



**CONTINUOUS CASTING
PROCESS AUTOMATION**
OPTIMIZE YOUR PRODUCTION WITH
OUR AUTOMATION EXPERIENCE

THE NEXT LEVEL IN INTELLIGENT CASTER AUTOMATION

IMPROVE YOUR CASTING PROCESS FOR OPTIMUM PERFORMANCE

The CC Optimization is the next level in intelligent caster automation. Through the optimal interaction of sophisticated models and experts, the system can provide plant operators with extended assistance, which will minimize the risk of human errors. CC Optimization is the next decisive step toward fully automated casting.

OUR SOLUTIONS

Primetals Technologies' tried-and-tested automation products provide sophisticated opportunities for optimizing and monitoring the casting process. Their pioneering component-based architecture offers a high degree of flexibility.

Based on a multi-layer software design, the database is used to obtain system and model parameters and to access historical or quality-related data. Human machine interface applications are also separated from the database via an object layer.

Primetals Technologies has developed and perfected a stable process optimization system based on proven packages.

Safety is our priority, and we are well on our way toward fully automated production that requires only quality and safety-related operator interaction on the HMI.

Flexible process models allow off-line tuning and simulation prior to release for production. As a result, no software modifications are needed to adapt model behavior.

Primetals Technologies rounds out its service spectrum by providing global metallurgical and automation assistance by local Primetals Technologies representatives and via remote links.



pure.hmi - multi-use
on many types of
devices





ADVANTAGES

- **Easy integration**
A comprehensive range of metallurgical models and packages that can be easily integrated into any existing or new slab, bloom, or billet caster
 - **Short project completion**
Connect & Cast® products with full functionality right from the first heat ensure short project completion times
 - **Short downtimes**
Minimum plant downtime thanks to maximum utilization of pre-tested, pre-configured, and proven components
 - **Maintenance and assistance**
Immediate metallurgical, maintenance, and automation assistance via secure data connections
 - **Dedicated HMI packages**
Operation and maintenance support with dedicated HMI packages
 - **Service and support**
Service and support for future system extensions after start-up period
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INTRODUCING CC OPTIMIZATION

ASSEMBLE YOUR CASTER OPTIMIZATION WITH PRIMETALS TECHNOLOGIES PRODUCTS



CC Optimization overview screens

MAIN FUNCTIONALITIES OF CC OPTIMIZATION

The basic functionality of CC Optimization is production plan handling and heat and slab tracking from the first announcement of a heat until the last slab has left the caster run-out area. Production events (for example, heat changes and turret and tundish movements) and quality-related information are tracked by the system.

A close connection to the basic automation system (CC Control or existing systems) ensures proper signal processing and reactions by the caster models and experts. Data received from production planning and upstream units in the steel plant are processed and used for tracking, heat pacing, and quality assessment purposes.

The model output is automatically forwarded to the basic automation system in order to optimize the production process.

SYSTEM EXTENSIONS

Thanks to the open system architecture, other Primetals Technologies products can be integrated into the caster process automation software without major implementation work.

HUMAN-MACHINE INTERFACE (HMI)

The HMI guides operators through the production process. Casting operator interaction is limited to quality- and safety-related activities.

- An overview of important information is presented on the main display – details can be easily accessed via an extensive set of dedicated screens
- Operator screens are displayed in the customer's language and units
- The system administrator is entitled to grant access rights for applications or single screens
- Primetals Technologies' process explorer comprises a configurable set of applications
- The user can select predefined texts instead of inputting them
- The caster production overview offers a Web-based presentation of current data



Cutting overview screen of a two-strand slab caster

MAINTENANCE AND SIMULATION SYSTEM

Primetals Technologies provides an all-in-one setup, testing, and maintenance tool as an integral part of the package.

- Software deployment, configuration, start, stop, restart, and the ongoing supervision and troubleshooting of caster optimization processes
- Online checks of basic automation data and an overwrite function for emergencies
- The “Link Analyzer” facilitates the long-term monitoring of basic automation data consistency during cold testing or parallel runs with legacy systems.

SIMULATION AND TESTING PHILOSOPHY

The “Simulator” provides the functions necessary for testing and training operators in an off-line environment in order to achieve smooth system start-ups.

