which enables the automation of all processes related to the feeding of scrap into the EAF. The system’s precise and perfectly repeatable movement patterns lead to faster EAF charging and reduced maintenance needs.

The EAF Chargeopt technology also vastly increases the safety of the staff and the involved equipment. The execution of all automated routines is monitored by an operator in the control room. EAF Chargeopt can easily be added to existing plants and typically leads to a significant reduction in plant downtime. The mechanism for the unloading of scrap into the EAF supports both a main crane (to lift up the ladle) and an auxiliary crane (to pull the ladle’s opening latch at the right time). Power-off times are shortened, and a drop in human-labor requirements and equipment costs can be expected as well. The amortization time for an EAF Chargeopt installation is usually between 9 and 15 months short.

In addition to the EAF Chargeopt, an advanced scrap-yard automation concept has been devised in close cooperation with an Italian partner. Based on a specifiable loading recipe for the ideal scrap composition, the system is capable of loading the scrap buckets, which are typically located on scrap cars, exactly as desired. Once filled, the scrap cars are transported to the melt shop without the need for any human intervention whatsoever, to then be picked up by the charging crane. The rather impressive accuracy for both EAF Chargeopt and scrap-yard automation is at 1 cm horizontally and 0.5 cm vertically. Remarkably, even complex scrap-yard layouts can be accommodated, and multiple yards can be incorporated into one automation setup.

A recent addition to the proven capabilities of the scrap-yard design of Primetals Technologies is the automation of scrap-yard cranes. The development of this aspect of the fully automated scrap yard has reached a progressed stage, and the first implementations in steel plants are expected to start soon, as customers have already shown keen interest in the technology.
At the steelmaking stage, more and more tasks that used to be done by human operators can today be executed automatically. For a while now, most converter-based measurements have been taken without the involvement of manual labor, yet some of them have proven to be harder to automate. Primetals Technologies has developed solutions to digitalize those trickier yet essential processes. One example of a more challenging task is taking samples at the tilted converter prior to tapping. Not only is this job potentially dangerous to staff, it also needs to be executed in a well-controlled and precisely reproducible manner. The horizontal measuring manipulator of Primetals Technologies takes care of exactly that. It can be installed at either the charging or the tapping side of the converter, and respectively takes measurements before tapping.

The manipulator introduces the advantage of precisely determining factors such as the position and the depth at which measurements are taken and the speed of the evaluation process. This allows for extensive customization of the sample-taking operation. In some steel plants, dedicated robots are the method of choice for the handling of probes. At voestalpine’s Linz-based plant, for example, Primetals Technologies was commissioned to install robotic solutions on three 180-ton converters, with the goal of automating probe handling at the sublances. The resulting system has now been in successful operation for almost two years and has proven to be capable of maintaining the highest standards in terms of process reproducibility and reliability.

In general, fully automated converter operation covers all process steps from the initial charging of the converter to the blowing control to the final tapping. Depending on a production facility’s preexisting equipment, customized modernization packages can propel converter operation into a fully automatic operation mode, improve process consistency and safety, and vastly increase both transparency and efficiency.
LIQUIROB: A TIRELESS WORKER
FOR HIGHER EFFICIENCY, QUALITY, AND SAFETY

The LiquiRob robot system was specifically developed by Primetals Technologies for improving workplace safety and measurement quality under the harsh conditions encountered in the ironmaking and steelmaking industries. It has numerous applications in a wide variety of work activities across the entire production process.

FOR THE HOTTEST APPLICATIONS
LiquiRob is a highly flexible robot system that meets the challenges of a number of tasks that require working with—or close to—liquid metal. The system is installed to support plant equipment such as electric furnaces, converters, secondary metallurgy, and continuous casting machines. Fully automatic measurements and procedures increase process reliability and workplace safety as well as flexibility, productivity and—by extension—product quality. Every work activity performed automatically by the robot can be monitored from the control room, where operating personnel are kept at a safe distance.

IN OPERATION SINCE 2007
LiquiRob is the world’s first successful industrial-scale system of its kind on the market. It premiered in 2007 in the Gwangyang steelmaking plant of POSCO in South Korea. The robot system in that facility is responsible for sample taking, measuring steel temperature in the tundish, and feeding casting powder on the casting platform of a two-strand continuous slab caster.

A HIGHLY ADAPTABLE SYSTEM
A standard industrial robot with six axes is used for all activities. An optional, additional axis extends the working area. The robot is equipped with different tools and components that allow it to perform a variety of tasks. This includes equipment such as tool changers, fire-proof protective enclosures, and position detection systems. Using a combination of these components, LiquiRob can be adapted to nearly all plant types and automation systems with a high degree of reliability and flexibility.

