FURNSTAR

FURNACE CONTROL & OPTIMISATION

MINTEK

A Global Leader in Mineral and Metallurgical Innovation

PROCESS IQ

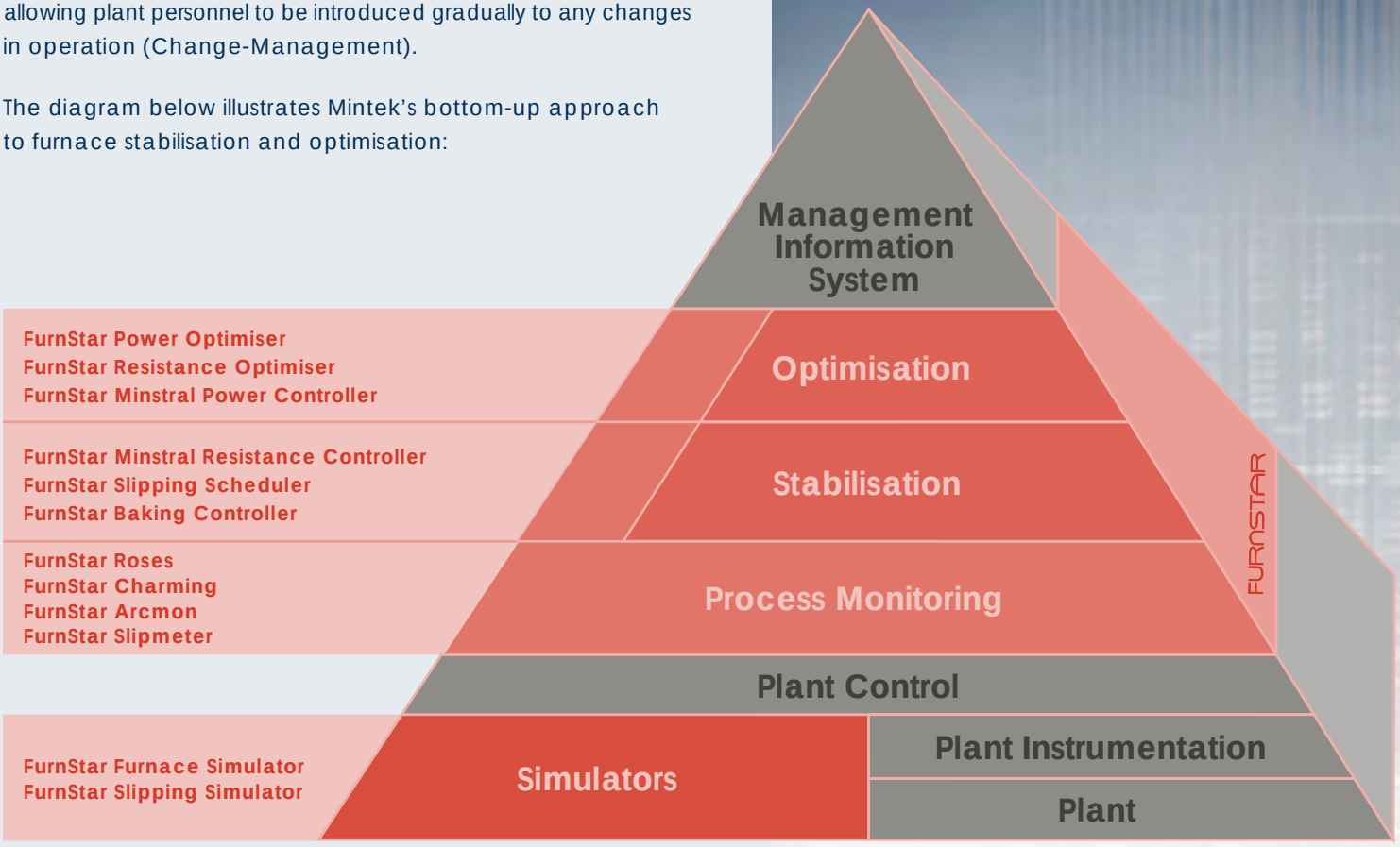
Smelting is a complex process that is affected by a multitude of factors. Many of these are inherent in the electrical circuit design, and are aggravated by electrode management issues and feed material variations.

