

Introduction

With more than 100 installed PiT Indicators, Powitec thermography is at the forefront for flame monitoring in cement and lime kilns. Powitec high-tech systems optimise industrial combustion processes in rotary kilns (cement, lime, hazardous waste), power plants and waste-to-energy plants. The main benefit of Powitec technology is the improvement in energy efficiency at an increased production rate, combined with emission reduction.

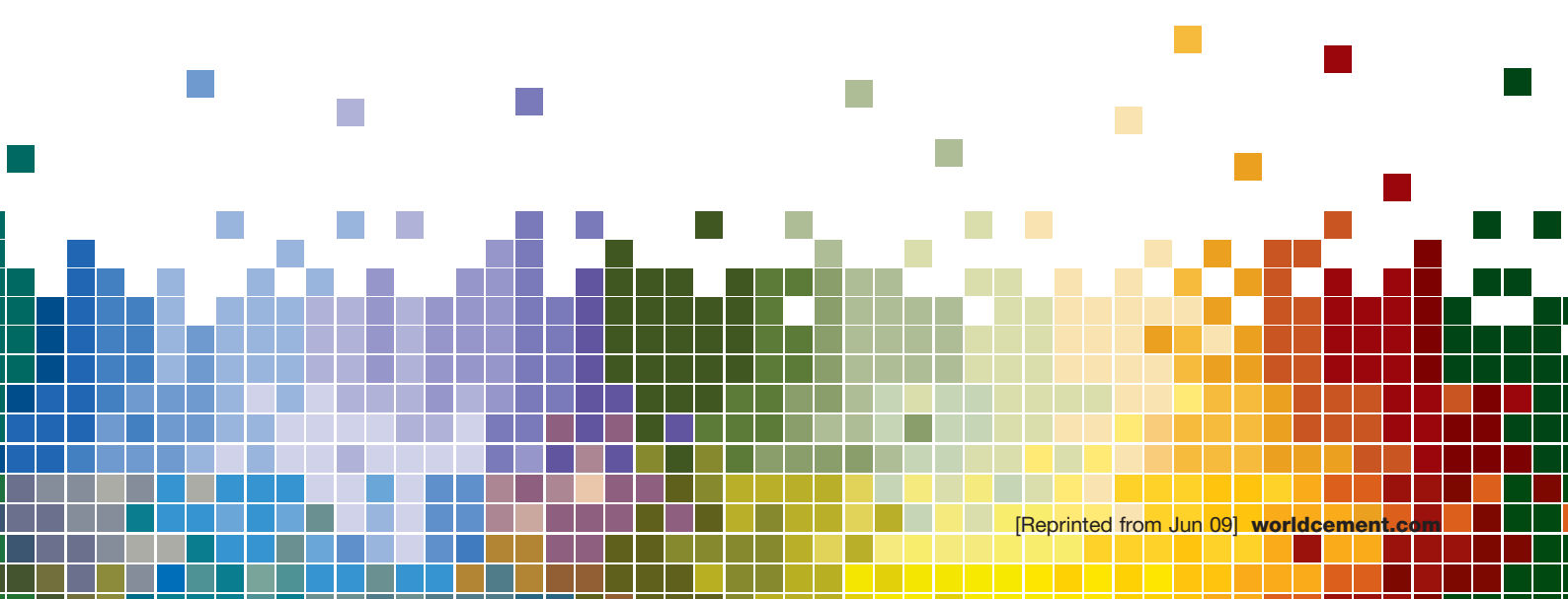
The classical thermography from the front optimally analyses flame diameter, sintering zone and clinker bed. The additional video image enables the operator to be aware of the texture of the clinker and the clinker discharge area. With the new Side View Thermography, it is possible to precisely analyse PLUM length, ignition point, flame diameter and main flame combustion zone.

This makes it possible to discover new correlations between alternative fuels and clinker quality.

The simultaneous analysis of elements, such as the ignition point and temperature of secondary air, ensures faster reaction on the changing process situation and changing fuel properties.

HIGH-TECH THERMOGRAPHY

Alexander Hanf, Sales Director,
Powitec, Germany, describes
the company's new Side View
Thermography instrumentation.



