The SinterCast Process - Ladle Production

The SinterCast Process

The process control for ladle production is based on the measurement and feedforward correction of each ladle as it moves through the foundry process. The initial base treatment is intentionally undertreated in order to allow a small and accurate addition of magnesium and inoculant immediately prior to pouring. During series production, the average addition of magnesium in the final correction step is less than 30 grams/tonne. The measure-and-correct strategy prevents the variation that naturally occurs during base treatment from being transferred to the final product, resulting in consistent CGI castings with an optimal CGI microstructure and preventing shrinkage defects.

Process Flow

Process flow begins with the thermal analysis of a 200 gram sample of the magnesium and inoculant treated base iron. The thermal analysis sample is obtained by immersing the patented Sampling Cup into the iron for three seconds. After completion of the thermal analysis, the SinterCast software calculates the necessary amount of corrective magnesium and/or inoculant to produce an optimal CGI microstructure. These additions are automatically added in cored-wire form by the SinterCast Wirefeeder. The ladle is then released for pouring. Further sampling and deslagging are not required. The entire measure-and-correct process requires approximately 3.5 minutes and is conducted in parallel with normal foundry operations, allowing continuous operation of the moulding line. Results from each ladle are also fed back to the base treatment operation to continuously improve process accuracy. The System 3000 *Plus* also provides automatic control of the base treatment, using a second network-linked wirefeeder. The optimal addition amounts for each base treatment are calculated based on automatic input of ladle weight, temperature and sulphur content, plus the historical SinterCast results for recovery.

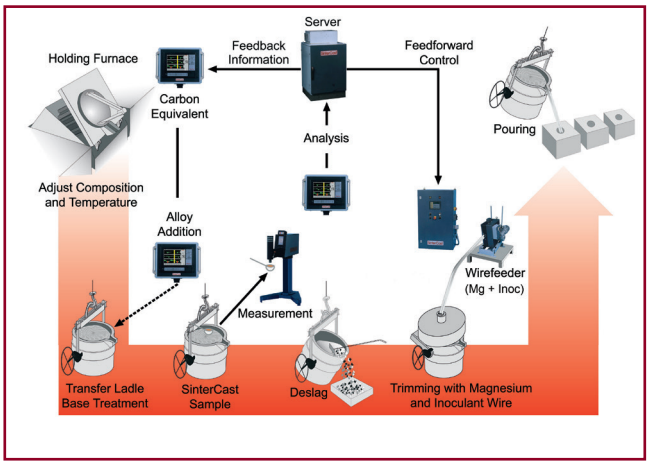

Figure 1: Process control for ladle production

Measure-and-Correct

Despite all good foundry efforts and discipline, variation in the base treatment addition of magnesium and inoculant is inevitable.Regardless of the state of knowledge of the base iron and its history, one-step treatment methods cannot be relied upon to always fall within the narrow CGI window. This is shown in Figure 2 where the magnesium measurement results are plotted for 300 ladles that have been base-treated by Mg-wire. The actual Mg-results span from 26 to 44, while the casting specification window ranges from 38 to 46. By evaluating the iron after the magnesium and inoculant base treatment, SinterCast quantifies the actual base treatment result and activates the necessary control actions to optimise the CGI microstructure and provide consistent CGI castings.