The FurnStar suite of control modules utilises advanced process control to overcome design-related limitations and maximise furnace performance.

Mintek's modular approach ensures the design of a customised solution, specific to the objectives of each plant.

Furthermore, this approach allows for phased implementations which are useful both in assessing the benefit of the system, and in allowing plant personnel to be introduced gradually to any changes in operation (Change-Management).

The diagram below illustrates Mintek's bottom-up approach to furnace stabilisation and optimisation:



FURNSTAR MINSTRAL

FurnStar Minstral is a submerged-arc furnace control system that optimises furnace operation by means of a patented resistance algorithm, enabling stable operation at optimal power.

FurnStar Minstral is an extension to the market leading Minstral controller that has now been installed on over 90 furnaces in 8 countries around the globe.

Typical Benefits of Minstral Control:

- Improved power input (MWh).
- Lower specific energy consumption (MWh/ton).
- Improved load factor.
- Reduced electrode consumption.
- Reduced electrode breakages.
- Improved recovery.

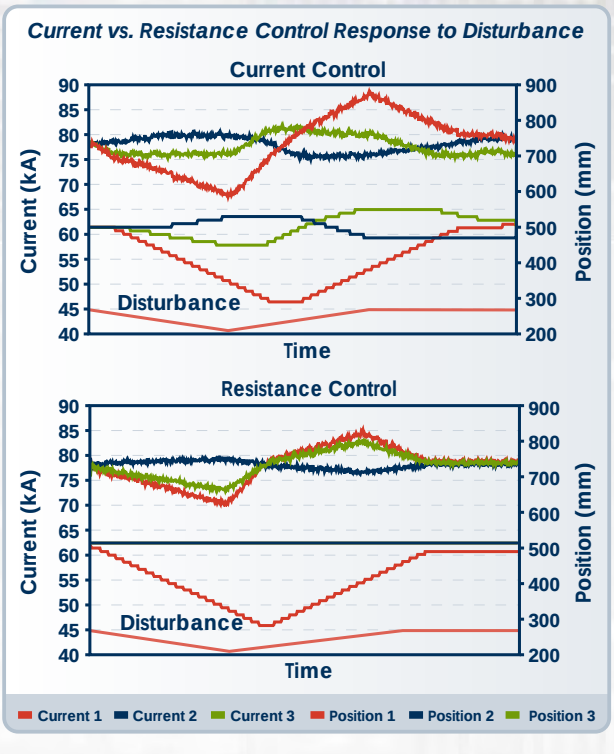
MINSTRAL ELECTRODE RESISTANCE CONTROL

The Minstral uses calculated electrode-to-bath resistances to control the penetration of the individual electrodes.

Primary measurements are used in the resistance calculation to improve accuracy, as opposed to using inaccurate and unreliable secondary measurements. No hearth connection is necessary.

Benefits of Resistance Control over Current Control Techniques:

- Elimination of electrode interaction.
- Accurate control of penetration.
- Consistent penetration at varying power levels.

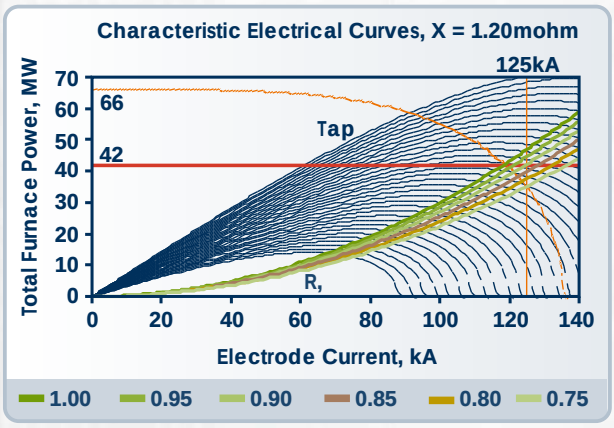


MINSTRAL POWER CONTROL

Using the accurate calculation of the furnace load, Minstral is able to predict alternate operating points to the present one in real-time.