Simulations include:

- Communication with other automation systems
- Replay and testing of various casting scenarios using predefined script files
- Predefined long-term stress tests in order to document the effects of software modifications

YIELD EXPERT

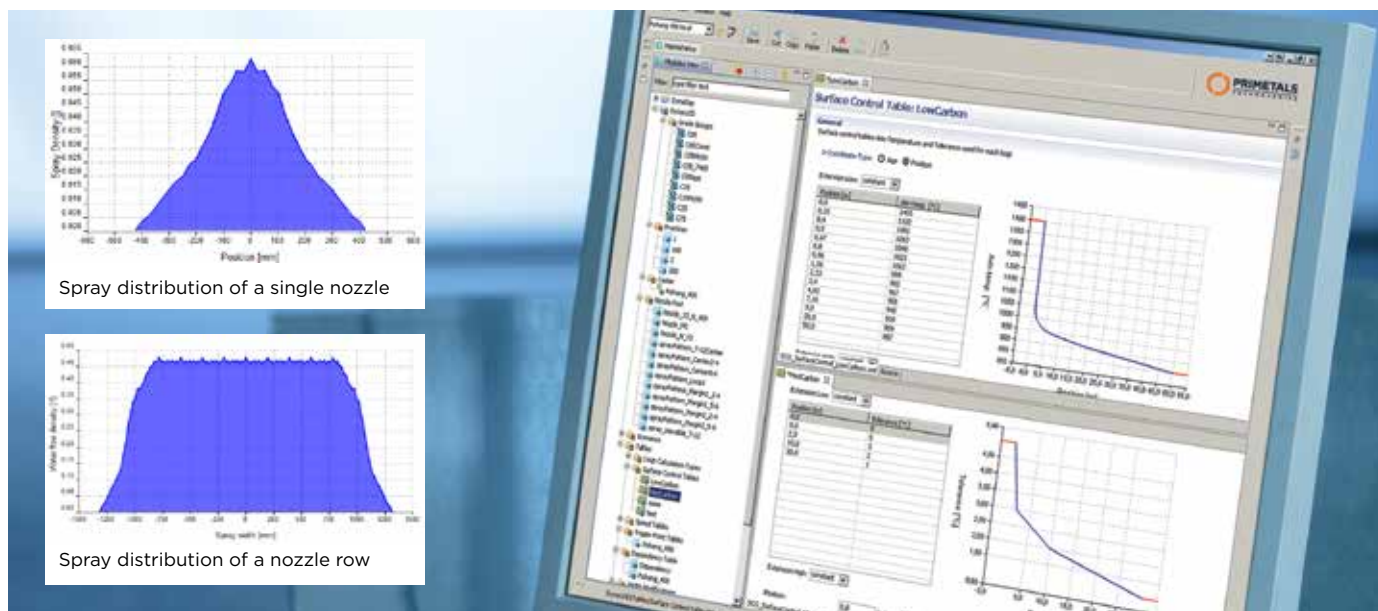
The aim of the Yield Expert is to minimize scrap and to optimize the yield. It considers scrap portions, quality defects, weight restrictions, sample cuts, and width changes while producing the maximum number of scheduled products.

- Optimization of product length or product weight in the case of scrap sections or quality-related defects
- Scheduling of mold width adjustments
- Scrap section allocation algorithms
- Optimization steps can be switched on and off online
- Replay of cut-to-length optimization steps, even in actual production situations

ONLINE SUPPORT

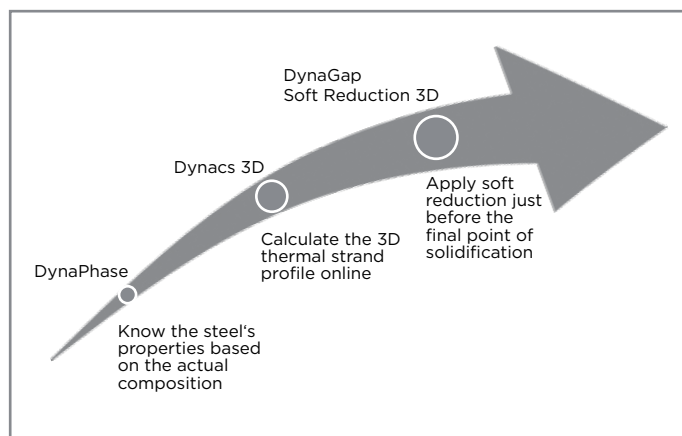
Primetals Technologies provides support and services to customers via secure online connections all over the world, and assists local Primetals Technologies representatives and customer maintenance personnel to provide first-level support. Service contracts guarantee assistance in the rare case of system problems that cannot be handled locally.