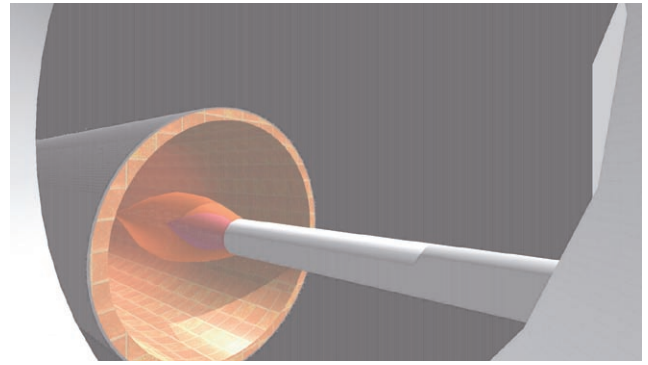
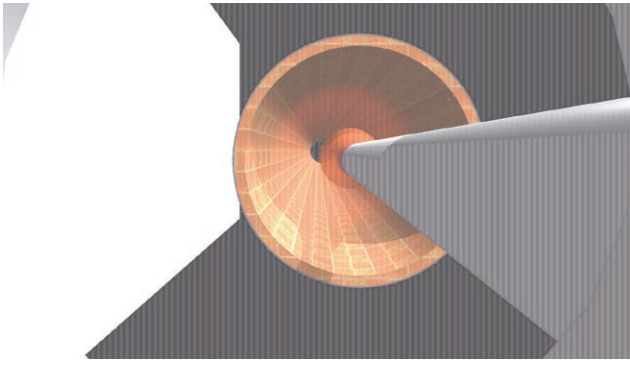


Figure 1. Front and side view (3D simulations with 90° optic; in the field 30° or 60° optics were used).

Side View Thermography

Prior to 2008, Powitec had tried to achieve a 3D-effect by installing the thermographic instrumentation angular to the burner axis; it was also possible to observe the ignition zone.

In 2008, the first plants selected a position at the side of the kiln head, such that the viewing area of the ignition flame was right in front of the burner nozzle.

These German plants belong to two big groups that operate with 60% alternative fuel rates, but those kilns without calcinators are fed with more than 80% AFs at the main burner. In these plants, adjustment of the multi-level burners is a daily routine.

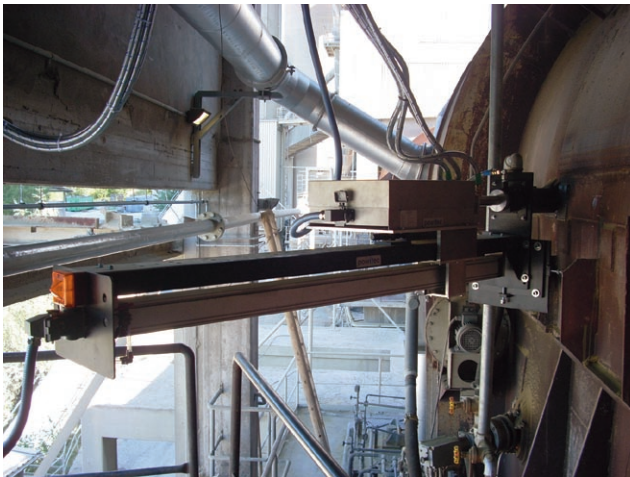


Figure 2a. PiT Multisensor on retraction unit for side view: mounting flange.

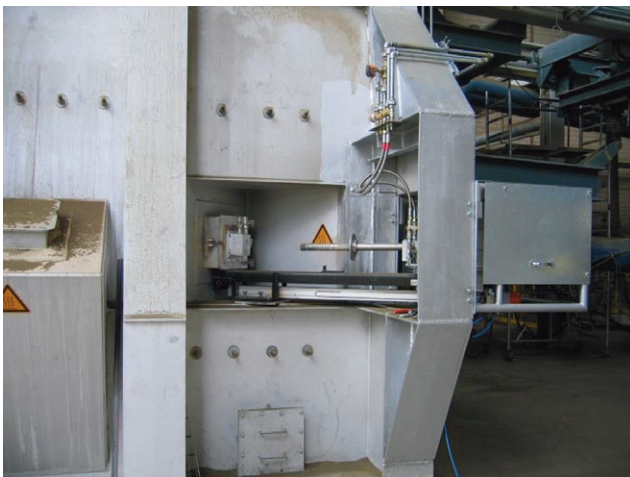


Figure 2b. PiT Multisensor on retraction unit for side view: "pocket".