This predictive power control strategy ensures that the furnace is operated at its optimum under all operating conditions, within the limitations of the furnace circuitry.

In addition, there is the option of differentially tapping the furnace transformers to provide even tighter control and compensation for unbalanced loads.



FURNSTAR MINSTRAL - WHAT'S NEW?

For those familiar with the more recent versions of the Minstral controller, the following improvements have been incorporated into the FurnStar Minstral:

StarCS

FurnStar Minstral utilises Mintek's generic control platform StarCS as its foundation, which has the following advantages:

- Ability to incorporate advanced control tools such as Fuzzy and Rule-based logic.
- Customisable implementation.
- SCADA-like user interfaces and trending.

Electrode Control

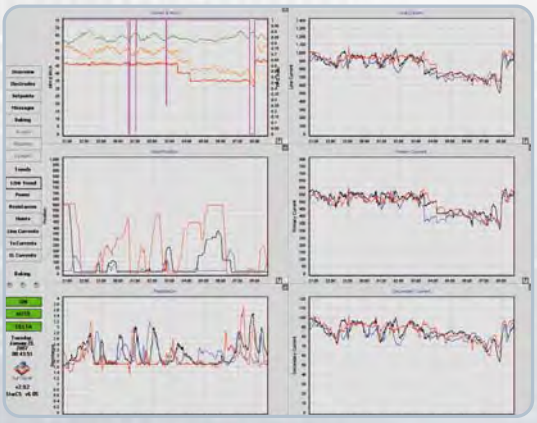
- Intelligent control by dynamically switching between sets of tuning (response) parameters to handle specific furnace conditions such as electrode baking, furnace tapping, and high asymmetry.

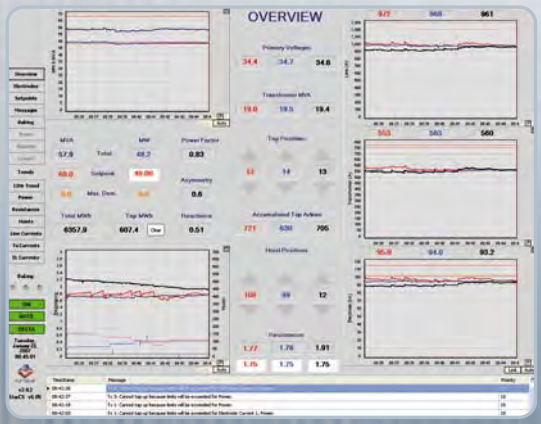
Power Control

- Simplified current, MVA, and power limit specification.
- Improved response to current spike conditions to avoid furnace trips.

Metering Fault Detection

The FurnStar Minstral includes a Fault Detection module that closely monitors the plant metering and uses redundancy to warn of potential metering faults.





In many instances economic factors and poor quality and variable feed materials have led to an increased variation in load and subsequently electrode consumption.

As a result, the manual estimation of electrode consumption and control of slip have become increasingly complex and tedious tasks.

The FurnStar Slipping Scheduler is aimed at replacing the inaccurate and unreliable manual techniques with an accurate, dynamic, and flexible automated system.

The FurnStar Slipping Scheduler comprises an industrialised slip measurement device - the “Slipmeter”, an electrode length estimator, and the scheduler itself.

Slipmeter

Fundamental to the FurnStar Slipping Scheduler is an accurate and reliable measure of slip provided by the Slipmeter.

The Slipmeter has a rugged design for operation in the harsh environment around the electrode slip rings, featuring electrical and mechanical isolation, vibration damping and compensation.

