

Go with the flow

Todd Melick, Promecon USA, discusses the benefits of efficient gas flow measurement in cement plants.

Introduction

For the proper operation of equipment in a cement plant, knowing the flow rate is essential. In the past, high temperature and particulate in the gas stream have prevented online gas flow measurement. But the Promecon Air Flow System utilises the particulate to measure the velocity of the gas stream.

Measurement technology

The system utilises the triboelectric principle. Electrical signals created by (dust) particle clouds passing each of the upstream/downstream sensors are cross correlated and referenced by their time shift. The digital system requires no calibration, imparts no pressure drop to the system, and does not drift over time. Various applications at different cement plants will be discussed and will illustrate how the direct measurement of dust

carrying gas flows has opened new ways to monitor, control, and optimise the cement making process.

A measurement point requires the installation of a pair of sensors aligned parallel to the longitudinal axis of the pipe. Electrical signals, created by particle clouds passing over the sensors, are analysed by the instrument. Charge patterns detected by the first sensor are cross correlated with patterns detected by the second sensor. Knowing the time shift of the signals and the distance between the sensors, the velocity can be very accurately determined. Using the cross sectional area of the pipe, as well as the pressure and temperature of the stream, the volume and mass flow can be calculated. Note that the only real measurement is time and that the measurement itself is not affected by temperature or pressure conditions of the stream.

The electrical signals from the two air flow sensors are processed in the McON Air Box shown in Figure 1.



Figure 1. McON Air.

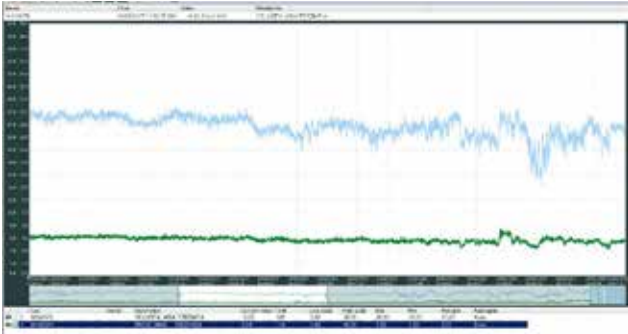


Figure 2. Tertiary Air Trend Line.

A new flow measurement is calculated every second. A larger multi-channel McON Air Box is also available for several applications that are located within 40 m.

Typical plant applications

Raw mill

The raw mill is usually a large vertical roller mill (VRM) that is designed to grind with a specific material to air ratio. Too little air flow and the mill can plug, too much air flow and the fineness can decrease, the additional fan power is expensive, and the wear through out the system is increased. The large power requirement of the grinding process results in a short payback. The first raw mill installation in North America in 2004 was in Midlothian, Texas on two mills. The high moisture content required higher than normal air flow to dry the material and the mill ID fan power consumption was about 60% of the total grinding system. The plant personnel determined that they could lower energy costs and reduce duct wall erosion by automatically controlling the fan speed based on flow measurement of the gas through the mill. The plant had tried several relative flow indicators such as differential pressure across the raw mill cyclones, calculated air flow using fan motor amps, differential pressure across the fan itself, and mill inlet pressure. None of these approaches provided a reliable measurement that could be used for consistent operation. Air flow sensors were located after the cyclones and before the baghouse. After startup, the plant performed pitot traverses of the duct and concluded the Promecon measurement agreed. The

energy savings (as determined by the plant) was 0.5 – 1 kWh/t of raw meal.

Downcomer gas flow

The gas flow measurement in the downcomer can be utilised by a 'high level' control system to stabilise the kiln operation and save fuel costs. A previous control strategy was to control the kiln ID fan with the oxygen measured with a gas analyser. The oxygen content should confirm the complete consumption of the fuel inside the calciner, but the oxygen value can fluctuate due to the changing heating value of the fuel. This fluctuating value is difficult to control and often requires smoothing. Also the dead time of the oxygen sampling system and analyses has to be considered. The gas flow measurement of the Promecon system is nearly real time. So controlling the kiln ID fan with the gas flow measurement and monitoring the oxygen content provides a more stable kiln operation. The gas analysis equipment requires maintenance, so using the gas flow measurement also avoids the blind kiln operation during these maintenance periods. Independent experienced process experts have confirmed that a more stable kiln operation can reduce the energy consumption up to 5%. But if only 1% reduction is achieved, then the return on investment is less than 3 months. If the downcomer has water spray nozzles, then the air flow sensors are located just upstream of the water spray.

Tertiary air duct (TAD)

The TAD is one of the most difficult applications in the cement plant. So many plants do not have flow measurement and only monitor the static pressure. The actual flow measurement of the TAD provides process knowledge and is more effective for closed loop control. The TAD flow measurement signal is used to regulate the load on the precalciner to achieve the optimal energy distribution and stabilise the process.

There is usually a long straight run of duct for this application, but the issue can be access to the TAD. At these elevated temperatures the clinker can be sticky, so provisions for purge air to keep the opening through the refractory clean might be required.

Figure 2 illustrates the trend of the Promecon volume flow measurement (blue line) in comparison with the pressure (green line) and showing that the flow measurement is more sensitive in following the process variations and detect incoming events.

Cement mill

If the cement mill is a VRM, then the application is the same as the raw mill described above. If the cement mill is a ball mill, then the applications can be to measure the air flow to the mill sweeps and the flow to/from the separator in order to stabilise the operation resulting in a more consistent grind.

Coal mill

The coal mill is usually a VRM so it is important to control the air flow accurately. The flow can be measured to the mill or at the outlet pipe from the mill. For direct fired kilns it is important to measure/control the primary air to the burner.

Clinker cooler

For control and process knowledge the off gas from the cooler can be measured. By this a complete air flow balance through the clinker cooler can be established. The secondary air going into the kiln can be calculated online out of this clinker cooler balance.

Bypass ducts and unique applications

Many plants have bypass ducts and unique applications that are not typical applications as described above. But the Promecon system provides the ability to measure and control some of these applications that have never been measured before.

Conclusion

The cement industry has learned to survive without flow measurement for many difficult applications. With the advent of triboelectric cross-correlation technology, accurate and repeatable flow measurement is now possible in very dirty gas streams at temperatures up to 1100°C (2000°F). Properly integrated into the plant control system, this technology will increase the efficiency and profitability of the processes where it is utilised.

A large number of installations have proven that the technology is reliable and requires virtually no maintenance. The air sensors can be installed online in most duct applications and there is no calibration required. A major advantage of this technology for process flow applications is that it is not affected by particulates present in the air stream. These advantages make the system attractive for measuring a very diverse range of process streams. 🌐

About the author

Todd Melick is a Mechanical Engineer with 38 years of industry experience with Babcock & Wilcox, GE, and for the past 15 years applying Promecon technology to power, cement, and steel plants.