DYNAPHASE, DYNACS 3D, AND DYNAGAP SOFT REDUCTION ADVANCED MODELS SUITE



Dynacs 3D maintenance system

The advanced DynaPhase, Dynacs 3D, and DynaGap Soft Reduction model suite takes precision and control potentials to the next dimension with completely new concepts for secondary cooling and soft reduction.



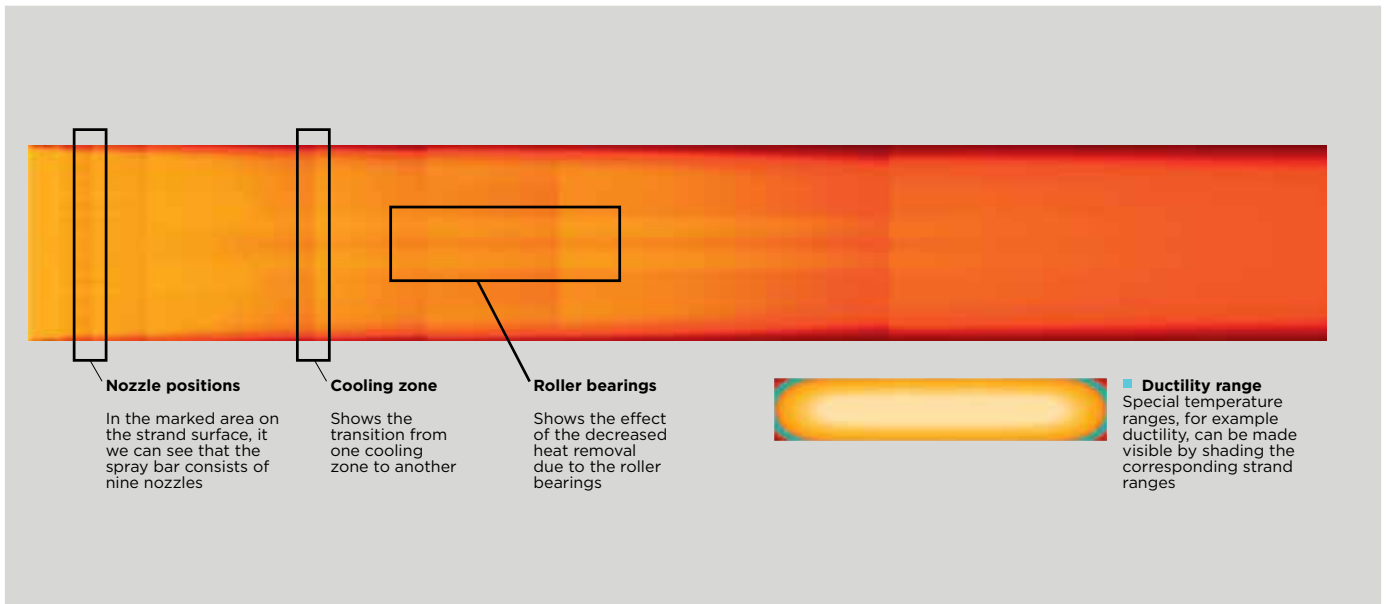
MSS - Maintenance and Setup System - enables the maintenance of the model suite's parameters and settings. Working with the offline simulation environment, this powerful tool supports metallurgists in their daily work. It enables operators to enter the machine geometry, cooling requirements, and formulas that describe water distribution and heat removal for each cooling loop, radiation, roll heat removal, mold heat removal, and natural convection.

DYNAPHASE

In order to calculate a 3-dimensional temperature profile of the strand material properties like enthalpy, solid fraction, density, and conductivity as a function of the temperature must be known. These material properties can be entered in the MSS or they can be derived using the add-on package DynaPhase, which determines these parameters from the steel chemistry using the thermodynamic Gibbs free energy and the Avrami model.

Traditionally, steel grades are grouped and a typical chemical analysis for this group is used to determine the material properties. With DynaPhase, the material properties are derived from the actual steel analysis. Calculations show that there can be a difference in the point of final solidification of half a meter or even more, by comparing the results of the actual steel analysis to the grade group analysis. This fact demonstrates the importance of having an online calculation using the actual steel grade in order to improve the quality of the cast products.

DynaPhase also indicates whether the current analysis of the steel is peritectic or not, and it alerts the operator in the event of an unexpected peritectic grade. This can reduce the risk of breakouts and improve quality.