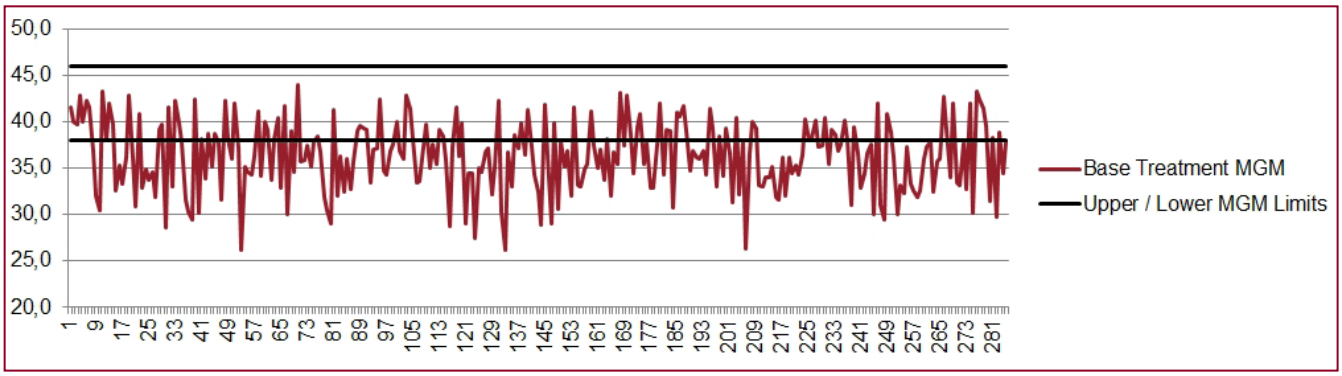

Figure 2: Base Treatment Modification results from series production of 300 ladles.

The SinterCast Process - Pouring Furnace Production

The SinterCast Process

The process control technology for pouring furnaces is based on feedback control logic. The SinterCast thermal analysis measurement is obtained from the iron in the exit spout of the pouring furnace. The result of the thermal analysis is used to determine the amount of the magnesium addition for the next base treatment ladle. The thermal analysis result is also used to determine the inoculant addition for each new mould. The dynamic control of both the magnesium and inoculant additions minimises process variation and ensures that consistent iron is delivered to the moulding line. The pouring furnace control technology can be applied to furnaces that are heated, unheated, pressurised, or non-pressurised.

Process Flow

The process flow begins by base treating the iron with magnesium. Cored wire treatment is preferred as this allows the wirefeeder to be directly controlled by the System 3000, providing a fully automated process. The size of the treatment ladle is determined such that approximately four ladles are required to completely fill the furnace. This ensures that changes in the amount of magnesium added to each new ladle have sufficient 'weight' to influence the iron already in the furnace. The regular input of freshly treated iron, combined with a predictable magnesium fade rate inside the furnace, provides a stable platform for the process control. The magnesium treated iron in the pouring furnace is inoculated by injecting cored-wire into the pouring spout of the furnace during the time that the stopper rod is open to dispense the iron into the moulds.

The process control actions are determined by the results of the SinterCast thermal analysis measurement. The timing for each control sample is determined by the System 3000 to ensure that the thermal analysis result is available on time to determine the magnesium addition for the next base treatment. The System 3000 will also automatically request additional samples if the moulding line has been down for a pre-determined time or if any other process anomalies have occurred. Depending on the result of the SinterCast measurement, the amount of magnesium wire added to the next base treatment is automatically increased or decreased to either concentrate or dilute the magnesium content of the iron already in the furnace. Similarly, the speed of the inoculant wire injection is automatically increased or decreased to change the amount of inoculant added to the exit spout during the constant time that the stopper rod is open.

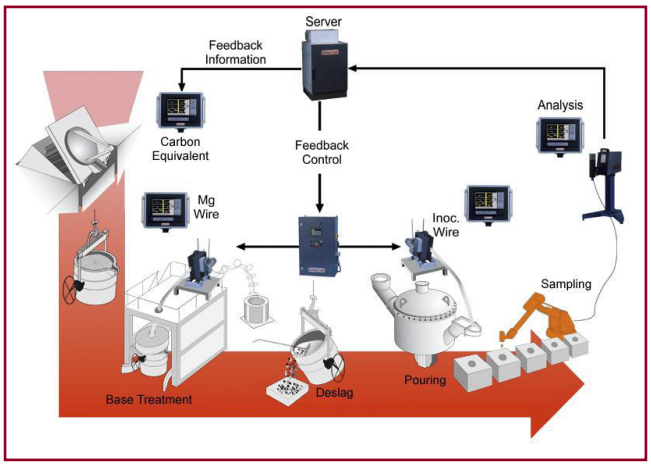

Figure 3: Process Control for Pouring furnaces

Process Automation

The System 3000 hardware and software configuration for pouring furnace production includes a peripheral data acquisition system to interface with the controls of the pouring furnace and the moulding line. The recorded information includes furnace weight and pressure, stopper actuation, moulding line indexing, shake-out time, base treatment ladle weight, temperature and sulphur content. Together with this data logging, the SinterCast thermal analysis result enable the System 3000 to determine the optimal timing for control measurements and also to alert the operators of any process anomalies. The process data logged by the System 3000, together with the full thermal analysis result history is available to the foundry engineers for traceability and quality control.