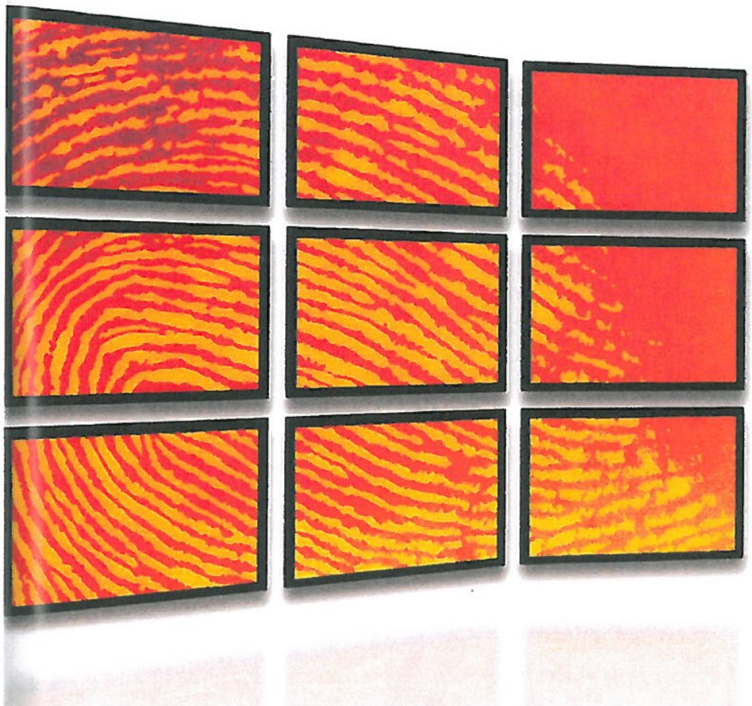
Alexander Hanf, Powitec Intelligent Technologies, Germany, explains the benefits of side view thermography at the kiln hood side.



Switching to Side View

Introduction

Using video at the kiln hood is standard technology; using thermography is becoming essential, particularly at kilns using large amounts of alternative fuels. Unstable flames caused by secondary cooler air and/or changing fuel properties have negative impacts on the sinter zone, coating, cyclone blocking, refractory, burner tip, etc. But the classic position at the kiln hood does not allow the user to optimally analyse the ignition point or changes in flame diameter over the flame length.

With the new side view thermography, it is possible to precisely analyse PLUM length, ignition point, flame diameter and main flame combustion zone. By considering these criteria over time and comparing the trends with quality criteria, it becomes possible to react appropriately and to increase the ratio of alternative fuels at constant or improved quality.

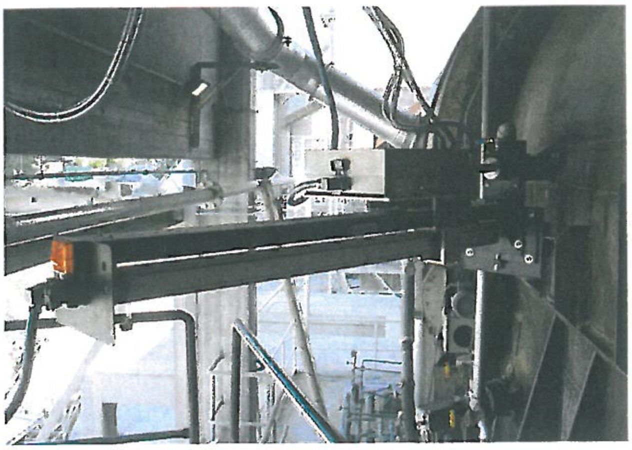


Figure 1. PiT Multisensor on retraction unit for side view - mounting flange.

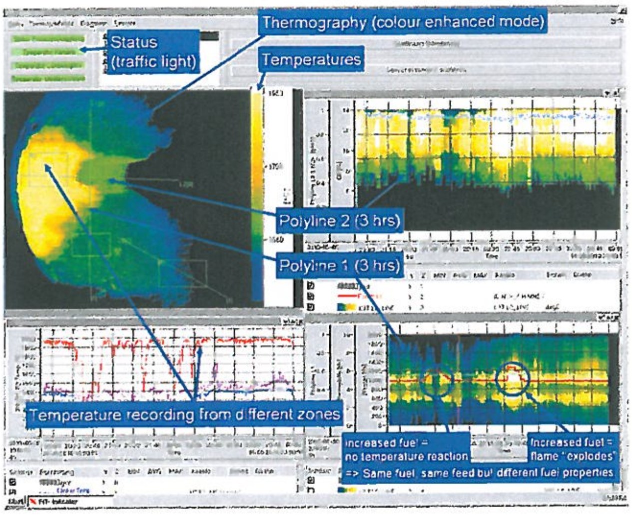


Figure 2. Generation of polylines and temperature recording.