Top and cross section view of the strand in the HMI

DYNACS 3D

The advanced secondary cooling model Dynacs 3D derives correct water flow rates even in transient casting situations such as steel grade changes, casting speed variations, different tundish temperatures, tundish exchanges, and at the beginning and end of a casting sequence. The water flow rate for each cooling zone is calculated to maintain a defined surface temperature profile throughout the entire casting sequence.

A finite-volume approximation is used to solve the heat-transfer equation and takes into consideration temperature-dependent material properties, such as density as well as the position-specific product cross-section.

The maintenance system allows the metallurgist to change cooling practices easily and introduce customer-specific cooling expertise. The offline simulation system is used to test the effect of the new settings in various casting situations before utilization in the production process.

BENEFITS

- 3D-temperature profile of the hot strand including critical edge temperatures
- Improved calculation of solidification area across strand width
- Natural shrinkage calculation for an optimal roll-gap adjustment

DYNAGAP SOFT REDUCTION® 3D

This package is based on the combination of Smart Segments and Dynacs 3D thermal tracking module. It dynamically adjusts the roll-gap profile even in transient casting conditions.

- Dynamic adjustment of the roll-gap profile for the entire strand (depending on mechanical segment setup)
- Flexibility to cast any thickness within the design range
- Optimized roll engagement for machine protection
- Improved internal quality thanks to minimized center segregation, especially for pipe and plate grades

Due to the modular design the model suite DynaPhase, Dynacs 3D, and DynaGap Soft Reduction can be installed on slab, bloom and billet casters as well as on casters supplied by third parties.



QUALITY EXPERT

A MILESTONE IN IMPROVED QUALITY CONTROL IN CONTINUOUS CASTING

Based on operational, metallurgical, and automation expertise, Primetals Technologies has developed a completely new computer-aided quality control system, Quality Expert, that is replacing the former VAIQ (in operation in more than 200 slab/bloom/billet casters worldwide).

Quality Expert determines the definitions necessary for quality-related process parameters, tracks the actual data during production, predicts the quality of the cast products, and automatically determines the subsequent product disposition. It supports the plant operators by on-line quality alerts and a preview of the quality of the cast strands in the machine.

Quality Expert is available in two distinct editions distinguished by basic or comprehensive product quality rating capability.

DISCOVERY SYSTEM

All tracked information and calculation results can be transferred from the Quality Expert's production module to the so-called Discovery system. This system is dedicated to the long-term archiving and evaluation of the huge amount of information tracked.

BENEFITS

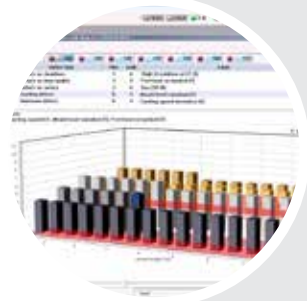
- **Improved product quality**
Thanks to consistent and dynamic production practice information that is made available to the plant operators
- **Cost savings**
Product inspection and conditioning activities can be largely avoided, which cuts material losses and handling costs
- **Configurability**
Quality Expert can be configured according to the needs of the user utilizing a flexible knowledge-base component
- **Quality-assured direct or hot charging**
Online quality prediction of cast products allows potentially defective products to be separated before charging to the downstream production units
- **Quality certification**
The long-term documentation of process specifications, process history, and quality results supports quality certification according to ISO 9001 standards

The Quality Expert was designed for flexibility from the bottom up. It can be easily adapted to changing production requirements using its comprehensive set-up system including a flexible rule editor, and it also features sophisticated process data-tracking capabilities. Its machine learning functionality allows for easy tuning of the product product-quality rating functionality based on the sample data provided.



PROCESS DATA TRACKING

Process data that influences product quality is recorded in detail targeting process documentation and product quality prediction. Data is recorded at high resolution (typical 1s) as transmitted from the basic automation system and process computers. A sophisticated projection method that takes the metallurgical area of influence into consideration makes it possible to determine the exact production conditions for each cast product from cut to cut.



QUALITY PREDICTION

Quality Expert features a completely new and flexible rule editor. Rule systems for predicting the quality of multiple product defect types, including cleanliness and surface and inner quality, can be developed from simple approaches to more sophisticated ones. The Quality Expert evaluates those quality rules online and displays the resulting quality rating. These quality previews are made available for the hot strands currently being cast in the machine and for products already cut, along with an explanation of the quality rating.



