In Full Flow

Hans Georg Conrads, PROMECON, outlines how gas flow can be better controlled and handled in the grinding and pyro processes in order to improve the efficiency of cement production.

In modern cement plants, an accurate measurement of gas flow is essential for the optimised control of processes. Whether it be the correct operation of the draught fan downstream of a downcomer in order to run the kiln air flows correctly, or the tertiary air flow into the calciner process, the correct gas flow is often the key to an optimised setting of essential process parameters.

In the cement industry, pressures as well as temperatures have often been used to calculate the process gas flows, however this method leaves uncertainty about the real flows of gas as well as enthalpy in the process.

Today, the following processes in the cement industry are of special interest when it comes to process gas flow measurement:

- Downcomer on kiln preheater: Better control of the ID fan downstream is of interest, especially the control over the O_2 content of the kiln off gas.
- Raw mill gas flow: Here the milling process is of interest, as well as the prevention of over- or underdrafting the mill. In several applications, the overall power consumption of the mill fans could be drastically reduced.
- Tertiary air duct: Here the focus is on the correct operation of the calciner as well as the right amount of bypass air around the kiln in order to reduce NO_x whilst keeping the rotary kiln at the right stoichiometry.
- Bypass: In order to measure the bypass amount of chlorine or other problematic gases in the process, the gas flow measurement is essential.
- Clinker cooler air balance: The clinker cooler is a central part of the process. The amount of enthalpy entering the cooler as solid clinker versus the amount of enthalpy leaving the cooler via the process gas is a key parameter for the optimised operation of the clinker cooler.
- Finished product: The cement mills are also usually prone to an unreliable gas flow measurement. Here, a new digital and drift-free alternative is of great interest.
- Stack: Additionally, a reliable and accurate measurement is needed on the stack. The swirl created by the ID fans is usually a challenge to any gas flow measurement. Here, the digital vector-based measurement offers a significant improvement in monitoring the total amount of emissions.

Nearly all these applications have several things in common which usually have a significant impact on conventional gas flow measurements:

- Dust load: Most of the above gas flows have a severe dust load, making it impossible to have a clean pressure tab on any of the process gas ducting. Any measurement using delta P uses the measured differential pressure as an analogue value in order to calculate the flow value by using K factors and other assumptions. The dust load makes it impossible to have a long term and drift-stable measurement. Other measurements such as ultrasonic or hot wire anemometers also suffer from the dust load, whether it is from becoming congested and dirty or suffering from heavy abrasion which makes the sensors wear out over time.
- Temperature: The second big obstacle is temperature. Some of the temperatures reach 1000°C which poses a problem for sensors themselves being subject to increased abrasion and even deformation, but also leading to a low gas density which makes delta P measurements as well as ultrasonic measurements nearly impossible.

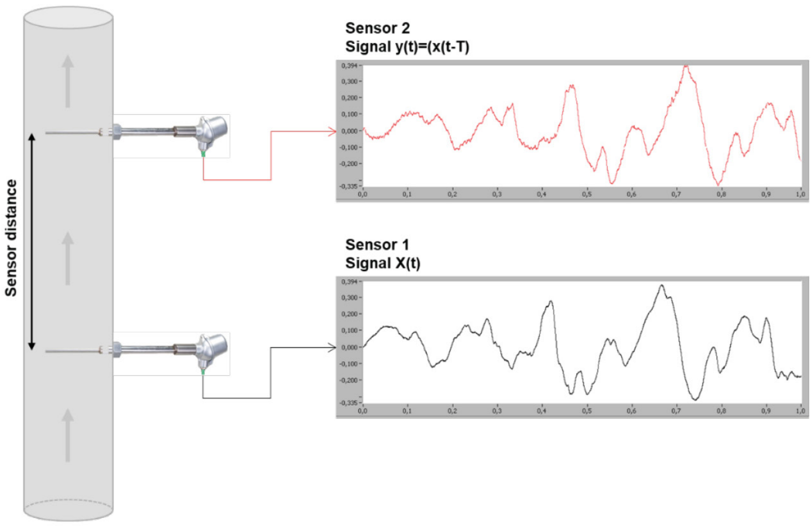

Figure 1. Digital measurement of gas flow.

Figure 2. Dust covered sensor – its accuracy is unaffected.