Slipmeter

Electrode Length Estimator

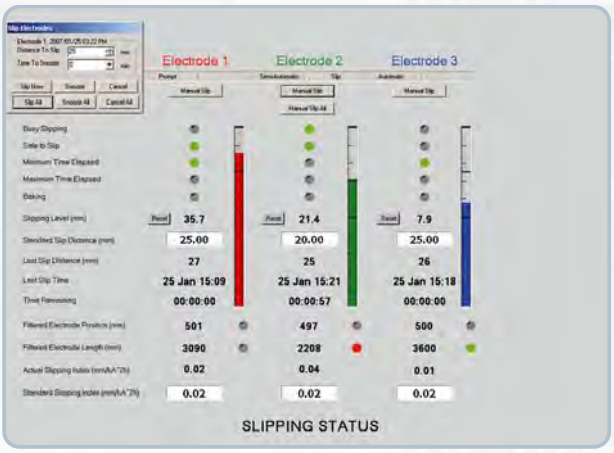
The Electrode Length Estimator uses the actual slip provided by the Slipmeter together with electrode consumption estimates to deduce the electrode length. The electrode consumption can be linked to a number of factors which are monitored and accounted for continuously.

The Electrode Length Estimator has the facility to back-calculate and correct consumption rates based on actual electrode measurements if and when these are taken.

Scheduler

Taking the electrode baking level into account, the Scheduler manipulates the slipping rates (within a permitted range) to achieve the desired electrode length and electrode holder position.

The Scheduler has a number of modes of operation, from merely prompting the operator to slip the electrode at the appropriate times to controlling the electrode slipping completely.



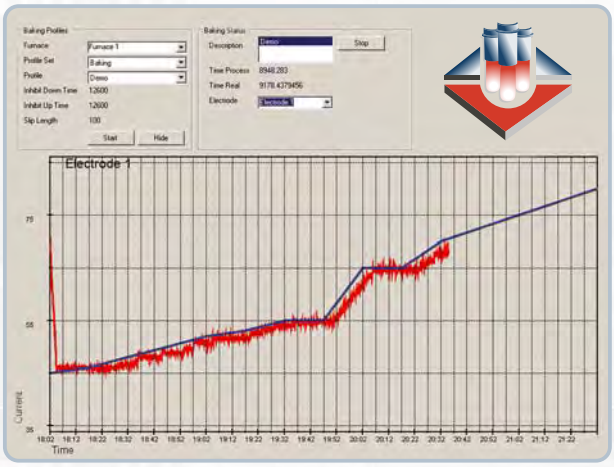
Scheduler

FURNSTAR BAKING CONTROLLER

The FurnStar Electrode Baking facility controls the electrode current through the electrode after long slips are taken to ensure proper baking of the electrode, and after long shutdowns to prevent thermal shock to the electrodes.

Customisable libraries of electrode baking and recovery (warm-up) profiles form the basis of the FurnStar Electrode Baking module. If a slip measurement is available, the module can automatically select and begin the appropriate baking schedule when a long slip is taken (otherwise the operator can initiate the profile).
Similarly, the module monitors the time for which the furnace has been shutdown and is capable of automatically selecting the correct recovery schedule once the furnace is switched back in.

The FurnStar Baking Controller can be configured to dynamically compensate for baking currents less than that required by the baking profile to ensure that electrode is baked properly.
This situation often occurs when more than one electrode is baked simultaneously, resulting in one electrode dictating the baking currents of the remaining electrodes.



Baking Controller

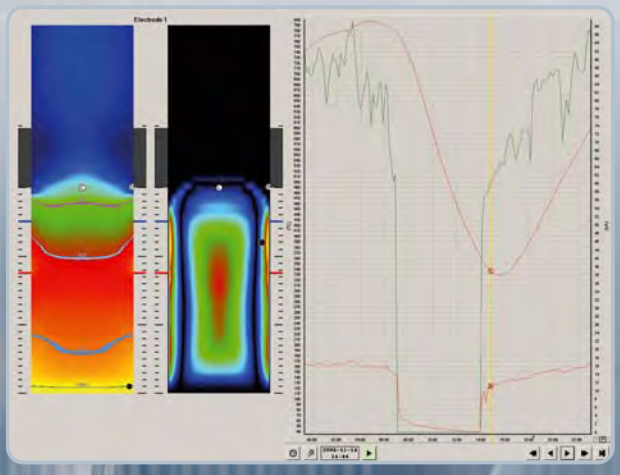
FURNSTAR ROSES

FurnStar Roses is a real-time, on-line electrode profile simulator that uses finite element analysis of the current and heat flow distributions within the electrode to simulate the temperature and stress profiles of the electrode. The model uses online measurements of the electrode slip and boundary temperatures to ensure accuracy.

