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**WHEN THE GOING GETS TOUGH,  
THE TOUGH GET GOING**  
THE LIQUIROB ROBOT SYSTEM FOR  
THE METALLURGICAL INDUSTRY

# LIQUIROB – IS THE FIRST TIME-TESTED ROBOT SYSTEM FOR THE METALLURGICAL INDUSTRY

## YOUR CHALLENGE

The metallurgical industry has its own rules. The extreme conditions found in metallurgical plants can hardly be found in any other industry. In such production facilities you will find large amounts of heat, dust, smoke gases and noise. This makes it necessary to apply the most stringent requirements with respect to job safety. At the same time, process quality and system availability must be maintained at very high levels.

## OUR SOLUTION

The LiquiRob robot system was specially developed by Primetals for the improvement of job safety and measurement quality under the harsh conditions found in the ironmaking and steelmaking industry. It is excellently suited to the wide variety of work activities necessary in the production process.

## LIQUIROB FOR THE HOTTEST APPLICATIONS

LiquiRob is a highly flexible robot system that meets the challenges of a number of tasks that require working with liquid metal. The system is ideally installed at applications such as electric furnaces, converters, in secondary metallurgy and continuous casting machines. Fully automatic measurements and procedures increase process reliability and job safety as well as flexibility, productivity and product quality. Every work activity can be monitored in the control room, where operating personnel are kept at a safe distance from hazards.

## IN OPERATION SINCE 2007

LiquiRob premiered in 2007 in the Gwangyang steelmaking plant of POSCO in South Korea. The robot system in that facility is responsible for sampling, measuring the steel temperature in the tundish and casting powder feeding on the casting platform of a two-strand continuous slab caster.

## TESTED WORLDWIDE ON AN INDUSTRIAL SCALE

LiquiRob is the world's first successful industrial-scale system of its kind on the market. This makes Primetals a world-class leader in the field of complete robot systems that can be successfully integrated into the process landscape of metallurgical facilities.

## YOUR LIFECYCLE PARTNER

As your lifecycle partner in the iron and steelmaking industry, we support you by providing solutions that are precisely tailored to your individual needs. We also remain at your disposal in the areas of customer service, spare parts and expansion of the functionality of your robot system.

## UTILIZE THE EXPERTISE OF PRIMETALS

- We know the production plants and processes of our customers and understand optimization potentials in metallurgical facilities.
- We understand the required capabilities of robot systems in metallurgical facilities and know where and for which tasks they can be used.
- We have the experience and expertise required to integrate our robot systems based on standard industry robots into your plant design and automation systems.
- We offer a full range of safety systems
- Our own experience in metallurgical plants is continually integrated into the further development of our robot-supported automations systems



# STEADILY AT YOUR SERVICE IN THE METALLURGICAL PLANT

Many plant systems in the metallurgical industry have been in operation now for more than fifty years. As a plant operator, you face the challenge of continually optimizing your systems in order to keep up with the stiff competition.

## MAIN BENEFITS OF LIQUIROB

- High flexibility and freedom of movement through use of a standard industrial robot
- Substantially increased job safety
- Better reproducibility of the measurements and higher process availability
- More available and easy-to-maintain equipment as compared to manipulators with single functions
- Time-tested and adaptable
- Reduction of maintenance costs primarily

## HIGH PRECISION IN THE METALLURGICAL FACILITY

LiquiRob is a robot system that autonomously completes tasks at a high level of precision and reproducibility in a wide variety of different metallurgical areas. Employees are freed from the burden of having to perform difficult and dangerous work activities.

## THE SYSTEM

A standard industrial robot with six axes is implemented for all activities. An optional axis extends the working area. The robot is equipped with different tools and components that allow the performance of work activities in the metallurgical industry. 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 an extremely high degree of reliability and flexibility.

## FLEXIBLE HANDLING IN CONVERTERS

Rapid and flexible handling of the probe is necessary when taking samples in converters. With limited space availability and in a harsh operational environment the probes are taken from the storage rack, placed exactly onto the lance, and are then inserted into a downspout for analyses. Such challenges must be met primarily by existing units or new implementations in existing basic oxygen furnaces (BOFs). LiquiRob successfully meets this challenge. The highly flexible handling solution for the substance, including cartridge exchange, ensures smooth BOF steel production.