- Swirled flow: Most gas flows in large plant ducts have some form of swirl. Such swirl may originate from a radial or axial fan. Yet, even without a fan, swirl is very often induced by turns of the ducting, especially by multiple turns in different dimensions. A 90° turn to the left and then a subsequent turn to the front will make the gas flow swirl, as the gas by its inertia will tend to follow its initial flow impulse, which is bent in another direction by the turns.

The new system from PROMECON is a direct and digital measurement to determine the velocity of the process gas in the duct. This measurement is achieved by two sensors sensing the electric field of the particles in the process gas, passing by each antenna. The antennas are mounted at two different locations in line with the flow path of the gas.

The measurement determines the time of flight of the dust particles between the two sensors by digitally sampling the electric field of the gas and calculating the time lapse between the two sensors.

Any use of K factors or other proportional or non-linear corrections is not necessary in order to measure the gas velocity directly. Furthermore, a drift in amplitude of any of the raw signals will not have an impact on the measurement result, as the algorithm of the system only calculates the time shift between the two raw signals by observing their pattern. The amplitude of these signals is not used to calculate any flow value, which is why this measurement will not react to any dirt or dust on the sensors themselves.

As can be seen in Figure 2, even substantial amounts of dust on the sensor has no impact on the accuracy of its measurements.

As the velocity measurement is purely based on time, it is not influenced by the density of the gas. This means that even at very high temperatures, the velocity of the process gas can be measured without any degradation in accuracy. Gas temperatures of up to 1000°C are possible, therefore measurement of tertiary air or other hot combustion gases is not a problem. Further to this, it must be noted that even slight abrasion on the antennas will not lead to any accuracy issues, as the slight change in sensor diameter or cross-sectional shape does not impact on the measured time delay between sensor 1 and sensor 2.

The last big aspect of the measurement – namely the swirl of the flow – is taken care of by the fact that the sensor measures the gas velocity as a vector. The two antennas are installed parallel to each other along the flow path of the gas. The algorithm, which compares the patterns of the two sensors, comes up with a time shift of gas flow between sensor 1 and sensor 2. The velocity is subsequently calculated by dividing the distance between the two sensors by the timeshift measured. The distance between the sensors, however, is a vector that stands orthogonal on both antenna rods. Hence the calculated velocity is the vector that stands orthogonal on both sensors. As the sensors are mounted perpendicular to the duct's longitudinal axis, the measured velocity is the one along that axis. Any lateral or azimuthal component of the velocity is ignored by the measurement. This is one of the strongest aspects of this type of measurement. Not only in large ducts but also in stack

Figure 3. Gas Flow Measurement System McON Air Compact.

Figure 4. St Genevieve Measurement of air flows on all finished product mills.

applications behind an ID fan, this becomes a major advantage in terms of accuracy.

Developing the technology

PROMECON has developed this technology over the last 20 years. In addition to cement manufacture, it is used in steel mills, smelter plants and coal fired power stations. The measurement has been approved as SIL2 compliant in order to be used in safety-relevant applications according to IEC 61508.

Major cement producers, such as LafargeHolcim, CEMEX, Italcimenti, HeidelbergCement and many more are using such technology worldwide. Moreover, equipment manufacturers, such as Loesche, GPAG and FLSmidth have installed PROMECON systems on their equipment. New plants in Africa are being built by major players such as SINOMA using PROMECON flow measurements.

The possibility of accurately measuring gas flows in the cement making process opens up new ways to optimise the process itself via the following aspects:

- Saving of fan power (a major source for energy consumption).
- Making the operation of the kiln more stable and hence less prone to quality problems with the clinker production.
- Lowering NOx emissions via improved control of the calciner process through the tertiary air measurement and control.
- Better finished product quality control from due to improved management through the mill.
- Improved energy management in the clinker cooler via measurement of the enthalpy flows out of the clinker cooler.

As one of the most energy- and CO_2 emissions-intensive production processes in the world, cement making has great potential for optimisation. A major part of this in the future will be the better control and handling of gas flows in the grinding as well as the pyro process. PROMECON has become part of that process and the company aims to work hard with its clients to make cement production as efficient as possible and with that, minimise the ecological impact as far as possible. ■

About the author

Hans Conrads is an Electrical Engineer in the field of signal processing and controls with more than 25 years of industry experience. With his company, PROMECON, he holds numerous patents and applies measurement technology to power, cement and steel plants.