MAIN BENEFITS
• Increased workplace safety
• Better reproducibility of measurements
• Higher availability
• Lower maintenance costs
The precise acquisition of liquid metal parameters such as temperature, oxygen activity, and carbon content, is one of the most important requirements for delivering high-quality results at minimal production cost. However, measurement lances and their wiring are subject to high thermal and mechanical stress, thus requiring frequent testing to prevent unknown deviations. Lance Guard from Primetals Technologies significantly speeds up and fully automates this process at minimal hardware cost. A lance adapter is attached to the lance contact block and Lance Guard starts feeding data to the system, emulating a typical one-way measurement probe. With closed-loop feedback from the automation system, all values are verified and checked for violations of the specified limits. The result is a seamless quality record of all components in the measurement chain. Lance Guard can be used with all lance systems; both with manual lance applications and fully automatic systems such as LiquiRob, which also enables automatic cleaning of the contact block.

A RANGE OF APPLICATIONS

Semi-automatic manipulators are widely used at converters, at electric arc furnaces, and in secondary metallurgy. However, each of them performs only one specific task, and each requires special maintenance. A single LiquiRob can assume the responsibilities of several manipulators. At the converter, for example, the system provides a highly flexible solution for probe handling in combination with a sublance system, including cartridge exchange. With limited space availability in a harsh operational environment, the probes are rapidly taken from the storage rack and placed exactly onto the sublance, which then inserts it into a downspout for taking samples and performing measurements. Not only does this improve workplace safety, but it also increases the reproducibility of measurement results. A newly developed robot tool expands the range of applications to enable measuring and sampling at converters without sublance systems.

At the electric arc furnace, a newly developed LiquiRob feature makes the hazardous task of inspecting the furnace via camera system through the slag door fully automatic. LiquiRob can also open the tap hole, using a lancing tool with an oxygen lance. By means of a tool changer, the same robot can be used for deburring the tap hole.

In continuous casting, the dangers to personnel can be even more acute. LiquiRob can substitute humans and take measurements and samples, charge casting powder, or do ladle preparation, stripping, and lancing. The latest addition to LiquiRob’s faculties in continuous casting is fully automatic shroud manipulation.

LIQUIROB IN ACTION

Scan the QR code or type in the link below to catch a glimpse of LiquiRob in action.

bit.ly/liquirob
SMART-SENSOR PACKAGES

Primetals Technologies has developed a variety of sensor solutions for steelmaking. These sensors generate the data required for condition monitoring, and play an important role in determining necessary maintenance efforts. They contribute to the proactive prevention of standstill times, and improve overall production-process reliability. In this overview, we have selected three sensor packages to illustrate the wider commitment of Primetals Technologies to comprehensively digitalize the steelmaking production stage.

BAG-BREAK DETECTION SYSTEM

The Bag-Break Detection System continuously monitors the status of filter elements in a pulse jet filter. By measuring the dust at the filter exit, damaged filter elements can be detected and localized.

The system also allows for integration with the condition-monitoring system of Primetals Technologies, so that a precise analysis of the state of the filter bags attached to a valve can be conducted.

The system therefore plays a crucial role in terms of ongoing maintenance and improving cleaning efficiency, as it allows damaged filters to be replaced as necessary. Consequently, the time and money spent on identifying damaged filter bags can be significantly reduced.

Basic overview of the working principle of Primetals Technologies’ Bag-Break Detection System.
SPARK-DETECTION SYSTEM

Sparks or flames in exhaust gas ducts can cause considerable damage to upstream machinery. For instance, sparks can cause significant damage in pulse-jet bag-filter systems if they are not identified in time, or at all. Damage to the hoses can cause a direct increase in exhaust gas emissions, which means taking the relevant chamber out of commission in the worst-case scenario. This could result in a production stop to allow for the damaged filter bags to be repaired. The Spark-Detection System of Primetals Technologies not only handles spark detection fully automatically; it is also a spark-extinguisher system for all types of exhaust pipes. Because the system takes measurements within the infrared spectrum, reliable detection can be guaranteed even in extreme darkness or where the situation is complicated by the accumulation of dust or very-high-volume flow rates. Integration with a condition monitoring system (such as Primetals Technologies’ BOX Concept, see pg. 34) is also possible with this product, thanks to spark counters or spark-extinguisher status signals.

SLOP-OVER PREVENTION SYSTEM

The Slop-Over Prevention System was created for ladle-transfer cars. Given that steel at 1,600°C is as fluid as water, any overly jerky movements will cause slop over, which greatly increases the risk of significant damage and danger. To minimize the risk to staff and equipment, Primetals Technologies has developed a slop-over prevention system for ladle-transfer cars that uses a model-based ruleset for acceleration and deceleration curves, in order to effectively reduce the risk of slop over.

