Combustion Optimization

Reason for being

To optimize combustion processes, both O2 and CO must be measured on-line. Excess O2 in the exhaust stream represents energy waste as this air volume is heated by the combustion and then lost through the chimney. By reducing the excess O2 levels in the boiler exhaust, fuel is saved. For boilers larger than 40 MW thermal power production, even a reduction of 0,1 % in excess O2 represents millions of dollars annually in fuel savings.

Excess O2 in exhaust streams is caused by feeding more air to the boiler burners than is needed for combustion of the fuel qualities present. Being that air contains around 79% nitrogen and nitrogen at the high furnace temperature produces NOx, reductions in O2 translate into reductions in NOx emissions as well.

In attempting to minimize the excess O2 levels a point is reached where CO production rises sharply. CO is essentially incompletely burned fuel due to insufficient oxygen for the burner's needs. The function of any burner is to provide the best possible homogeneous mixture of air and fuel. Variations from the perfect air/ fuel mix are the result of burner placement in the furnace, burner condition and fuel characteristic variations. The only way to ensure that the correct air/fuel ratio is maintained at all times is to measure both O2 and CO concentrations online in the exhaust.

ProCeas' improved resolution and shorter measurement cycle times (roughly 2 minutes shorter than the current Zirconium Oxide sensor response times) open doors to new excess O2 regulation possibilities. By varying the air feed to a single burner alone, and measuring simultaneously the CO level, the optimized individual burner air feed is determined directly from one exhaust stream measurement point.

Features and benefits

- the system is more accurate than the existing O2 and CO sensors currently installed. This accuracy makes the concentration variations more visible.
- the O2 measurement reactivity is around 2 minutes faster than Zirconium Oxide sensors. Cyclic variations of short duration are visible (periodicity under a minute).
- the measurement of both O2 and CO requires only one sample probe (sample extraction point)
- the system analyses both O2 and CO based on exactly the same sample which provides a perfect correlation of the two measurements
- the system adjusts each measurement to the actual condition of the instrument. This is the equivalent of a full instrument calibration for each measurement and provides exceptional long term measurement reproducibility
- the low pressure sampling system (LPS) reduces the sample pressure to 50 mbar from the point of extraction to behind the laser cavity. This reduces the danger of condensation significantly
- the fact that the sample pressure is reduced just after the sample extraction means that the sample expands in the sample transport line. With a pressure reduction to 50 mbar the sample transport speed is 20 times faster than it would be at atmospheric pressure.
- being that the sample transport speed is multiplied the sample flow rate that is extracted from the chimney can be reduced while still ensuring rapid sample transport. The lower sample extraction flow rates prevent filter clogging.
- sample extraction is interrupted during chimney sweeping cycles. Samples are only extracted during periods where soot loads are low
- no sensors are exposed to the high temperature exhaust stream
- low pressures translate into reduced corrosive attack on the instrument. Even with high H2S concentrations the instrument does not drift.
- though only CO and O2 are measured for most systems, H2S, H2O and NH3 can be measured with the same system concept through addition of lasers with different wavelengths

ProCeas configuration

- standard Mural IP-65 cabinet
- dual and single laser module versions
- vacuum pump mounted on cabinet base plate
- CEM sonic nozzle for sample gas extraction
- 4-20 mA measurement output if needed
- potential free contact input to signal chimney sweep procedure
- RS-485 serial data output
- Ethernet with modem installed for remote technical support (RJ45) inside the unit housing
- USB connection on side panel for PC connection
- optional cooling system for ambient temperatures between 35 - 55°C.
- power supply: 100-240 VAC / 2A 50/60 Hz

High Speed Stream Selector

Optimization of individual burners by varying the air feed and measuring excess air and CO concentrations in the exhaust gas stream takes about a minute per burner. If there are more than 8 burners in the combustion chamber, the time needed to monitor each burner directly takes too long. In such cases, a grid of sample extraction points is installed just after the boiler heat exchanger. The stratification of the exhaust gas stream at this point, allows the measurements taken in the grid section to be used to characterize the individual burner conditions.

For this approach a fast sampling concept is available. Up to 32 sample streams can be analyzed with a new measurement from all extraction points every minute. The software supports full data management. Stored data can be provided as snapshots of the sample extraction grid concentrations with a new grid snapshot every minute. All spatial and temporal variations at all grid points can be reproduced.

A Fast Sampling System for 6 grid points is shown in the diagram below.