Further systems, including two sensors for each kiln, are being installed this year so that the operating companies can realise the value of two separate viewing areas.

Same system, different customer target

For the new Side View Thermography, Powitec has applied the same hardware as for the installation at the kiln hood (frontal thermography). However, the endoscope is slightly longer to enable refractory penetration at a sloping angle.

Customer demand requires that the software be supplemented to describe the point of ignition as a digital value (PLUM function, representing the zone where the fuel is not yet ignited), which as a signal can be transmitted to the DCS. This reveals a new thermographic application with completely different objectives. The gasification and ignition zone right in front of the burner nozzle, i.e. the first 500 – 700 mm, can now be optimally inspected. Thus it is possible to define the flame position in the kiln (flame shaping) and to monitor the influencing effects of secondary air, clinker bed temperature, and such like.

Benefits of changeovers

Positive experience has been gained during the change of burner and kiln reconstruction. At one plant, the burner was adjusted one week ahead of schedule by the producer's own commissioning staff as, with the help of the new PiT Thermography system, it is now possible to visually check the results of the adjustments immediately. In the critical first weeks of operating a new burner, or a reconstructed kiln, both shift leaders and operators can quickly learn the correlations between the new equipment and the process. The video image, in particular, can be interpreted and is useful to all participants. Experience proves the advantage of installing the system prior to changing the burner or kiln reconstruction. The staff are therefore already acquainted with the system when it comes to "hot" operation. The simultaneous introduction of a new burner and the new thermographic system at the same time would make excessive demands. There is also a big advantage during the initial adjustment and optimisation phase if the 'reference flame' – represented by the thermographic photographs of the old burner – is available.

Benefits in specific situations

Burner start-up

Monitoring of the ignition zone in front of the burner nozzle is very helpful in order to avoid the flame's breakaway. At plants without a flame detector, i.e. where there is no automatic

interruption of the fuel supply at extinction of the flame, the operator is in charge of that important safety function. Therefore, monitoring the flame from the side is ideal.

Raw meal feed

During raw meal feed, kilns are often too dusty to interpret a video image but thermography can still deliver the required information.

Fuel changes

During fuel change, which in cement plants is a continuous process since the cement producer permanently looks for high-margin alternative fuels, thermography allows one to quickly establish a similar flame in the kiln (ignition point, length, diameter). Additionally, it is now possible to analyse which alternative fuels are considerable to the estimate of the overall costs (profit vs. process-/quality problems).

Readjustment of burner position

This effective process set value is now being used by plants more often, since the view from the side allows to easily control the effect.

Evaluation

After half a year of operational experience, a first evaluation of the PiT Indicator's functionality was given by the users.

Video image

An immediate interpretation is possible with the video image. Thus it can be used without specific training and experience of operational process. A big advantage is given by the evaluation of the flame "at a glance".

Polyline diagrams (flame variations displayed over a time axis)

Such a function allows for objective analysis of flame variations over a longer period. In Figure 4, L1 (horizontal, centre burner axis) and L4 (vertical, flame centre) have proven to be the most significant Polylines because they clearly display ignition point, fuel distribution, fuel properties and flame diameter.

