Optimised sintering

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Cement clinker is produced in a series of processes, where the raw material, a mixture of components, particularly calcium oxide (CaO), silicon dioxide (SiO_2) and in smaller amounts oxide from iron (Fe_2O_3) and from aluminum (Al_2O_3) is heated in a rotary kiln to a partial melt at approximately 1450°C. This process called sintering is a critical to quality to the cement and requires an accurate control of the energy input. Accurate process control and optimised heat energy input is the basis for an optimised sintering process.

Combustion is the process that transforms the chemical fuel energy into the heat that is needed to burn the clinker. Since the ratio of energy costs versus entire production expenses in the cement industry is very extensive, secondary fuels are applied to a high degree, to save primary fuels. Secondary fuels often have fluctuating heat values. This could influence the relatively complex thermal and chemical conversion of the raw material in a negative way. Insufficient heat will cause an increase of unconverted lime in the clinker. Too much heat will shorten the lifetime of the refractory bricks in the kiln, possibly damage the kiln shell, diminish the product quality and causes an increase of the overall process costs.

What can you do?

Process control systems, as well as expert systems for optimisation task and, last but not least, the kiln operator need reliable online data from the sintering process to control the production of the clinker in the kiln and optimise the combustion process as well as the cooling process at the clinker cooler.

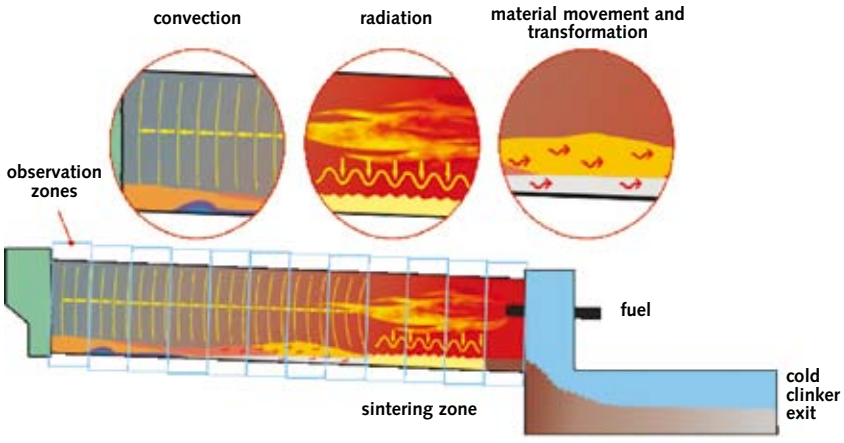
The Durag Intelligent Sensor System is an instrument to gather this reliable online information, which can not be measured with any of the standard process instrumentation.

How can you do it?

The Durag Process and System Technology GmbH can provide a system that meets the following requirements:

- real time and colour video presentation of the sintering zone at the kiln outlet
- detection of flame form and position and irregularities of the main burner
- clinker bed formation at the grate cooler to detect 'snowman' and 'red river' occurrence
- detection of burner nozzle position and condition.
- temperature measurement at the sintering zone, flame and clinker bed
- temperature distribution with spatial resolution
- evaluation of radiation energy of the flame.

The intelligent sensor system consists of industrial air-purged and water-cooled sensors, field control cabinets for data-preprocessing of the video-, thermography-, spectroscopy- and sensor signals, as well as the control PLC for the sensors safety supervision. Video monitors and the system PC are installed normally in the process control room.



The sintering process

What does the system do?

The video system:

The video system gives you a coloured real-time video image of the sintering zone and of the clinker cooler. These 'films' are permanently shown on the video monitors in the control room, to police the flame form and position, the burner nozzle position and condition and the clinker bed situation.

The thermography system:

The Durag thermography system is an optical pyrometer, based on video data processing. In addition to the video system it uses false color imaging to provide methods for:

- determining the spatial temperature distribution out of the field of view of the sensor's video system (thermal image)
- measuring the temperature within freely definable areas, region of interest (ROI) and on user definable lines (LOI = Lines of Interest)
- analysing of thermal patterns to reveal anomalies.

All data provided by the thermography system such as analytical data and temperatures are available for the control

system via standard interfaces.

What are the benefits?

