Maintaining Accuracy with AccuMax™ Performance Enhancing Zirconium Oxide Oxygen Probes

The zirconium oxide (ZrO_2) cell is the technology of choice for measuring oxygen in combustion flue gases. Key advantages of the ZrO_2 cell are:

- Output is inverse and logarithmic. Raw oxygen signal from the cell increases at the very low levels of oxygen usually found in combustion processes. Instrument accuracy also improves with decreasing oxygen levels and is stated as a percentage of reading, rather than a percentage of full scale range.
- ZrO_2 cells operate well at high temperatures. Indeed, the optimum operational temperature for the technology is around 700-800°C.
- ZrO_2 cells are very robust and survive well in combustion flue gas applications.

X-STREAM In Situ Oxygen Transmitter with Xi Enhanced Interface improves accuracy and reduces calibration maintenance costs

Despite the robust nature of the ZrO_2 cell, periodic recalibration is required, even for those cells operating at optimum temperatures (high temperature applications must be addressed separately). Cell degradation takes place due to deterioration of the platinum electrode structure. There are two mechanisms of sensor cell electrode structure degradation. The first mechanism is related to the coarsening of the electrode structure during operation at normal/optimal temperatures (750°C). This process is very similar to what occurs with grain growth in metals during recrystallization. Increase in the platinum particle and the pore size of the ZrO_2 sensor reduces the number of pathways for oxygen ions to pass through the cell, resulting in a progressively lower output signal for a given oxygen level over time. As a result, the cell resistance increases and cell output drops, resulting in high measurement error, sluggish response and a low cell slope.

The second mechanism is related to chemical corrosion. Sulfur is the most damaging substance commonly found in combustion flue gases. Under oxygen depleted or reducing conditions sulfur dioxide will react with combustibles present in the flue stream to form gaseous sulfur as follows:

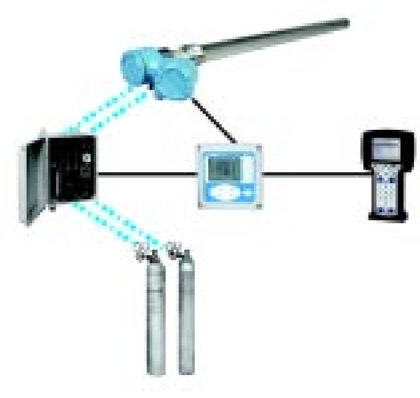
$$SO_2 + 2CO \Leftrightarrow 2S(g) + CO_2$$

Gaseous sulfur reacts with the ZrO_2 sensor's platinum electrode materials, forming a platinum sulfide which is volatile and evaporates at operating temperatures shown as follows:

$$Pt + S = PtS$$

Again, the cell resistance increases and cell output drops, resulting in high measurement error, sluggish response, and a low cell slope.

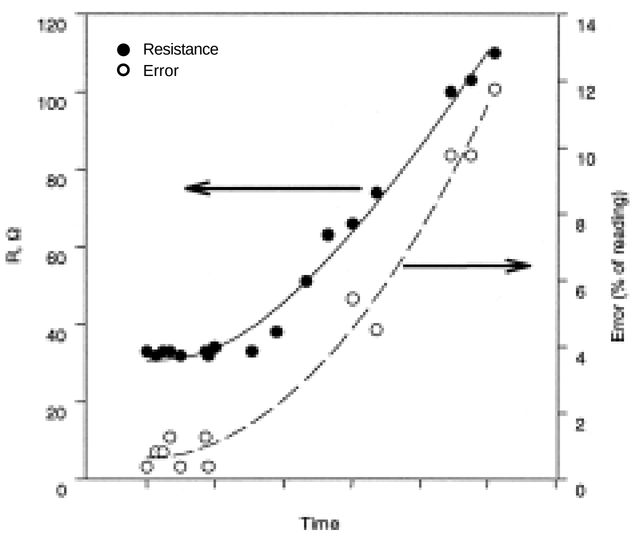
There are numerous other variables contributing to the overall accuracy of the measurement. Degradation of the ZrO_2 cell due to process variables is one. Some others are effects due to process flue gas temperature, flue gas flow, calibration gas standard's accuracy and even the way calibration gas is introduced to the sensor during the calibration process. All of these variables can influence and create more subtle errors which negatively impact the overall accuracy of the oxygen measurement.



X-STREAM In Situ Oxygen Transmitter & Xi Enhanced Interface Auto Calibration System

How Does AccuMax Help to Improve Accuracy?

Numerous variables create small inaccuracies in oxygen measurements that can result in less than efficient combustion control and wasted fuel. The measurement of flue gas oxygen is critical to the efficient operation of any combustion process and reduction of greenhouse gases. Calibration intervals for ZrO_2 cells are extremely important for the improvement of the operation of the system but the design of the X-STREAM™ In Situ Oxygen Transmitter is the first oxygen analyzer to be tested for the impact of these variables and designed to make measurable improvements. The re-designed internal mechanical assembly has been built around the premise that the more stable the cell temperature stays the more accurate the oxygen measurement is. The 'Process Temperature Effect' has been reduced to less than .05% due to the new design of the heater and the control software supporting the cell signal. Other developments include the infusion of cell gas in a manner closely replicating the process diffusion of flue gases to the sensor. Traditional oxygen analyzer systems can induce as much as a .2% error in the measurement by injecting the gas too closely to the sensor.



AccuMax & Xi Enhanced Calibration Recommended Diagnostic

As with other Rosemount Analytical products the measurement of cell resistance is still the major indicator of ZrO_2 cell health and relates very strongly to accuracy, as shown in the graph on this page. Emerson Process Management has enhanced this diagnostic feature developed for our earlier product which measures cell impedance on-line. The re-designed circuitry and increased frequency of these on-line measurements improves the reliability of this diagnostic function.

This feature has been incorporated into the Rosemount Analytical X-STREAM In Situ Oxygen Transmitter and Xi Enhanced Interface. The X-STREAM Oxygen Transmitters' 4-20 mA signal output representing oxygen is unaffected during this instantaneous measurement of cell quality. When cell impedance increases to a point where a need to calibrate is indicated, the operator is notified in several ways:

- Indication is provided over the 4-20 mA signal wires via HART® protocol and may be displayed on a Model 375 Hand-held Communicator or on a PC console through AMS software
- The Xi Enhanced Interface can give a visual indication of cal recommended or a relay out put from the Xi can trigger a remote indication that the X-STREAM In Situ Transmitter should be calibrated.
- If the Xi is connected to an automatic calibration system (SPS or IMPS) the calibration recommended alarm can trigger a calibration.

This feature has the potential to greatly minimize the resource requirements normally associated with oxygen flue gas analyzer calibrations and maintenance. For example, instrument technicians may never need to visit the analyzer location on the stack until an actual failure occurs. Routine calibrations done on a preventative basis are no longer required. This can reduce maintenance hours spent on these analyzers and lowers the overall consumption of costly calibration gases initiated by unnecessary work. These savings can provide a return on investment (ROI) for the oxygen analyzer in very short time periods, sometimes only a few days or weeks.

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