UNISENSE

Temperature response of Unisense oxygen microsensors

The signal of an oxygen sensor is temperature dependent, as factors influencing the sensor signal varies with temperature. Within the temperature range from 5-30 C the signal *S* of a Unisense oxygen sensor, at the temperature *T* and partial pressure *P* can be described as (1):

$$S(P,T) = Z + a(T)P \quad (1)$$

The zero current *Z* for a Unisense sensor is approximately temperature independent. The coefficient *a* is temperature dependent as described by equation 2:

$$a(T) = Ae^{kT} \quad (2)$$

By substituting 2 into 1 we get the following expression

$$S(P,T) = Z + Ae^{kT}P \quad (3)$$

The sensor signal at a known temperature T_0 and partial pressure P_0 is

$$S(P_0,T_0) = Z + Ae^{kT_0}P_0 \quad (4)$$

Which can be rearranged to

$$A = \frac{S(P_0,T_0) - Z}{e^{kT_0}P_0} \quad (5)$$

Substituting 5 into 3 and 4, we can rewrite these to

$$S(P,T) = Z + (S(P_0,T_0) - Z)\frac{P}{P_0}e^{k(T-T_0)} \quad (6)$$

or

$$\ln(S(P,T) - Z) = \ln(S(P_0,T_0) - Z) + \ln\frac{P}{P_0} + k(T - T_0) \quad (7)$$

By plotting the signal *S(P,T)* as a function of temperature *T* a fixed partial pressure *P* in equation 7, *k* can be determined as the slope to a linear fit of the plot.

$$P = \frac{S(P,T) - Z}{S(P_0,T_0) - Z} P_0 e^{k(T_0 - T)} \quad (8)$$

Once k is determined it is from (8) possible to determine the partial pressure P from sensor signals S and temperature measurements T, providing the zero current Z, and a standard signal at a known temperature and partial pressure $S(P_0,T_0)$, is known.

The temperature coefficient k can vary from sensor to sensor due to differences in internal dimensions and membrane thickness, although it for most sensors is between 0.015 T^{-1} and 0.025 T^{-1}. The temperature coefficient has to be determined individually for each sensor if an exact correction is needed.