The optical online analysis of the sintering process provides a number of qualitative assessments such as clinker size, flame conditions, turbidity and kiln dust level as well as 'snowman' and 'red river' conditions in the clinker cooler entry. The video system enables the operator to evaluate the current process conditions. Especially when using alternative fuels, the calorific values might change unexpectedly and subsequently, the sintering process and the quality of the clinker are significantly influenced. The thermal online analysis of the sintering process with the thermography system provides explicit data and information from the sintering process. These data are the real-time basis for the automatic process control and for the operator to take objective appraisals concerning the process and the product quality.

These data are the basis, to take active control of:

- the amount of fuel for the main burner
- the composition and ratio of secondary fuels for the main burner
- the amount of raw material and the rotational speed of the kiln
- predictive maintenance
- the amount and distribution of cooling air in the clinker cooler
- the feed rate for the grate in the clinker cooler.

The emission spectroscopy system and software is applied to analyse the monochromatic radiation from the burning process in the kiln. The spectroscopy system provides two important enhancements to the basis video and thermography system. One enhancement is the capability of accurate real temperature measurement of the burner flame and of the clinker at the kiln outlet based on quotient pyrometric analysis. The second enhancement is the possibility for gathering specific data from the sintering process with the spectral analysis and that these data can be mathematically correlated with specific data from the process control system for a free lime prediction (patented).

With spectral analysis of the specific radiation, the thermal influence from the kiln burner flame for the burner process, like emissivity and temperature transport in the sintering zone, is analysed and valuated. Under the provision that the composition of the raw material is homogeneous and stable, the temperature transfer to the raw material is decisive for the free lime content of the clinker. In this connection the prediction can be calculated with high accuracy. The online free lime prediction helps to eliminate the downtime, ie the time delay between the burning process in the kiln and the chemical analysis of the burned clinker. The free lime prediction serves to optimise the burning process and gives the operator and the process control system the opportunity for the fine tuning of the control system set points at an early stage. The free lime prediction is not a replacement for the laboratory clinker quality analysis or even the knowledge of the operator, but a good information source to optimise the process.

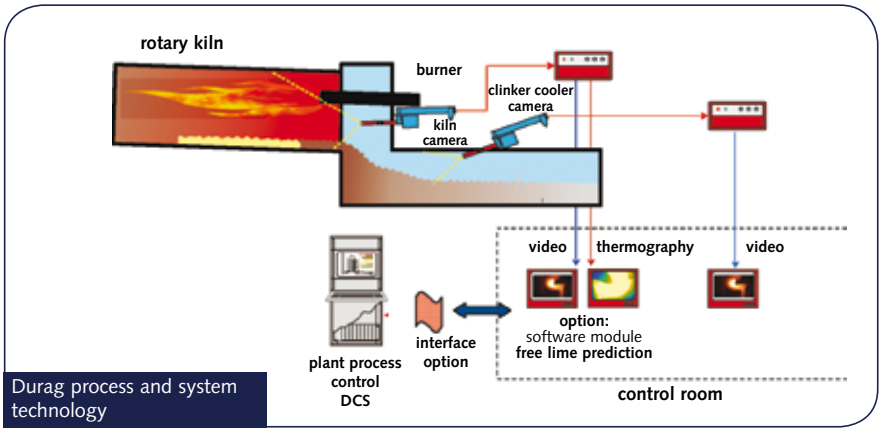
The sensors are water cooled and the optical lens systems are air purged

Where can you install the system?

To guarantee the largest possible observation space, the sensors with their optical systems are inserted directly into the high-temperature areas at the kiln hood and at the clinker cooler. Typical installations are in the oven door at the kiln hood and at the side wall of the cooler housing. For the installation at the cooler housing a sensor with a 45° optical elbow objective is used. To resist the high temperature and dusty environment conditions in this area, the sensors are water cooled and the optical lens systems are air purged. For online visualisation of the process in the sintering zone and in the clinker cooler, one video monitor for each sensor and a PC with a graphic monitor for the thermography and temperature measuring is needed in the control room.

Conclusion

The production of cement clinker by means of the burning process in a rotary kiln is from the point of view of automation control, a multivariable, non-linear system. As the sintering process is critical to the quality of the clinker, accurate control of the energy input into the process is required. With the specific output data from each of the Durag process and system technology system components, such as the video system, thermography system, temperature measurement and the free lime predictor, online data is available to assist the process control system and the kiln operator (based upon his skills and operating experiences), to control and optimise the clinker production process.



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