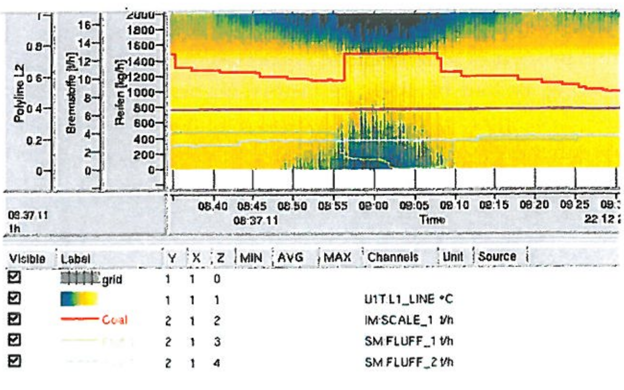


Figure 3. Multi diagram, showing polylines and process data for visual correlation.

Side view thermography

The side view thermography camera is mounted at the kiln head side (Figure 1) with an optimised viewing angle to see the burner tip and as much flame as possible.

The sensor uses an air or water-cooled, rigid endoscope with optical output to a digital camera acquiring 25 pictures/second, each with a resolution of 1024 x 768 pixels. Sophisticated software - Adaptive Electronic Dust Filter (AEDF) - reduces the negative impact of the dust load and allows reproducible images. The AEDF makes a selection of the pictures taken per second with varying exposure times from 1/10 sec to 1/10 000 sec. From this expansive image source, the AEDF selects those pixels offering the best contrast and brightness. Selected pixels are merged into a single image, which becomes the information source for RGB thermography and pattern recognition. Depending on the dust load, a new picture is shown every 1 - 10 seconds.

Temperatures are reflected by the colours (blue = 1000 °C, yellow = 1800 °C) and indicated on the right axis of the main thermographic image.

This reproducible and clear thermographic image is measured along a selected area (straight lines or polygons) referred to as the 'polyline'. These polylines are automatically transferred to a diagram whenever the image updates. With the passing time, the copied polyline scrolls to the left as the most recent one is entered at the far right position. The resulting chronological local temperature distribution offers a fast and reproducible geometric indication of the main burner flame attributes, as well as of the conditions in the sintering zone and the clinker bed.

Polyline and multi diagram

On the basis of the polyline diagram, the multi diagram is used to define the ignition point, i.e. to correlate it with conventional process data. By interfacing with the process control system, any desired process parameters can be included in the multi diagram (Figure 3). This allows correlation of the flame with major process data such as:

- Fuel (primary/secondary: quantities/calorific value or energy inputs).
- Air flow at the burner.
- Secondary air temperature.
- NOx, O_2.
- Feed.
- FCaO, C_3A, sulfation, etc.

Polyline and PLUM function

The high camera resolution enables for a PLUM function. By detecting local temperature gradients, the PLUM function determines the ignition point (Figure 4) and transmits this as a numerical value to the control system. This signal can then be processed either by chart 'ignition point/time' or by expert systems. This delivers user-friendly information on 'ignition point/flame diameter' for optimal positioning and usage of modern automated burners.

Installations

The new side view thermography has been installed at the following plants:

- Dyckerhoff Geseke, Germany.

- Dyckerhoff Lengerich, Germany.
- Deuna, Germany.
- Hranice, Czech Republic.
- Nowiny, Poland.
- Dyckerhoff Göllheim, Germany.
- Holcim Höver, Germany.
- Leube, Austria.
- Dyckerhoff Amöneburg, Germany (white cement).

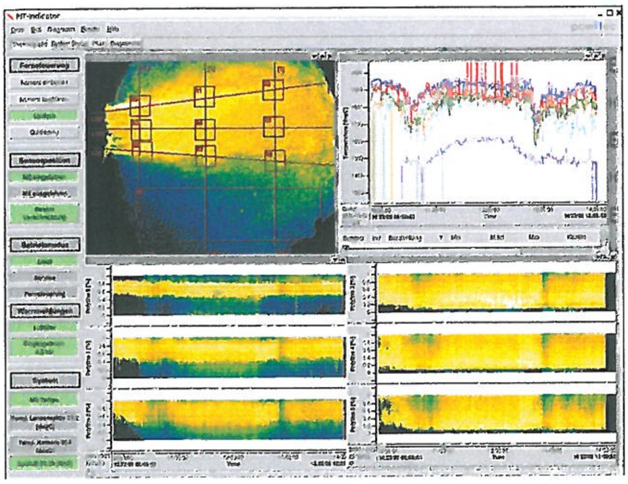


Figure 4. Six polylines showing PLUM length ignition point and flame diameter.

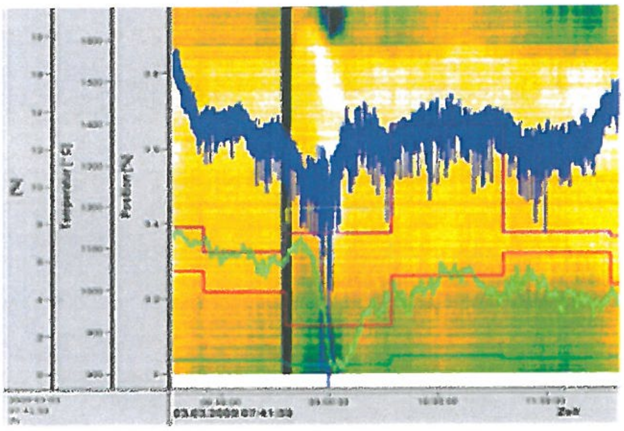


Figure 5. Correlation of the flame diameter, sintering zone and secondary air temperature with laboratory values (free lime, C_3A).

