GETTING THE RIGHT BALANCE

Hans Conrads, Promecon, outlines how new gas measurement technologies could help enable a more consistent and accurate gas flow balance in the clinker cooler, leading to a more efficient and sustainable cement making process.

Over the past 15 years, a new measurement technology has entered the cement-producing world; this is the measurement of dusty process gas flows by cross correlation-based velocity calculation. This new technology has opened up the door for process optimisation in the pyro process, the raw milling section, as well as the finished product grinding.

Using this new technology, the following things can be optmised:

- Energy consumption of fans
- Fuel consumption in the pyro process
- Thermal NOx emissions
- Consistency of the clinkering process, including free lime formation

Figure 1. McON Air Compact System.

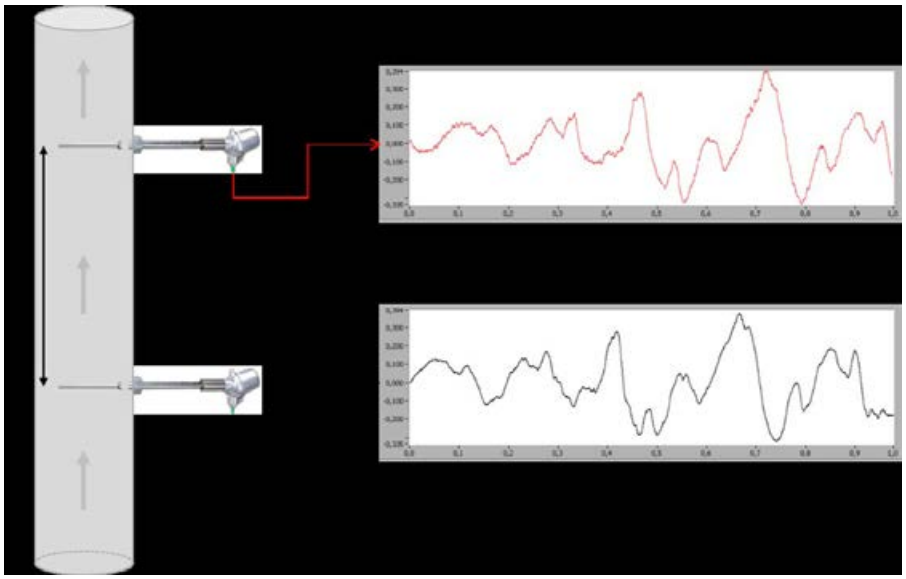

Figure 2. Cross correlation of the measurement signals.

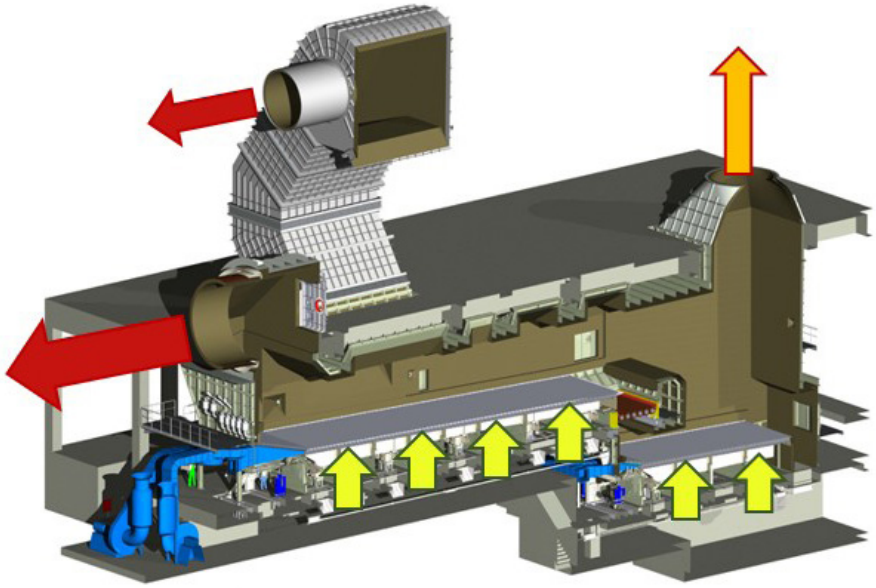

Figure 3. Clinker cooler.

PROMECON measurement systems are used in downcomers, bypass lines, tertiary air ducts, raw mill outlets and recirculation ducts, finished product mills and coal mills, and waste heat recovery ducts etc.

The basic advantage of the system is that it measures the gas flow as a digital value of time shift between two sensors. Two sensors are installed in the duct in line with the flow direction of the process gas. The clouds of the passing dust, whether clinker dust, raw meal or cement dust, will leave a charge on the antennae. This charge will be measured and digitalised. The sequence of signals recorded on each sensor are fingerprints of the succession of dust clouds travelling by. These so-called time signatures will be very similar for each measurement. However, they will have a slight time shift against each other. This time shift can then be determined by processing the signals using a cross correlation algorithm.