## ROBOT-AIDED MEASUREMENT AND SAMPLING IN ELECTRIC ARC FURNACES

LiquiRob permits fully automatic temperature measurement and sample-taking in electric arc furnaces (EAF), including cartridge exchange. This makes manual or manipulator measurements obsolete. LiquiRob is a reliable and flexible system that provides you with continuous, uninterrupted, error-free, and controlled steel production in the electric arc furnace.

## AUTOMATICALLY PERFORMED CASTING TASKS

As one of the world's leading providers of continuous casting plants, we have a deep understanding of the industrial requirements. Particularly the conditions on casting platforms pose dangerous conditions to the operating personnel and can lead to reduced plant availability. Tundishes and molds can spill or overflow, and the danger of splattering is also ever present. LiquiRob possesses the capacity to automatically conduct all manual tasks during the casting process.

## ROBOT SYSTEM TASKS IN STEELMAKING

- Temperature measurement
- Sampletaking
- Carbon measurement
- Hydris measurement

## ROBOT SYSTEM TASKS IN CONTINUOUS CASTING

- Temperature measurement
- Casting powder charging
- Ladle lancing
- Sampletaking
- Ladle preparation and stripping
- Carbon measurement
- Hydris measurement



# INCREASING PRODUCTIVITY AND PLANT AVAILABILITY

The very harsh conditions and numerous risks taken by operating personnel have a strong influence on the availability of production systems. Automation has numerous advantages in this respect. For one thing, work steps are carried out with meticulous precision, and each process is repeatable. Also, robots can perform a wide variety of different tasks. This means that operating personnel must no longer work directly next to hazards.

## ADVANTAGES OF SIMETAL LIQUIROB FOR HIGH PLANT AVAILABILITY

- Reproducible processes
- 24/7 availability
- Improved yield

### LIQUIROB FOR CONTINUOUS CASTING MACHINES

The Austrian steel producer voestalpine Stahl GmbH is the world's first to use several robot systems on a single casting platform. Whether feeding casting powder, ladle lancing or hot taking measurements, LiquiRob contributes significantly to plant availability. LiquiRob works without making any errors, is available at the touch of a button and can be used around the clock. When more than one robot is used, it is possible to automate nearly the entire casting platform and thus reduce personnel costs sustainably.



### LIQUIROB FOR STEELMAKING FACILITIES

Automation pays for itself, too, in converters, electric arc furnaces and in secondary metallurgy. Semi-automatic manipulators have been used to date to perform work activities. Each of these manipulators can be used only for the specified task, and each requires special maintenance steps. A single LiquiRob assumes the responsibilities of several manipulators. This substantially reduces maintenance costs.

### PERFECTLY INTEGRATED INTO THE PRODUCTION LINE

Control of the robot system is integratable into the entire plant and function as a plant part. The sophisticated LiquiRob system coupled with our expertise in the field of processes and plant systems guarantees full integration into the production line.

### LIQUIROB IN CASTING PLATFORM APPLICATION

A LiquiRob robot system is installed on the casting platform at Usinas Siderurgicas de Minas Gerais S.A. (Usiminas), a flat steel producer in Brazil. This system is responsible for sampling and temperature measurements in the tundish. This is an important step for considerably improved operator safety because the operating personnel must no longer come into direct contact with the danger. High-quality slabs of different steel grades are cast on the single-strand continuous slab caster. Equipped with the LiquiRob and additional technology packages, the steelmaking plant in Usiminas is the first of its kind in South America and is a pioneer in implementing the most modern technologies.



# HIGH LEVEL OF JOB SAFETY THROUGHOUT THE ENTIRE PROCESS

As the steelmaking plant manager, you bear the responsibility for the job safety of your employees and for strict compliance with legal regulations. The health and safety of each person who works near steel and slag at very high temperatures are two of our main concerns. These concerns are satisfied with the LiquiRob robot system. No manual activities are required in these hazardous areas as soon as the system is installed and running. As a renowned plant builder, we know the safety-relevant areas of the metallurgical plant and are in a position to provide comprehensive safety strategies.