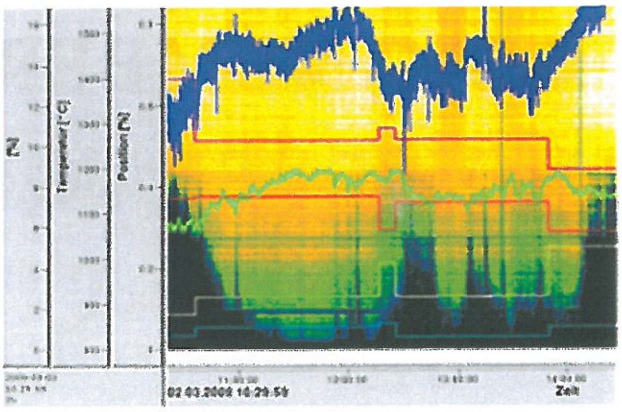


Figure 6. Correlation of the ignition point, sintering zone and secondary air temperature to laboratory values (e.g. free lime, C_3A).

Benefits

Benefits from increased and stable flame quality

Detecting the combustibility of alternative fuels

A moving ignition point and a reduced PLUM size give an early indication on loss in energy input, a change in alternative fuels qualities, or influence of secondary cooler air. Without side view thermography, this came about one hour after results of the laboratory measurements were obtained. Operators are now able to react faster to achieve a stable quality.

Impact of flame shape on quality

Depending on the general process, kiln and burner layout, the sintering process can be very sensitive to flame changes. In some plants very small changes in the flame diameter have radical effects on the clinker quality. Those plants report the following:

- The clinker burning takes place at different positions in the kiln – therefore the classic sintering zone pyrometer is of limited use in kilns with a high rate of alternative fuels.
- Long term analysis proved that the ignition point is not as important as commonly expected for the clinker quality.
- Small changes in flame diameter, even when temporary, have a larger impact on clinker quality than previously thought.
- Conclusion: changes in ignition point and thus movements of the sintering zone have been overrated. Changes in flame diameter have more impact on the product quality than changes of the flame ignition point.

For plants struggling with the general uncertainty of the availability and quality of alternative fuels, the side view thermography has become a great help in determining the impact of alternative fuels on the flame and thus on the product quality (Figure 5). It proved for some plants that the humidity of the fuel is less influential than particle size.

Burner adjustment from visual impression

Without the side view thermography, it was forbidden for operators to change the burner position, as this could lead to a dangerous suction effect. With the new instrument, operators have a clear view of the flame. In some plants, it is now possible to regularly adjust the burner position as a very effective quality control actuator.

Faster readjustment after fuel changes

As, nowadays, the fuel mix is more influential on overall plant results, fuel is purchased according to its financial benefit. Process engineers using the installed system report that it makes it easier and faster to adjust the same flame (ignition point, flame length and diameter) and to reach a stable process condition directly after a fuel change.

Fuel impact on clinker quality

For process engineers, this new instrument is extremely useful when discussing fuel qualities with the purchasing department, as the quality impact is easily visible in multi diagrams (Figure 6).

With the new side view thermography, it is possible to precisely analyse PLUM length, ignition point, flame diameter and main flame combustion zone.

Financial benefits

Increased usage of alternative fuels

For some plants, burning alternative fuels is a significant source of income. The PiT side view thermography allows for increased use of alternative fuels; some plants have increased to a constant ratio of 80% alternative fuels at the burner.

Financial benefit from flame measurement

The side view thermography delivers new process insights and allows for flame measurement. Now, as a measured variable, the flame is controllable.

This leads to:

- Reduced cyclone blockings.
- Reduced refractory wear.
- Prolonged lifetime/protection of burner tip.

Reduced energy input

Before applying the side view thermography, a sinter zone temperature decrease led to increased fuel input. If the ignition point moves away from the burner and secondary air changes, this is an indication that the sinter zone temperature signal is misleading and that it is not necessary to increase the amount of fuel.

Which alternative fuels contribute?

Because some alternative fuels are more problematic than others, there must be a full cost comparison of earnings from the alternative fuel type against the process and quality problems.

The multi diagrams allow for a direct comparison between quality problems and the type of alternative fuel and thus support a full cost comparison.

Further benefits

The side view thermography can be further upgraded to:

- An online soft sensor, predicting free lime, NOx and C_3S with unbeaten accuracy.
- A secondary cooler air control to stabilise the whole burner cooler system.
- A self-learning adaptive controller, allowing for increased production and reduced energy consumption.