CEMENT / LIME KILN APPLICATIONS

Rotary cement kiln looking towards the burning zone

Overview

Rotary kilns are cylindrical furnaces that rotate on their long axis. They are constructed with a steel shell and a refractory lining. The axis of rotation is tilted so the limestone / clay and other chemicals are continuously fed into the high-end, travel down the furnace toward a burner at the low end, and discharge in a clinker cooler area then onto a conveyor that transports the material for grinding in ball mills.

Rotary kilns are used in a variety of processes, though primarily in cement and lime manufacturing, but also in the production of high temperature refractory materials such as Dolomite. Kilns operating at lower temperatures are used to calcine lime.

Temperature monitoring at several locations is essential to ensure product quality and throughput, to minimize emissions, and to prevent damage to the kiln shell and material handling conveyors. Critical applications are the Burning Zone, Process Material Pre-Heat, Exit Temperature, Kiln Shell, Clinker Cooler, and Conveyor material transport.

Process Material Preheat

Exhaust gases from the kiln are used to preheat the cold raw material before the gases pass to the scrubbers and the stack. This improves the efficiency of the process and reduces emissions. Inadequate preheating can signal problems in the heat exchanger that will reduce efficiency.

Models M316, PSC-G40N, PSC-G55N or PSC-CS-laser-2MH, can be sighted on the preheated material to provide an alarm if the temperature falls below a pre-set level.

Burning Zone

The burning zone is the last stage before the material exits the kiln. A single burner fires towards the approaching material. 2-color models PSC-SR55N or M311 or are extremely effective as they compensate / ignore the effects of dust obscuration in the IR sensor's sight path. These non-contact infrared thermometer models should not be sighted through the flame, but sighted along the axis or below the flame, measuring product or the refractory walls. Process Sensors IR 2-color models offer a video output that provides a video of the burning zone on a video monitor or PC.

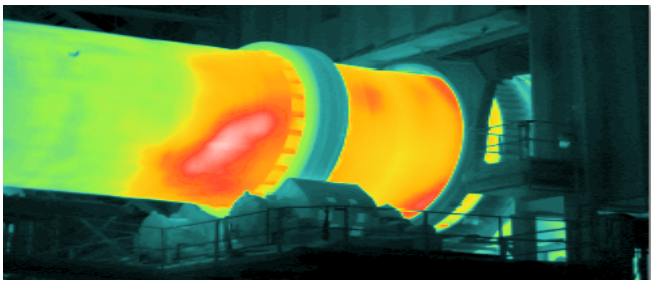
Additionally, PSC's 1-color model MY46 with a spectral response of 4.6μ, is used to measure flame temperature, but can be affected by dense dust or particulates in the sight path. The PSC-12C-DW Thermal imaging camera profiles provides thousands of temperature points for viewing a large area inside the kiln. An air actuated mechanism is used to retract the camera's lens from the kiln, if the Air Purge is shut off, protective the camera from being damaged. Cooling and purging accessories are essential for all models.

Thermal imager sighted into burning zone

Thermal image of burning zone (Note material dam build-up)

Kiln Shell Temperature

Hot or cooler areas on the kiln's outer surface are caused by a ring-dam formed by a build-up of process material in the kiln. This reduces the flow of material, resulting in a hotter area downstream of the ring, and a cooler area where the ring has formed. Collapse of the refractory lining will result in a hotter area.



Thermal image of kiln shell hot-spot close to bearing ring/tire area.

Unevenly heating the kiln shell distorts the metal skin and the cylinder becomes banana shaped, damaging the kiln bearings, causing a process shutdown.

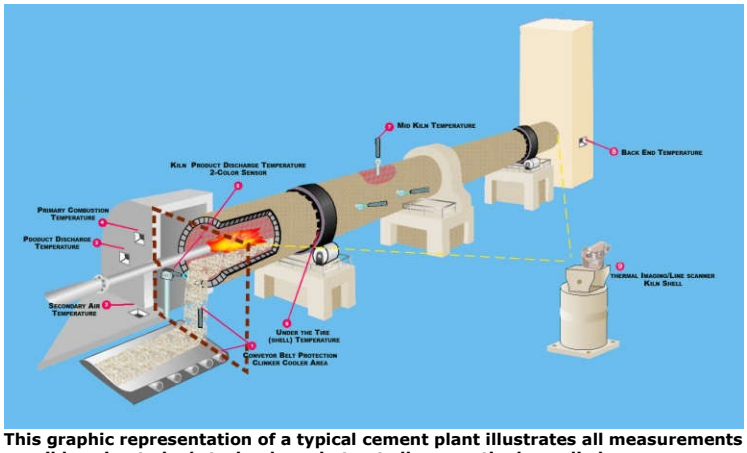
Rapid detection of uneven heating allows the plant operators to break down the dam with a canon shell, or to "steer" hot process material into any gaps in the refractory lining as a temporary solution until routine maintenance comes due.