The left-hand side of Figure 4 shows the thermogram and the position of the Polylines (L0 to L5). The colours in this image reflect the temperature allocation; the temperatures are indicated with numbers on the right side of the image. The thermogram is measured along selected areas named "Polyline". Six such lines (they can be drawn as straight lines or as polygons) are drawn onto the thermogram to measure the flame diameter and main part of the flame length as well as the plum and ignition point. These Polylines are automatically transferred to a time axis (right hand side of Figure 4) every second as the image updates. As

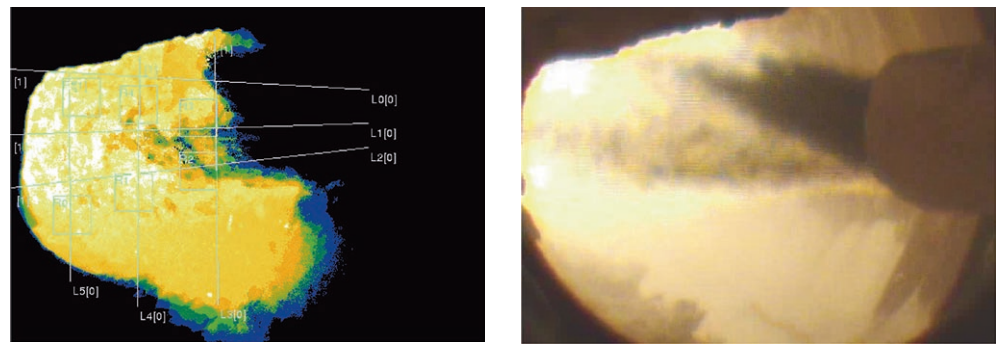


Figure 3. Left: Thermogram with PLUM function. Right: Regular video image.

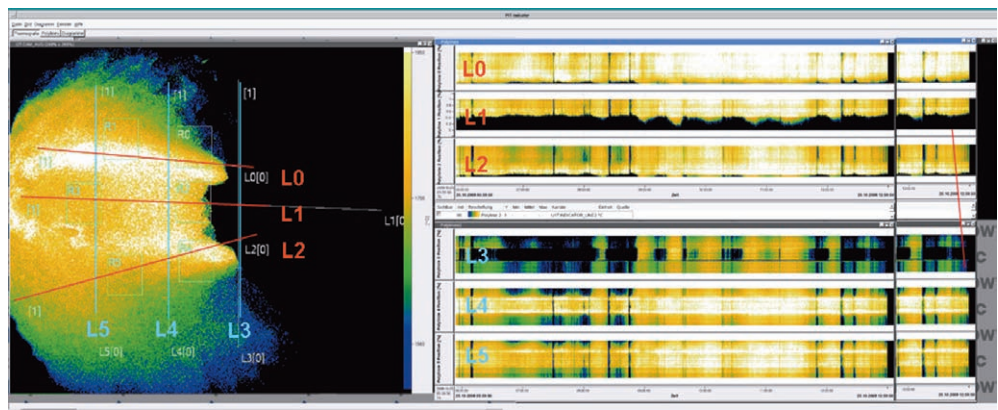


Figure 4. Thermogram with Polylines (left), Polyline-diagram (right).

time passes, the copied Polyline indication scrolls to the left as the most recent Polyline is entered at the far-right position of the axis. The resulting chronological display of the local temperature distribution offers a fast and reproducible geometric indication of information, such as flame shape, radius or diameter, distance to the burner tip and the energy radiation.

Multi-diagram (arbitrarily chosen process signals in a diagram)

The multi-diagram is used to correlate the ignition point (Polyline 1) with conventional process values like the temperature at the sinter zone or of the secondary air. The bidirectional interfaces (OPC, Profibus, Modbus etc.) to the DCS allows all the desired process parameters into the multi-diagram. Only the simultaneous and user-friendly analysis of the ignition point and temperature of secondary air allows for the evaluation of cause and effect.

ROIs (temperature measuring fields)

Based on the thermogram, the operators can use areas (regions of interest) that are marked in the matrix where the minimum, maximum and average temperature over time are calculated and displayed. This pyrometer function can also be externally used for the process control in the kiln control system, or for expert systems.

PLUM-function (ignition point as digital value)

These functions are to be applied in the next step, when it comes to automatic application within the DCS or via burner control, e.g. the PiT Navigator.