The Roses temperature profile display provides useful information about the position of the baking zone in the contact clamp region of the electrode, and shows visually how the position of the baking zone drops as the slipping rate becomes high.

The stress profile provides a visual indication of the thermal stresses developed by fluctuating electrode current, particularly during warm-up after a shutdown.

Snapshots of the electrode temperature and stress profiles are stored continuously so that extended periods can be played back at high speed to give an impression of the general trends of the temperatures and stresses in the electrode over the period in question.



Roses Playback

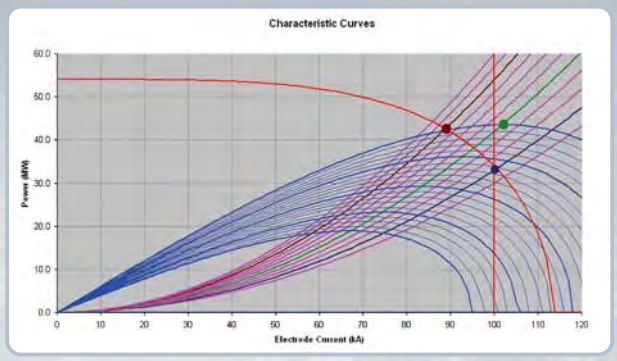
FURNSTAR POWER OPTIMISER

The FurnStar Power Optimiser is the next generation of power controller that provides improved control and increased flexibility in terms of the objectives of the controller. The Power Optimiser is based on an objective function where one can place different weightings on the various parameters, such as power input and current asymmetry (unbalance).

The controller uses these weightings to select the transformer tap position combination that best satisfies the objective function for the given furnace load. The controller's responses can therefore be customised to suit any client's preferences.

FURNSTAR RESISTANCE OPTIMISER

The reactance of a furnace changes over time for a number of reasons. For a given set of electrical limits and furnace transformer characteristics, this change in reactance influences the optimum electrical operating point of the furnace. The FurnStar Resistance Optimiser continuously monitors these changes and adjusts the resistance setpoint appropriately to ensure that the optimum electrical operating point is maintained. The Resistance Optimiser is most suited to furnaces where the furnace transformer(s) are often operated on maximum tap position(s), or where the furnace is operated close to electrode current and transformer MVA limits.

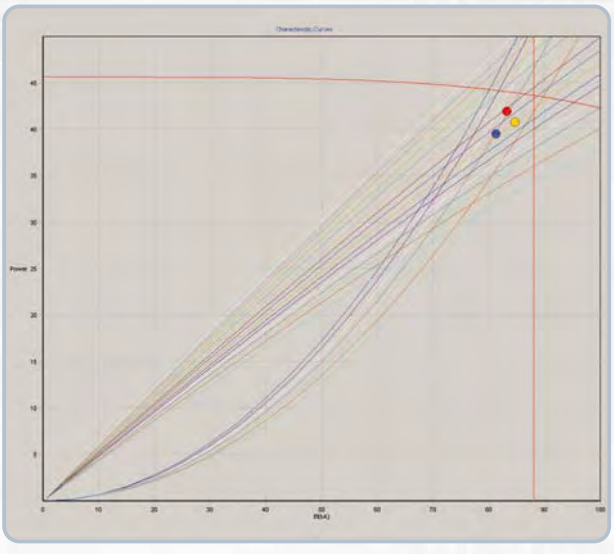


Optimum Electrical Operating Points

FURNSTAR CHARMING

FurnStar Charming provides a dynamic display of the furnace characteristic curves, and has been developed to present furnace operating personnel with a visual representation of the operating point of the furnace.

The characteristic curves are continuously updated with the fluctuating supply voltages and furnace reactance.



FurnStar Charming

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