## THE ADVANTAGES OF LIQUIROB FOR THE HIGHEST JOB SAFETY IN PROCESSES

- Meeting highest safety standards
- Monitoring from the control stand
- Avoidance of mechanical damage through active movement monitoring
- More precision of recorded measurement data
- Consistent observation of steel temperature and composition

## WORLD'S FIRST ELECTRIC ARC FURNACE APPLICATION

For the first time, LiquiRob has been used in an electric arc furnace by the Riva Group Neuves-Maisons, France. The robot system assumes responsibility at this steel producer for sampling, temperature measurements and oxygen evaluation in the liquid steel. These strenuous and dangerous activities have been performed until now by operating personnel with the help of a manipulator inside the furnace enclosure. The robot system is operated and monitored from a central control station. Operating personnel no longer have to work in dangerous zones. This significantly improves the level of work safety. Primetals was responsible for the integration of the LiquiRob system into the existing furnace enclosure, integrating the existing automation of the electric arc furnace, startup and training of the operating personnel.



## LIQUIROB FOR CONVERTERS

Let's take a look at the basic oxygen furnace. The upper range of steel converter is extremely dust-laden, exhibits high CO values and additionally endangers employees because of splashing slag, flames and intense heat. In this area, gases are suctioned off and measurements taken. A slide shutter is opened above the converter and the measurement taken with a lance during regular operation. Sample material applied to the lance must be removed and sent to the lab for evaluation. The robot system makes these dangerous manual activities in this area of the plant obsolete.

## SAFETY IN CONTINUOUS CASTING PLANTS

Extremely stringent safety requirements also apply to continuous casting plants. It becomes very clear when you look more closely at the processes. The ladles located at the ladle turret must be prepared prior to teeming. This means that employees have to be located underneath or next to the ladle. This presents a very high level of danger. So-called skull left over from previous heats is built up at the top edge of the ladle. This skull is heavy and hot. There is always a danger of skull falling and hurting employees. Seldom, but much more dangerous, is the situation when a ladle break out occurs and liquid steel escapes. Persons on the casting platform are acutely endangered if this happens. This can lead to serious injury or even death. Another scenario shows how hazardous it is to work at a continuous casting line. The discharge can solidify at the mouth of the ladle and must then be burned off by an employee with an oxygen lance. For operator this means working dangerously near an area where steel can splatter during ladle lancing.

## PROTECTION FOR PERSONNEL

When the LiquiRob system is used instead of employing personnel in these hazardous areas, there is little danger to anyone. Robots would only incur material damage.



# MAKES PROCESSES REPEATABLE AND IMPROVES QUALITY

Precision measurements of temperature, oxygen and hydrogen as well as precision sampling during regular operation have a direct influence on the quality of the produced steel. Productivity is also directly impaired by the duration of cycle times and the occurrence of measuring errors. These activities, when automated, can be conducted precisely and without any error. LiquiRob decisively increases the degree of reproducibility in the production processes.

## ADVANTAGES OF LIQUIROB FOR PROCESS QUALITY

- Improved measurement processes and product quality through reproducibility
- Continuous monitoring of the process
- Active adaptation of the submerge depth of the probe into the steel bath
- Repeatable results through exact positioning of the measuring lance or sampling level

## HIGHEST QUALITY STANDARD FOR BRAZILIAN WORKS

Using LiquiRob for the submerge improves safety and quality. This is shown by the example of ThyssenKrupp CSA in Brazil, where respective functions were installed at two LD converters. This includes the measurement and compensation for contact rod deformation, mounting of T, TSO and TSC probes and the discontinuation of non-functional probes.



## OPTIMIZED PROCESS CONTROL

The robot-aided measurements and taking of samples makes processes repeatable and ensures the quality of the products, as is the case with the application of LiquiRob in an electric arc furnace. Operation of the production facilities is controlled through adaptive process models that are continually adapted to the model. This makes it necessary to take reliable measurements in order to achieve optimized process controls. Measurements performed by robots, in contrast to those made by operating personnel, are always of the same quality because robots always measure at the prescribed position. Deviations in manual measurements make it necessary to conduct further measurements, and this proves to be costly.



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