QUALITY SUPERVISION

Plant operators are supported by online alerts in the event of limits or specifications being violated during production. Process engineers can specify which process parameters will be monitored and which alert types need to be acknowledged by the operators. Operators also can view a preview of the preliminary quality rating of the cast hot strands while they are leaving the mold. The explanations displayed for these ratings reveal any quality deficiencies and enable operators to take immediate action if applicable.

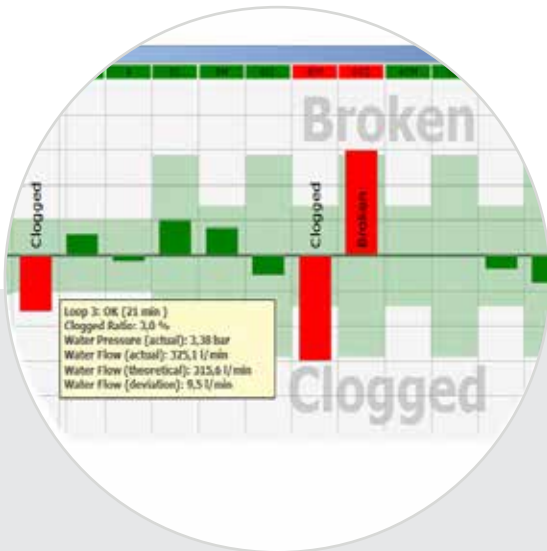


MAINTENANCE AND SETUP SYSTEM

The on-line quality control functions can be flexibly configured using the Quality Expert maintenance and setup system. The necessary technological expertise is stored in a metallurgical database. The end user (metallurgist, process engineer) can adapt the quality rules or enter new ones without the intervention of software engineers. The extensive and easy configurability of Quality Expert allows the process engineers to react quickly and flexibly to changing quality demands.

MODELS AND EXPERTS

INTEGRATED EXPERTISE ENSURES QUALITY AND PRODUCTIVITY



NOZZLE EXPERT

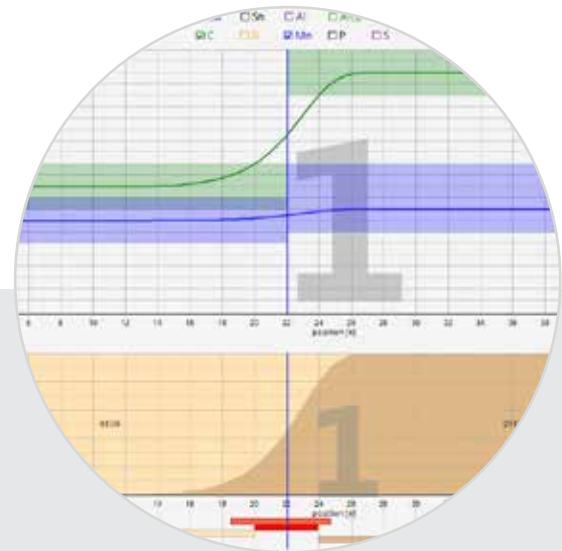
The Nozzle Expert helps to detect clogged nozzles and broken hoses in continuous casting machines and so ensures that the strand is evenly cooled for high-quality steel production. The Nozzle Expert is based on statistical models and indicates the clogging ratio in each zone.

It automatically monitors the condition of the nozzles during the casting process. The model can also be manually activated during casting breaks. The advantage is that nozzle status can be checked following maintenance work or segment changes and immediately repaired before the casting process is re-started.

Changing segments in the caster can also be a source of problems. Hoses can be easily ruptured or jammed. Because they are aware of the consequences of leakage or clogged nozzles, maintenance personnel spend a large number of working hours checking whether nozzles are operating properly.

BENEFITS

- Cost reduction by dramatically reducing maintenance hours
- Early detection and highest accuracy in detecting clogged nozzles and broken hoses
- Problems with clogged nozzles will be detected and fixed before casting
- Operators need to inspect only those zones for which an alarm is generated



