IMPACT OF ATMOSPHERIC CONDITIONS ON OXYGEN MONITOR READINGS

Micro-fuel cell sensors are partial pressure devices. Changes in atmospheric conditions cause variations in oxygen partial pressures and therefore produce variations in sensor outputs. In this note, we examine the effects of changes in atmospheric pressures and relative humidities on sensor responses assuming the oxygen percentage remain constant.

To estimate the effects of changes in ambient conditions, we note that the atmospheric pressure is the sum of the partial pressures of its constituents:

$$P_{atm} = P_{oxy} + P_{water} + P_{other\ gases}$$

The ratio: $[P_{oxy}/(P_{oxy} + P_{other\ gases})]$ is about 20.9% and is generally referred to as percent oxygen.

The partial pressure of water, P_{water} is a function of temperature and relative humidity. P_{water} at 100% R.H. and 33 degrees Centigrade has a value of ~5 kPa (or 1.48 inches of mercury).

Changes in atmospheric pressures:

Atmospheric pressures typically vary between 29 to 31 inches of mercury. Assuming a relative humidity of ~50% (corresponding to a partial pressure of approximately 0.74 inches of mercury or 2.5 kPa), this implies the partial pressures of oxygen will vary from:

$$20.9\% * (29 - 0.74) = 5.91 \text{ inches of mercury}$$

to

$$20.9\% * (31 - 0.74) = 6.32 \text{ inches of mercury}$$

(assuming oxygen percentage remains at 20.9%).

A micro-fuel cell sensor spanned (set to 20.9%) at 31 inches of mercury will show an oxygen percentage reading of:

$$20.9\% * (5.91 / 6.32) = 19.54\% \text{ (a drop of 1.36\%)}$$

as the atmospheric pressure drops to 29 inches of mercury in spite of the fact that the actual oxygen percentage remains constant.

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Likewise, a micro-fuel cell sensor spanned (set to 20.9%) at 29 inches of mercury will show an oxygen percentage reading of:

20.9% * (6.32 / 5.91) = 22.35% (a rise of 1.35%)

as the atmospheric pressure rises to 31 inches of mercury.

Changes in relative humidity:

Assuming the atmospheric pressure remains constant at 30 inches of mercury, change in relative humidities from ~50% to ~100% (corresponding to a change in water partial pressure of 0.74 to 1.48 inches of mercury) causes the partial pressures of oxygen to vary from:

20.9% * (30 - 0.74) = 6.11 inches of mercury

to

20.9% * (30 - 1.48) = 5.96 inches of mercury.

A micro-fuel cell sensor spanned at 50% R.H. will show an oxygen percentage reading of

20.9% * (5.96 / 6.11) = 20.39% (a decrease of 0.49%)

as the R.H. rises to ~100%. On the other hand, its reading will change to

20.9% * (6.11 / 5.96) = 21.4% (an increase of 0.5%)

after spanning if the R.H. changes from near 100% to 50%.

Changes in temperature:

The sensor is compensated for temperature changes through the use of a thermistor. This scheme is specified by Teledyne to compensate the output of most microfuel cell Oxygen analyzers within 5% of scale in a steady state condition. During periods of rapid temperature change, the output can exhibit errors in excess of the 5% of scale specification, as the thermistor and the sensor equilibrate to the new temperature at different rates.

Overall impact:

A sensor spanned at 31 inches of mercury atmospheric pressure and 50% R.H. could show a reading of 19.05% (a drop of 1.85%) if the pressure drops to 29 inches of mercury and R.H. increases to ~100%.

However, depending the actual changes in atmospheric pressure and R.H., the drifts in oxygen monitor instrument reading may not be significant as change in atmospheric pressures could compensate for the effects due to the change in R.H.

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