The quality and composition of iron produced in the blast furnace is directly related to the hearth temperature. This, in turn, is dependent on the temperature of the hot blast delivered from the blast furnace stoves.

To maximise the efficiency of the stoves, they are operated at high temperatures, close to the safe working limit of the refractories. This makes it critical to carefully monitor the stove temperature.
Blast furnaces heat iron ore to produce the iron required as a raw material for steel-making. For efficient operation, the air is heated before being sent into the furnace. This ‘hot blast’ technique – preheating air blown into the blast furnace – dates back to the Industrial Revolution, and was developed to permit higher furnace temperatures, increasing the furnace capacity.

Preheating the air intensifies and accelerates the burning of the coke. A blast furnace fed with air preheated to between 900-1250°C (1652-2282 °F) can generate smelting temperatures of about 1650°C (3002°F), which significantly reduces the consumption of coke per ton of iron produced.

A typical hot blast stove consists of a vertical steel cylinder lined with firebrick, with the interior divided into two chambers. The combustion chamber burns gases from the blast furnace and from other sources such as the coking plant. The regenerative chamber is filled with a checkerwork of refractory brick, heated by the burned gas.

The stoves act to store heat from the blast furnace waste gases. After a period of accumulation, flow is reversed, and the hot stove is used to preheat the incoming air. Stoves are alternated, storing heat and dissipating heat on a regular flow reversal plan. Many blast furnaces are serviced by three or more stoves, so that while two are being heated, the air blast can pass through the regenerative chamber of the third stove on its way to the furnace.

Accurate monitoring of the stove temperature supports efficient operation – higher temperatures are more efficient and, by reducing coke consumption, are more cost-effective. However, temperatures that exceed the working limit of the refractory will damage the brickwork and shorten the lifespan of the stove.

This important measurement is ideally taken by measuring the temperature at the dome underside, but can also be effective if taken from the brick checkerwork. In addition, continuous monitoring of the hot blast main provides the data required to optimise the efficiency of the blast furnace operation.

USING THERMOCOUPLES IN FURNACE MEASUREMENTS

TRADITIONALLY, IMMERSION THERMOCOUPLES WERE USED TO MEASURE TEMPERATURES IN THIS APPLICATION.

However, the harsh environment caused by high temperatures and high pressures significantly reduces the lifetime of these thermocouples, due to contamination and migration of the tip materials. The metal sheaths used to protect conventional thermocouples are not viable above 1200 °C (2192 °F). Alternative sheaths are easily broken or damaged by the expansion and contraction of the ceramic brickwork during the heating cycle.

In addition, sudden pressure relief (or ‘snorting’) can cause a drop in the temperature reading of between 20-30 °C for about 30 seconds. This makes the thermocouple signal unsuitable for use in automatic stove reversal control systems.

Waste gas produced by the blast furnace is enriched with natural gas or coke oven gas and used as fuel in other areas of the steel works.
NON-CONTACT MEASUREMENT SYSTEMS

CORRECTLY INSTALLED, AN INFRARED PYROMETER SYSTEM WILL PROVIDE ACCURATE TEMPERATURE MEASUREMENTS FOR THIS APPLICATION WHILE OVERCOMING MANY OF THE PROBLEMS ENCOUNTERED BY THERMOCOUPLES.

A short-wavelength pyrometer is required for this measurement, as this will ‘see’ through the gases produced by combustion.

The non-contact infrared measurement technique ensures maintenance-free operation for many years. However, the pyrometer electronics can be affected by the harsh environment, so correct installation is critical to ensure effective operation.

A specialised mounting arrangement will provide isolation and protection from the heat and pressures.

Depending on the mounting position, specific components may be required. For example, if alignment is important, it may be necessary to use bellows or alternative methods to provide sealing and permit sighting adjustments. A gas-purged window assembly is essential to provide optical sighting for the pyrometer and to protect it from the high stove pressures.

For most widely used stove designs, two measuring systems are mandatory to meet operating specifications. However, a third system may also be installed to ‘police’ the other two.

Any significant deviation between this pyrometer and either of the two in continuous use would indicate a need to inspect the system.

It is also important to fit an isolation valve, allowing access to the system components if this inspection becomes necessary, and for maintenance or replacement of parts.

APP NOTE

A blast furnace may run continuously for up to ten years with only occasional short stops for planned maintenance.

AMETEK LAND’S STOVE DOME SOLUTION

AMETEK Land recommends the SPOT R100 FO fibre-optic infrared pyrometer for this application, installed as part of the specifically developed Stove Dome system.

For the hot blast main, the SPOT R100 FO views a hollowed refractory brick in the main that attains the gas temperature rapidly.

In the furnace stove, it can be installed to either look up at the stove dome – generally the most desirable measurement location – or to sight down onto the checkerwork.

The SPOT R100 has a very rapid millisecond response speed and, unlike a thermocouple, operates effectively for many years.