Early detection of hot or cooler areas can be achieved with a thermal imaging camera "instant thermal picture" in comparison to a line-scanning camera. Both provide a thermal picture of the skin temperature in related colors. Although Single point IR thermometers (IRT's) mounted on a mechanical rotary scanner or mounted in several fixed locations can be used, they are not practical as they are viewing only one small spot on the kiln shell. In Addition, pricing for thermal imaging camera systems have significantly decreased in recent years.

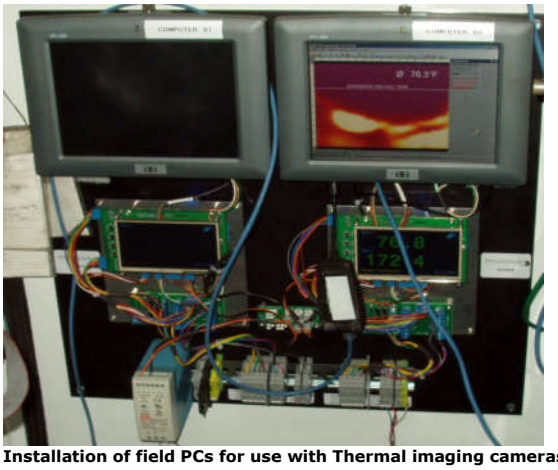
Clinker Conveyor

Hot process material leaving the kiln is passed under cooling water sprays before travelling to ball mills to be ground into powder. Failure to cool the material thoroughly can result in fires along the conveyor in inaccessible locations, or in the ball mills.

Detection of inadequately cooled clinker is therefore critical. Infrared thermometer Models PSC-T42L, PSC-52LT, PSC-T40L, PSC-CS-laser-LT, or with a wide-angle field of view thermal imaging camera Model PSC-X80LT, to observe a large area.



This graphic representation of a typical cement plant illustrates all measurements possible using today's technology, but not all are routinely applied.



Installation of field PCs for use with Thermal imaging cameras.

Mid-Kiln Measurements

Infrared Thermometers (IRT's) have been applied in cement plants for over 50 years. Prior to that, thermocouples were the only technology available and required frequent replacement due to mechanical wear and damage from the outdoor environment.

To obtain a Mid-kiln temperature measurement, an inconel or high temperature metal closed end target tube is incorporated into the side of the kiln. The IR sensor is aimed at the bottom of the closed end target tube / thermowell, having dimensions from 4 to 6-foot-long with a minimum I.D. of 4 to 6 inches.

The target tube required needs to have a large enough I.D. due to the axial movement of the kiln, allowing for expansion and shrinkage of the kiln during heat up and cool down. Therefore, the IR sensor must have a high-resolution Field of view (FOV) / small spot size, to ensure that the Pyrometer is measuring the bottom of the target tube and not along the inside wall. During each kiln rotation, the IR sensor measures the bottom of the target tube to infer and ascertain the mid-kiln temperature.

Plant Operating Environments

Cement plants are not usually under cover, apart from the burner hood, so IRT's and thermal imaging cameras will be exposed to the elements. In some geographical locations, weather extremes are severe, calling for some form of protection for the instruments and support services such as cooling water and compressed air for purging the optics.

This may be as simple as a mechanical shield and careful routing of the services. Though it represents an added expense, using nitrogen for purging can eliminate such problems as frozen condensate in the lines.

Turnkey System Engineering

Process Sensors IR products are enhanced by the Company's capability to offer a fully engineered, turnkey system, whether it is a single loop or several. System engineering includes data acquisition and processing, alarms and controls utilizing Windows compatible computer software, etc.

Kiln Cameras /IR Temperature Sensors

Burning Zone and Product Discharge

Metis M311, PSC-SR54N, MY46 or the model PSC-12C-DW Thermal Imaging camera system

Mid-Kiln

PSC-G55NL, PSC-G54NL, PSC-G40N, PSC-CS-Laser-2M

Clinker Cooler / Conveyor Belt Area

PCS-52LT, PSC-T42L, PSC-CS-LASER-LT, PSC-X80LT Thermal Imaging camera