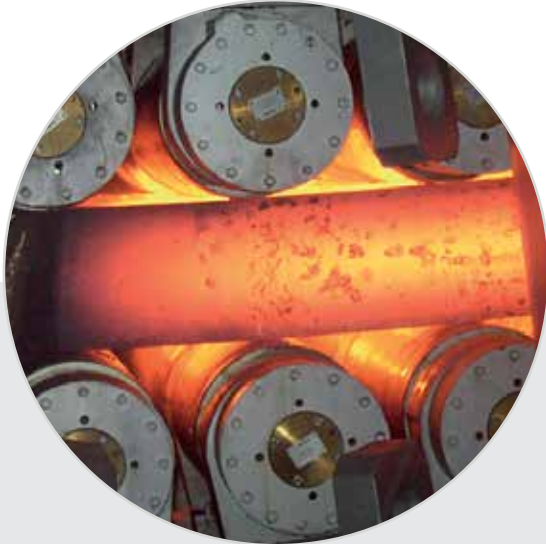
INTERMIX EXPERT

The Intermix Expert assures that prime quality in the strand is determined precisely in case of mixing different grades during sequence casting. This information allows the Yield Expert to cut prime products before and after the incompatible section of the strand. Steel mixing takes place not only in the tundish but also in the mold and upper parts of the strand. Mixing in these areas is evaluated by a mix-box-type submodel of the Intermix Expert that makes it possible to calculate the chemical composition of the steel at any position along the cast strand. On the basis of the chemical composition of the steel, the Intermix Expert calculates whether the mixed steel zones may be used for the desired product application or if the steel has to be downgraded or even scrapped.

Input parameters like analysis, tundish weight, and dimensions of the strand are considered and the computed results are visualized in the HMI.

BENEFITS

- Combining the output with the Yield Expert assures maximum prime-quality yield
- Calculation of mix steel area and incompatible strand portions along the strand
- Powerful simulation environment for testing intermix of different steel grades
- Exact knowledge of the chemical analysis at any position on the cast slabs



SPEED EXPERT

Quality improvement and throughput are the main focus of the Speed Expert, where factors that influence the casting speed are combined and an optimal casting speed for any casting situation is cyclically calculated.

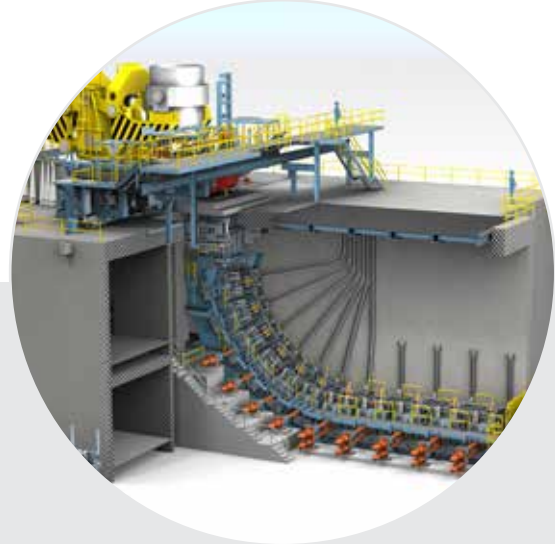
Selecting a proper casting speed on a continuous caster is of high importance. Many factors (for example, superheat, min/aim/max speed of the grade, quality, safety, machine limits and production requirements) influence the choice of the casting speed.

The calculation of the casting speed is based on different limits, and considers the different factors. Each rule determines a speed range that satisfies its requirements. The Speed Expert determines an optimal casting speed from the intersection of all of these speed ranges.

Priorities can be assigned to each rule. If there are contradicting results, the rule with the lower priority is ignored.

BENEFITS

- Optimal casting speed for increased throughput and improved quality
- In steady-state conditions, the recommended speed is calculated so that the point of final solidification is positioned at the end of a segment for optimal soft reduction
- Speed set-points are displayed in the HMI and are sent to Level 1 to be executed automatically
- Powerful maintenance system for defining new or modifying existing rules



EQUIPMENT EXPERT

The task of the Equipment Expert is to monitor the installed equipment of the caster and give the operators valuable information about the maintenance work required on them. An equipment can be an entire segment, individual rolls, a mold, or mold plates. For every equipment, a lifetime or partial lifetime criterion is defined. These criteria can be the number of heats, casting time, casting length, tons, durations, or other factors. The Equipment Expert collects these criteria on each piece of equipment and informs the operators when the lifetime criterion will be reached (for example, “change the mold-wide side plate before May 30 because 500 heats will be attained by then”). With this information, preventive maintenance work on casters is well organized. If there is more than one caster in the steel plant, a single Equipment Expert handles all of them, because the same equipment can be used on both casters.

BENEFITS

- New equipment can be added with no programming work required
- Well-organized preventive maintenance for the caster equipment
- Automatic equipment detection with RFIDs
- Equipment test reports, manuals, and instruction documents for equipment are available in the HMI

Operators are alerted with appropriate information when the installed equipment needs to be replaced.

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