The digital measurement allows a flow reading that is free from drift. Any influence from dirt or dust will not lead to a change in time shift of signal between the two sensors, which is why the measurement will hold its repeatability over its entire life. No recalibration, re-zeroing or other frequent adjustment will be necessary. Other traditional devices such as a delta P probe may give drifting values after only a few hours of operation. They usually cannot be used in dusty gas flow environments without substantial drift or even failure. Hence, for many decades, cement plants could not use process-gas flow values to optimise their process. Now however, these values

are available to give deep insight into process parameters, such as:

- Enthalpy flow and heat transport.
- Quality of fan control loops.
- Oxygen transport to the calciner.
- Air leakage in kiln preheaters.
- Bypass and recirculation flows on pulverisers.

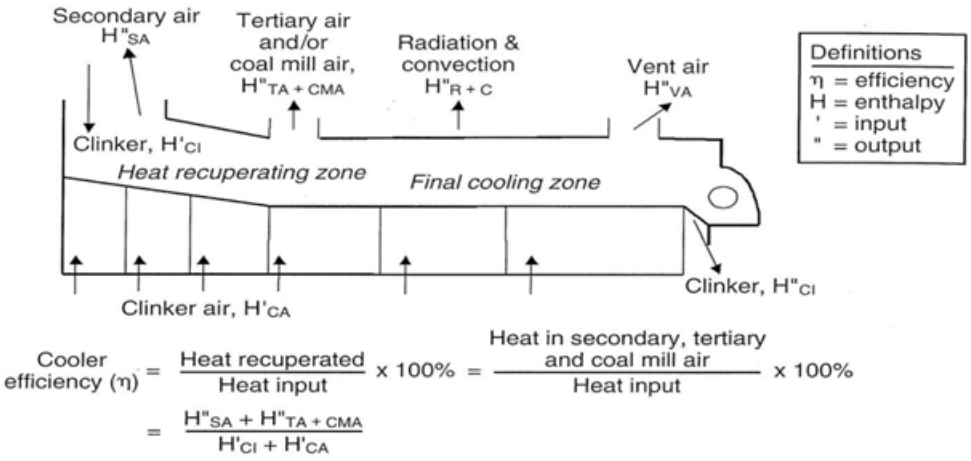

Figure 4. Efficiency of a clinker cooler.

This article looks more closely at the centrepiece of any pyro process in the cement plant – the clinker cooler.

A clinker cooler has a central function in the clinker production process:

- Cool off the clinker in a defined temperature profile.
- Recover the waste heat from the material.
- Deliver a controlled oxygen flow to the main kiln burner through the kiln outlet.
- Deliver a controlled oxygen flow to the calciners via the tertiary air duct.
- Deliver vent air for heat recovery.

The efficiency of the clinker cooler is the central point of its performance. Any clinker cooler has a flow of enthalpy into the cooler and a flow of enthalpy out of it. The inflow is dominated by the clinker itself, which comes from the kiln and drops into the cooler. The outflow is mainly dominated by the gas flows out (see red arrows in Figure 3). The efficiency of a clinker cooler is described in Figure 4.

The mass energy balance through the clinker cooler is tied to the gas flows in and out of the cooler. Traditionally, the inflow of the gases can be be measured as they consist of ambient air. But how does one measure the outflow of gases from the clinker cooler? Here, new measurement technologies can be a significant help. The tertiary air constitutes a large portion of the enthalpy out of the cooler. Waste heat at the back end can also be directly measured. Even the secondary air flow can be calculated through a gas flow balance over the whole clinker cooler. All air flows in, minus the tertiary air and waste heat gas which flows out. Of course, there will be an in-leakage into the clinker cooler which cannot be measured directly. However, besides the direct gas flow balance, the amount of secondary air can further be estimated quite well if additional measurements past the kiln inlet are used to make an additional gas flow balance over the kiln. These measurements are: the bypass measurement, tertiary air measurement into the calciner and the gas flow through the downcomer, measured in combination with an O_2 measurement.

All these measurements have been performed by PROMECON in many cement plants and can be used to look at the performance of the clinker cooler as well as the flat lined operation of the kiln and burners.

Many clients are already able to use the new measurements in order to have more consistent and accurate balance of their clinker cooler. With the rising level of good gas flow instrumentation, the cement plants of tomorrow will be able to use their new optimisers and expert systems better than before in the prediction of the complete pyro process, including the formation of product parameters such as free lime, as well as emission critical parameters such as NOx and heat loss.

Summary

Gas flow measurement has been a neglected or even widely ignored process parameter in cement manufacture because its reliable measurement in the process was so hard to achieve. Now, new solutions could lead to an even better, more efficient and more sustainable cement making process. ■

About the author

Hans Conrads holds an Electrical Engineering and Signal Processing degree from the RWTH University of Aachen, Germany. Hans has over 25 years of experience in the power industry as an entrepreneur and inventor of novel measurement systems to optimise combustion of large steam generators. He also has multiple international patents and innovation awards and is the owner and CEO of PROMECON GmbH in Germany.

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