PROCESS SENSORS CORPORATION
a KPM brand

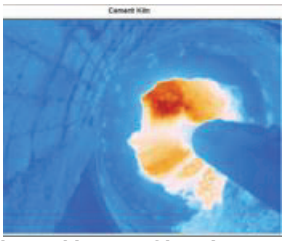
Application Note

Issue 4

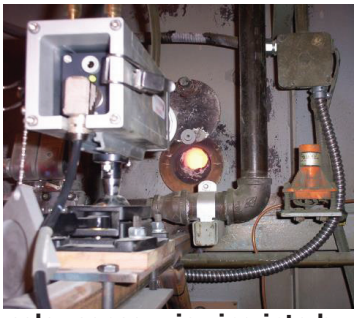
CEMENT / LIME KILN APPLICATIONS

Rotary cement kiln looking towards the burning zone

Thermal imager sighted into kiln



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



M311, 2-color sensor viewing into 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 and other chemicals that are continuously fed into the high-end, travel down the furnace toward a burner at the low end, and discharge onto a conveyor. The conveyor transports the material to a cooler before grinding in ball mills.

Rotary kilns are used in a variety of processes, though primarily in cement and lime manufacture, 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 a number of 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, and Clinker Conveyor.

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.

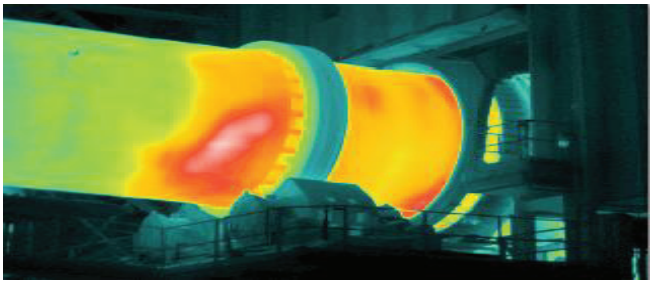
Models M316, PSC-G54N, PSC-G42N, or PSC-CS-laser-2MH can be sighted on the preheated material to provide an alarm if the temperature falls below a pre-set level.

Burning Zone

The burning zone is the last stage before the material exits the kiln. A single burner fires towards the approaching material. A 2-color Model M311 is extremely effective as it compensates and ignores the effects of dust partially blocking the IR sensor's sight path. Non-contact infrared thermometers should not be sighted through the flame, but sighted along the axis or below the flame. The Model M311 can also offer, an integral video chip that provides a video of the burning zone on a video monitor or P.C. PSC's single-color model MY46 has a spectral response of 4.6 to measure the temperature of the flame but can be affected by dense dust or particulates in the sight path. The model PSC-764-1M Thermal imaging Camera system with 330,000 points of temperature measurement with cooling and purging accessories is used to profile the kiln interior.

Kiln Skin Temperature

Hot or cooler areas on the kiln 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 also result in a hotter area.

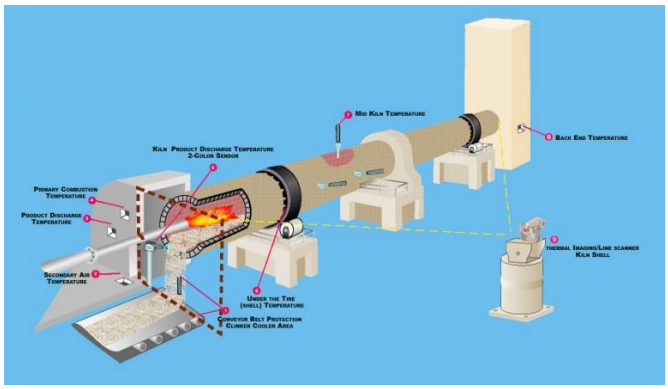


Thermal image of kiln shell hot-spot close to bearing ring/tire area.

Uneven heating of the kiln shell distorts the metal shell and the cylinder becomes banana shaped, damaging the kiln bearings, causing a very expensive 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 a routine maintenance comes due.

Early detection of hot or cooler areas of the kiln can be achieved with a thermal imaging camera "instant thermal picture" or a line scanning camera. Both provide a thermal picture of the shell temperature in related colors, selected by the user.



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

Clinker Conveyor

Hot process material leaving the kiln is conveyed under cooling water sprays before travelling to ball mills to be ground into powder. Failure to cool the material thoroughly can result in damaging the conveyor belt or causing a fire.

Detection of inadequately cooled clinker is therefore critical. The Thermal imaging camera model PSC-X80LT or a single point pyrometer with a wide-angle field of view; models PSC-52LT, PSC-CS-laser-LT or PSC-T42L are applied to this application.

Mid-Kiln Measurements

Infrared Thermometers (IRT's) have been applied in cement and Lime plants for over 40 years. Prior to that, thermocouples were the only technology available and required frequent replacement due to mechanical damage and wear, or corrosion from process gases and the outdoor elements. This is particularly true of mid-kiln measurements.

A Non-contact method using a pyrometer, not only allows for accurate temperature measurements but also ensures for long term operation. The IR sensor is aimed down into an Inconel closed end target tube with dimensions from 4 to 6-foot-long with a minimum I.D. of 4 to 6 inches. During each rotation, the IR sensor measures the bottom of the target tube to infer and ascertain the mid-kiln temperature. This is performed activating the pyrometers peak picker circuitry.

The I.D. of the tube is critical as the Kiln expands and shrinks as it heats and cools. 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.

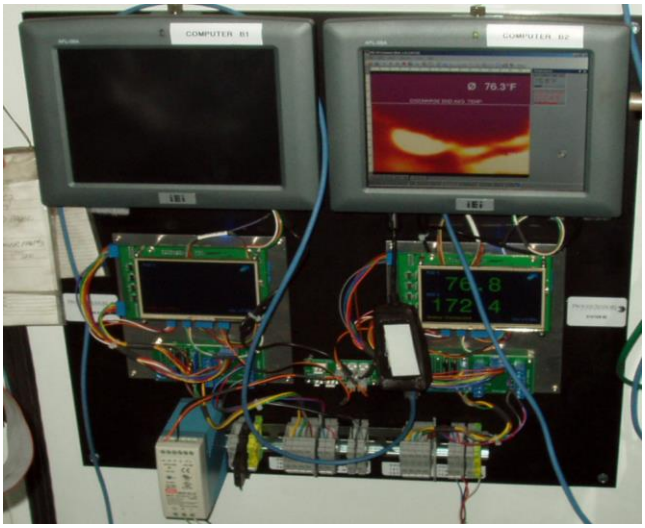
Plant Operating Environments

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



Cement Kiln Sensors

Burning Zone and Product Discharge

Metis M311, PSC-SR55N, MY46 or the model PSC-SF12C-DW Thermal Imaging camera system

Mid-Kiln

M316, PSC-G42N or PSC-CS-Laser-2M

Clinker Cooler / Conveyor Belt Area

PSC-X80LT THERMAL IMAGER, Pyrometers: PSCS-52LT, PSC-T42N, or PSC-CS-LASER-LT