DEVELOPING SENSORS WITH APPLIED CREATIVITY

Andreas Rohrhofer is part of the development team at Primetals Technologies for sensor-based products in steelmaking.

How has the recent push for increased digitalization promoted the development of new sensor solutions?

Andreas Rohrhofer: Digitalization has forced us to come up with new sensor strategies and concepts. Virtual sensors, for instance, allow new measurements and calculations to be made by linking existing sensors without having to install new hardware. This new sensor strategy minimizes any disruption to the equipment and keeps design costs low.

What are the challenges in the creation of new sensor solutions for steelmaking?

Rohrhofer: The best sensor is one that we will no longer need in the future, because it will have been superseded by mathematical models and software. Therefore, we have to work hard to properly recognize physical correlations in the process and to derive a mathematical relationship from that.

Is there any one recent sensor-related project that you find particularly intriguing?

Rohrhofer: The measurement of temperature and oxygen content using submersible probes is crucially important in steelmaking. Lance Guard ensures that the associated sensors are monitored and deliver accurate readings for production and process models.
The ECO Solutions of Primetals Technologies have been developed to improve the CO2 footprint of today’s steel plants, to save resources, and to achieve environmental compliance even under the most demanding conditions. It is evident that future-oriented steel-production facilities have to rely heavily on technologies that optimize both their ecological compatibility and their overall efficiency. As Primetals Technologies has a large variety of ECO Solutions in its portfolio, only a selection of them can be presented here to serve as examples.

Dynamic Suction Control is an important innovation that significantly reduces the energy consumption of dedusting systems. At its core, it is a sophisticated control algorithm that is based on mathematical models developed over time to reflect the complex processes taking place during dedusting. Dynamic Suction Control calculates the ideal pressure set-point and damper position, which can reduce the energy required for included-draft-fan operation by as much as 20%. The solution is easily adjustable and can be added to all types of dedusting systems.

GreenButton is as conceptually simple as it is effective. It is essentially a power scheduler for dedusting systems that systematically optimizes energy consumption during planned or unplanned plant-standstill periods. Plant engineers can predefined different scenarios in which GreenButton will be active, and can select the appropriate setup momentarily and with ease when indicated. GreenButton can capture even the most complex situations that occur in today’s as well as tomorrow’s steel plants.

Bag-Filter Control is another huge step forward for dedusting systems. It dynamically sets the cleaning pulse in order to reduce the consumption of pressurized air. Any damaged cleaning valves or filter bags are automatically detected, freeing workers from manual inspection and allowing them to focus on other tasks. The power electronics of the Bag-Filter Control system are maintenance-free. The operator has the option of overriding the automatic selection of advanced cleaning modes. Overall, Bag-Filter Control makes dedusting more cost-effective by reducing the consumption of production-related resources and lowering the need for human labor.
Dr. Thomas Steinparzer is Head of Technology and Innovation for ECO Solutions at Primetals Technologies.

How can ECO Solutions support full-scale digitalization in tomorrow’s steel plants?

Dr. Thomas Steinparzer: The waste-gas system is an integral part of any modern steel plant and has recently become mandatory. Proper waste-gas treatment is an important step toward optimized and energy-efficient production processes. Intelligent control systems can make a significant contribution when it comes to lowering a facility’s maintenance requirements and energy consumption, so that overall compliance with even the most stringent environmental standards can be achieved and kept over time.

Which markets are currently the most relevant, and which carry the most potential?

Steinparzer: Under the current market conditions, our business has largely shifted from greenfield projects to the modernization of existing steel plants and the implementation of specific upgrade packages to conform to the latest environmental guidelines. This has reintroduced Europe as an interesting market. Asia and Russia are also highly relevant, and I see great potential for our ecological innovations in Japan and Southeast Asia. Additionally, steel plants in China are putting much attention on lowering their emissions and increasing energy efficiency.

It seems that China is transforming more rapidly than many would have imagined. How would you assess the country’s recent ecological progress?

Steinparzer: China is currently undergoing a huge transformation due to the country’s new, more stringent environmental regulations. Compared to other regions, China’s emission standards are quite rigorous today. For the environment, this certainly is a positive development.

With all the controversy around the Paris climate agreement, do you foresee sufficient progress within our industry in the next four years?

Steinparzer: For many of our customers, CO₂ emissions continue to be a key topic. To use a metaphor, the train for minimizing the carbon footprint in steel production is unstoppable. It is hard to tell what speed this train will travel at due to a variety of political factors, but I am convinced that we will be seeing numerous steel plants with a vastly lower CO₂ footprint over the long term. Our ECO Solutions will make a significant contribution to this trend—particularly as we have many brilliant innovations in our pipeline for the years to come.