Comparison thermography/video and user groups

The video shows advantages when it comes to rapid judgment

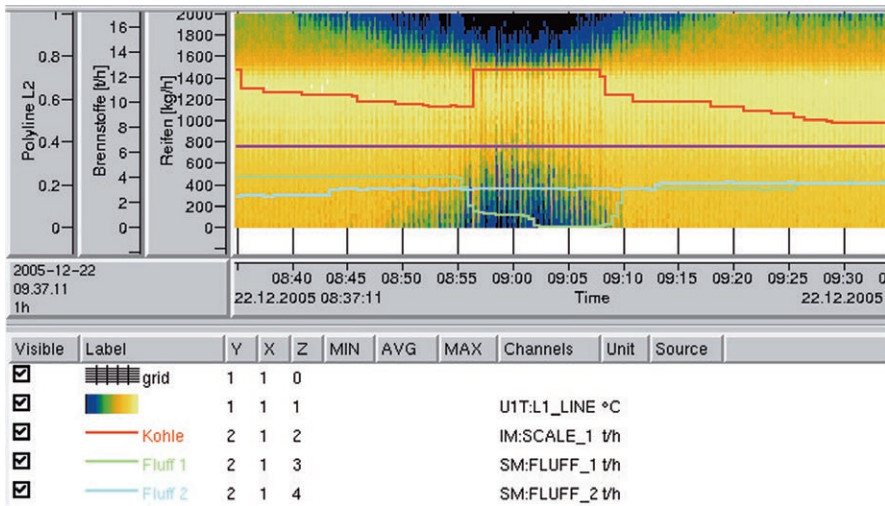


Figure 5. Flame diameter in correlation with coal and two types of fluff.

of the flame and the immediate application by the entire control room personnel. It is a very reliable aid during the ignition of the burner, and for special cases, like leaking solvents. Thermography reveals its benefits when comparing or analysing process conditions. It is also the only way for properly evaluating long term data (Polylines can be stored in a database for years). During the coming months, all customers are planning to specifically train their operators in thermographic systems, to establish short operating manuals for “reading”, and thereon to implement set point interventions along the kiln.

Results

Feedback from cement plants using the PiT navigator shows that the information about ignition point and flame shape provided by the equipment is reliable and helpful.

For example, previously, operators had just applied more fuel at a temperature drop in the sintering zone. Now, however, they can take a look at the PiT Indicator for the ignition point of the fuel. If it has moved away from the burner and the temperature of the secondary air has also dropped, operators know not to interfere and thereby save fuel.

In addition, new correlations between alternative fuels and clinker quality have been found. Before the usage of the side thermography, the igniting point and the connected placement of the sintering zone was reckoned to have a major impact on product quality. Now, the smallest or short-run fluctuations in

flame diameter are acknowledged to have a significantly larger effect on clinker quality.

Another benefit that process experts and operators have discovered is that the information from the flame is very direct and in time. Changes in fuels heating values and their impact on product quality are now instantly seen and instead of waiting for lab values for about one hour it is now possible to react directly.

Due to the knowledge and safety provided by the equipment, producers are able to operate kilns more efficiently.

This analysis instrument thus offers the possibility to improve the clinker burning process manually. The Powitec System also offers the possibility to be upgraded with automated burner control.

Currently 76 burners in power boilers are fully automatically controlled by the PiT Navigator.

Outlook and conclusion

Information from the flame combined with process information are the basis for the PiT Navigator. In an 8000 tpd kiln with a 6-stage, 2-string calciner at Gujarat cement works, the PiT Navigator achieved the following through active flame analysis:

- 1% increased production.
- 30% stabilised process.
- Reduced fuel consumption.
- 30% less NOx.

The PiT Navigator is closed-loop process optimisation software, based on statistical models (non-linear model predictive control (NMPC)) in combination with optical flame structure analysis. The PiT Navigator optimises processes with autarkic, self-learning and continuously readapting software. These NMPC models test hypothetical/alternative control actions with respect to their influence on the process. The control action that promises the best outcome concerning predefined targets is executed.

Results show that Powitec has some of the best available technology, enabling fully automatic control of the sintering process, even with a fully automated burner as an additional actuator for the holistic process control. 🌐