As a ratio pyrometer it uses two detectors, with one at 1 µm and the other at 1.2 µm. These wavelengths are short enough to ignore interference from combustion gases and accurately target the refractory brick.

Some blast furnaces monitor temperatures looking along the axis of a tuyere (the nozzle through which air is blown). The AMETEK Land SPOT R100 fibre optic pyrometer is perfect for this measurement.

In addition, the temperature of the iron that is tapped is an indication of desired quality and blast furnace conditions. Continuous non-contact temperature measurement can also be achieved using the SPOT R100 pyrometer.

STOVE DOME ASSEMBLY

RECOMMENDED SPOT R100 FO with Stove Dome Assembly

FOR NON-CONTACT TEMPERATURE MEASUREMENT

SPOT R100 PYROMETER

Single-spot, non-contact infrared pyrometers, optimised for a wide span of temperature ranges and process requirements.
THE SPOT PYROMETER

An infrared ratio pyrometer with fibre-optic attachment, the SPOT R100 FO supports optimisation of the blast stove process, helping to protect the stove interior from overly high temperatures.

The fibre-optic design provides the accurate, reliable readings required for efficient stove operation, while ensuring the sensitive electronics of the pyrometer are located away from hostile conditions.

Easy to install and position, the SPOT pyrometer range offers a flexible selection designed to match specific process challenges.

It is available in a variety of operating wavelengths and temperature ranges for different process requirements, with monochromatic and ratio versions, plus hybrid models that switch detectors according to the temperature level. Ethernet, Modbus TCP analogue outputs, alarm outputs and image streaming are all available to the operator, contained within a single device. Signal processing is performed within the sensor, so no separate device is needed.

By integrating sophisticated automatic beam alignment technologies that precisely focus the advanced infrared optics, the SPOT range delivers accurate stable measurements quickly, reducing maintenance time and enabling faster process adjustments.

FEATURES
- Self-contained single-sensor solution
- Range of digital and analogue communications
- Local and remote motorised focus control
- Easy plug-and-play installation
- Powerful software support

BENEFITS
- Faster, more accurate measurements
- Quick optimum focus using LED target sight
- Fibre-optic version ideal for inaccessible locations
- On-board processing - separate processor not required
- Long-life, scratch resistant sapphire protection window

THE STOVE DOME SYSTEM

AMETEK Land’s Stove Dome system is an application-specific solution which uses advanced infrared radiation pyrometer technology to monitor refractory temperatures around the stove dome or hot blast main.

Delivering an innovative non-contact measurement, the Stove Dome system avoids the maintenance problems and slow response associated with using thermocouples. This ensures there is no need for the regular replacement of expensive equipment, or to use multiple instruments to counter the high loss rate.

Utilising a highly accurate, high-pressure-rated sighting assembly, the pyrometer is installed on top or at the side of the stove. This allows it to focus onto the internal refractory checker or bridge brickwork, using a selected short wavelength to ignore combustion products and ensure process efficiency.

By measuring the refractory surface temperature rather than the gases, the Stove Dome system avoids the problems caused by pressure relief that affect thermocouples. This makes the system far more suited for automatic change-over control.

FEATURES
- Application-specific mounting
- Non-contact measurement solution
- Shut-off valve for easy removal
- Short-wavelength infrared measurement

BENEFITS
- Accurate, rapid-response measurements
- Long service life; lowers plant operating costs
- Minimal maintenance requirements
- Measurement unaffected by combustion gases

SPOT PYROMETER WITH FIBRE-OPTIC ATTACHMENT

STOVE DOME ASSEMBLY

AUTO SHUT-OFF VALVE ACTUATOR

TWIN SYSTEM FOR HARSH ENVIRONMENTS
SUMMARY

Accurate measurement of the stove refractory surface temperature is critical to ensure the efficient operation of the stove without causing damage to the ceramics in the regeneration section.

To overcome the difficulties caused by combustion gases, and to significantly reduce maintenance requirements, a non-contact infrared pyrometer system is recommended, using short-wavelength detectors.

The blast furnace environment is hostile to standard pyrometers, so a specialised installation, using fibre-optics, is ideal to protect the instrument from damage and deliver reliable, continuous monitoring.

AMETEK Land offers an application-specific solution for the stove dome, designed to overcome the challenges of temperature measurement in this location. In addition, this system can also be utilised to monitor the hot blast main, providing a comprehensive solution for this critical stage of the steel-making process.

AMETEK LAND PRODUCT SOLUTIONS FOR THE BLAST FURNACE:

SPOT Pyrometers
Fully-featured, high-performance pyrometers for fixed, non-contact infrared spot temperature measurements and a range of process requirements.

Blast Furnace Stove Dome System
Application-specific infrared pyrometer system designed to accurately monitor refractory temperatures around the stove dome or hot blast main.

DOWNLOAD THE BROCHURE AT: WWW.AMETEK-LAND.COM