Effects Of Operating Conditions On Oxygen Sensors

Matrix Gas Effects Humidity. Humidity affects the oxygen sensor only by diluting the oxygen in the air. This effect is greater at higher temperatures, as seen in the table below.

Humidity Effect on Apparent Reading (%) in Air

RH	0° C	20° C	40° C
0%	20.9	20.9	20.9
50%	20.9	20.7	20.2
100%	20.8	20.5	19.4

Cross-sensitivity. Parts-per-million levels of other gases have no effect on oxygen sensors. Oxidizing gases like chlorine, bromine, chlorine dioxide, and ozone at percent levels interfere proportionally to their oxygen equivalence.

Cross-sensitivity to Matrix Gases

Gas	Concentration (Volume %)	% of Signal Change
CO	20%	<-0.5%
CO_2	20%	~6%
CH_4	100%	0
H_2	100%	<-2%
Hydrocarbons	100%	0

Oxygen sensors are be damaged when used continuously in >25% CO_2 or SO_2, which absorb into the electrolyte, causing an increased signal. SO_2 also reacts to reduce oxygen under very high humidity contitions.

Carrier Gas Effect. High concentrations of matrix gases other than nitrogen (e.g., air), affect the response of one-year capillary oxygen sensors. The effect depends on the molecular weight difference in the matrix gas:

$$\text{Reponse} = \text{Response in } N_2 \text{ (air)} \times \sqrt{28/MW}$$

Where MW = average molecular wt. of the matrix gas:

28 = molecular wt. of nitrogen

For example, for a sensor calibrated in air and used to measure in 80% helium/20% nitrogen mix:

$$\text{Average molecular wt.} = 0.8\,(4) + 0.2\,(28) = 8.8$$

$$\text{Reponse} = \text{Response in } N_2 \text{ (air)} \times \sqrt{28/8.8} = 1.78$$

Therefore, the reading is 78% higher in the He/N_2 mix and would need to be divided by 1.78 to obtain the true reading.

Pressure Effects

The normal operating range for oxygen sensors is within 20% of ambient pressure. Pressure changes are common in such places as entering a tunnel, going up in a high-rise building, or flying in an airplane. RAE Systems provides both one-year and two-year oxygen sensors, and pressure effects on the two-year sensors are generally more pronounced.

Capillary sensors used by RAE Systems offer the advantage over non-capillary sensors in that their final response is unaffected by ambient pressure. They measure true volume percent. However, when a sudden pressure change occurs, the sensor gives a transient high or low response (pressure increase causes a high reading and vice versa). This transient response decays quickly to a stable reading in less than one minute when using a 1-year sensor. On the other hand, 2-year sensors have a narrower orifice that results in a slower response to pressure changes. The 2-year sensors may take several minutes to stabilize after a pressure change. Therefore, it is likely that the unit will alarm after a sudden pressure change. In such cases, the unit should be allowed to equilibrate for several minutes under the new pressure before turning on or recalibrating. After pressure equilibration, the response time of the 2-year sensors returns to normal and provides adequate protection.

Warning: The 2-year oxygen sensor may cause an alarm when subject to a sudden pressure change even when a safe level of oxygen is present.

Temperature Effects

Oxygen sensors show almost no effect of gradual temperature changes, the response being <15% lower at -20° C (-4° F) than at +50° C (+122° F). Sudden temperature changes cause a transient response similar to those caused by pressure changes, but in the opposite direction (a reduced response with a temperature increase and a high response at lower temperature). A sudden temperature change may cause the instrument to alarm, but the reading should equilibrate in <30 seconds. Temperatures over 100° C (212° F) permanently damages the sensors.

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