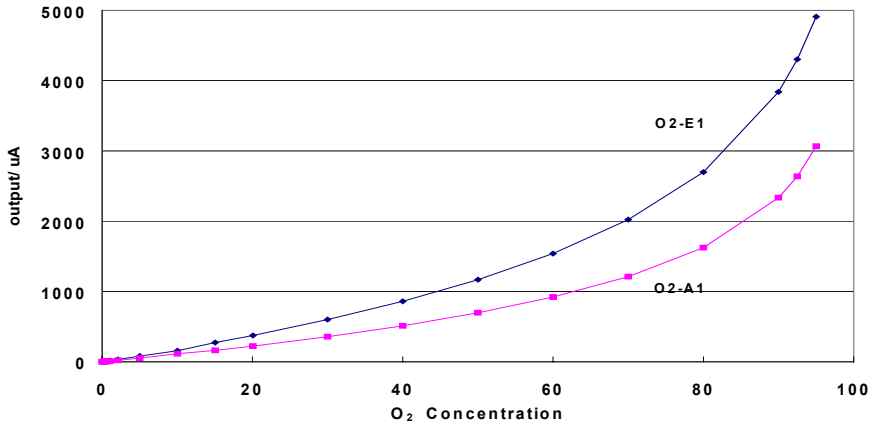
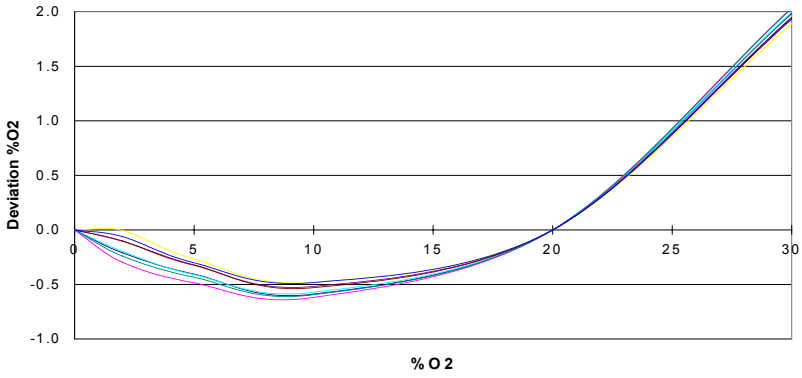
Non-Linearity of Mass Flow Controlled Oxygen Sensors

Figure 1 Output versus % oxygen concentration for an oxygen sensor



Electrochemical mass flow oxygen sensors, using a capillary for oxygen diffusion control, show a non-linear response to oxygen, as shown in Figure 1. This non-linearity is due to a pressure difference across the capillary, so is the same for all sensors.

Figure 2. Non-linearity from 0 to 30% oxygen for mass flow oxygen sensors



If a straight line intersecting at 0% and 20.9% oxygen is drawn through the non-linear response curve of an oxygen sensor, then the greatest non-linearity is half way, at 10% oxygen; see Figure 2 below.

T: +44 (0)1376 556700 E: sensors@alphasense.com W: www.alphasense.com
Sensor Technology House, Skyline 120, Great Notley, Braintree, Essex CM77 7AA, UK

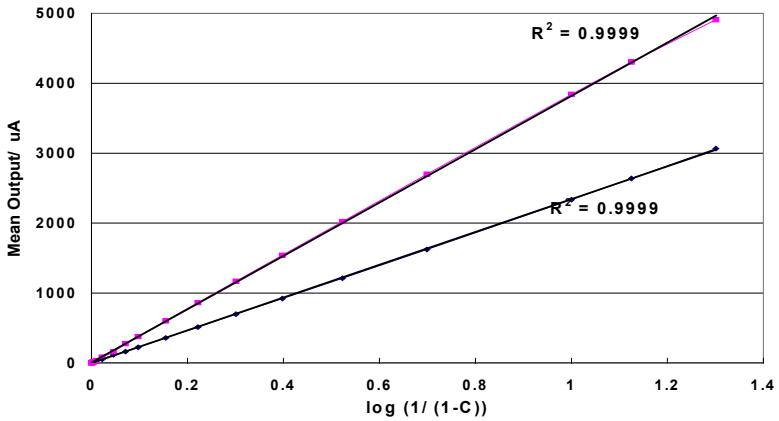
In practice this error is insignificant at normal oxygen concentrations in safety devices and can be compensated by using either the formula below or by simulating the non-linear curve with a polynomial.

Output = K*ln(1/(1-C))

(C is the fractional concentration of oxygen between 0 and 1 (ambient oxygen is 0.209), and K is a constant). This linearisation is shown in figure 3 below for oxygen sensors from 0 to 95% oxygen.

The above equation shows that at high oxygen concentrations the output of the sensor becomes very non-linear. In fact, at 100% oxygen the sensor output is about 20 times the output at 20% oxygen. Mass flow oxygen sensors are not recommended for measuring oxygen concentrations above 95% oxygen concentration because the non-linearity is no longer repeatable.

Figure 3 Linearised output for mass flow oxygen sensors: compare with figure 1.



Summary

1. The small non-linearity shown by Alphasense mass flow control oxygen sensors at normal oxygen concentrations can be ignored.
1. For sensors calibrated at 20.9% oxygen, the non-linearity is worse at half range: 10% oxygen.
1. If you wish to compensate for this non-linearity, then use either the log formula shown above or an equivalent polynomial expansion.
1. Do not use this type of oxygen sensor to measure oxygen concentrations above 30% oxygen continuously, or 95% oxygen for short times. Alphasense oxygen sensors are specified for use up to 25% oxygen but can, with shortened lifetime, be used at higher concentrations. For use above 25%oxygen with reduced warranty period, consult Alphasense.

T: +44 (0)1376 556700 **E:** sensors@alphasense.com **W:** www.alphasense.com
Sensor Technology House, Skyline 120, Great Notley, Braintree, Essex CM77 7AA, UK