AAN 003 NON-LINEARITY OF MASS FLOW CONTROLLED OXYGEN SENSORS

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.

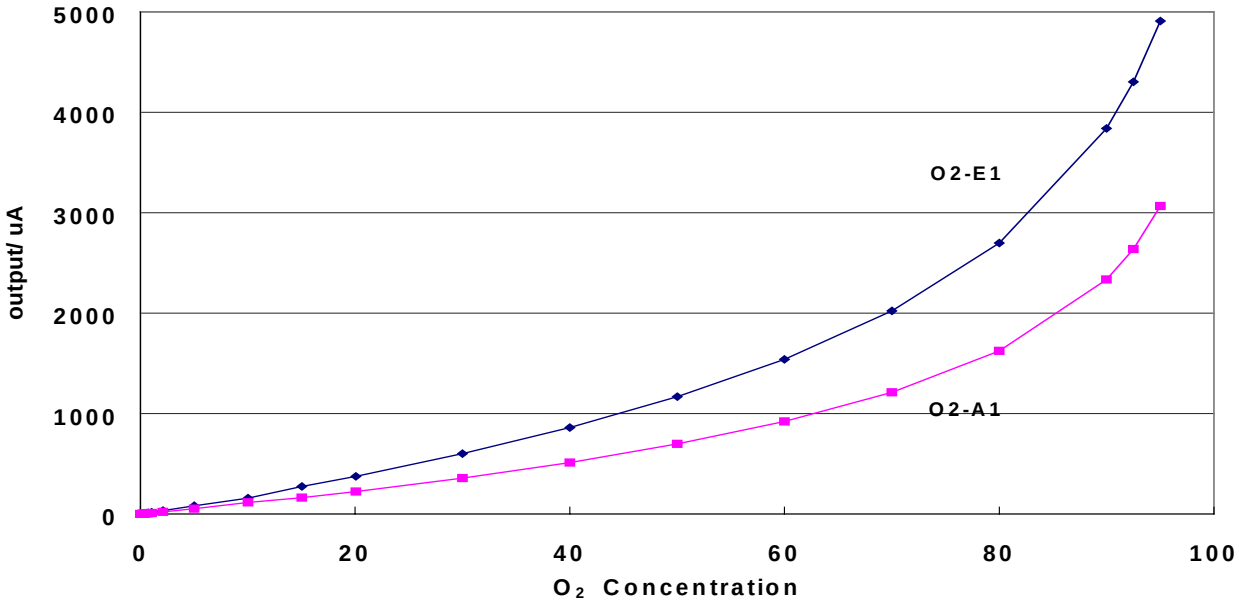

Figure 1 Output versus % oxygen concentration for an oxygen sensor

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.

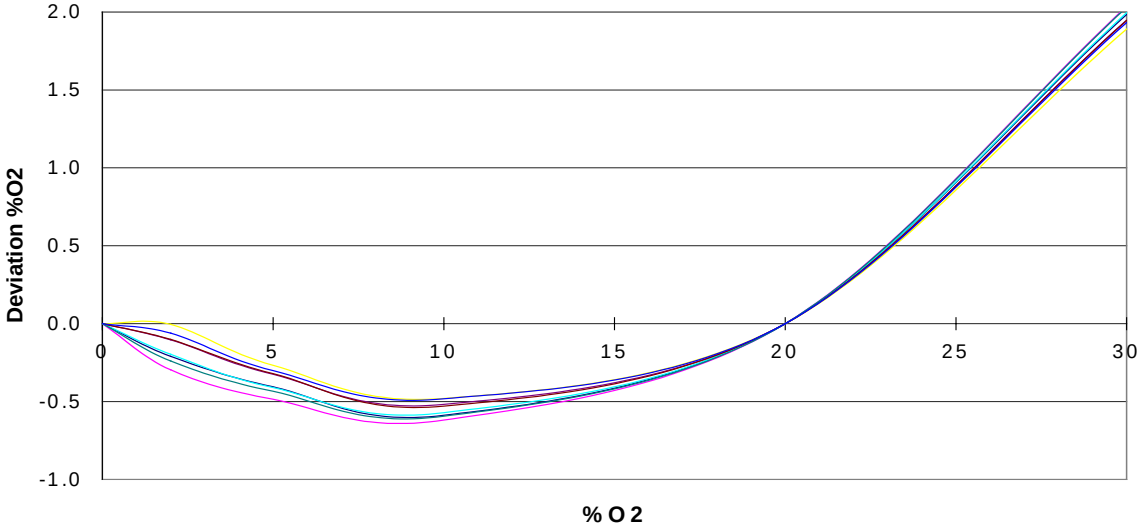

Figure 2. Non-linearity from 0 to 30% oxygen for mass flow oxygen sensors

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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.

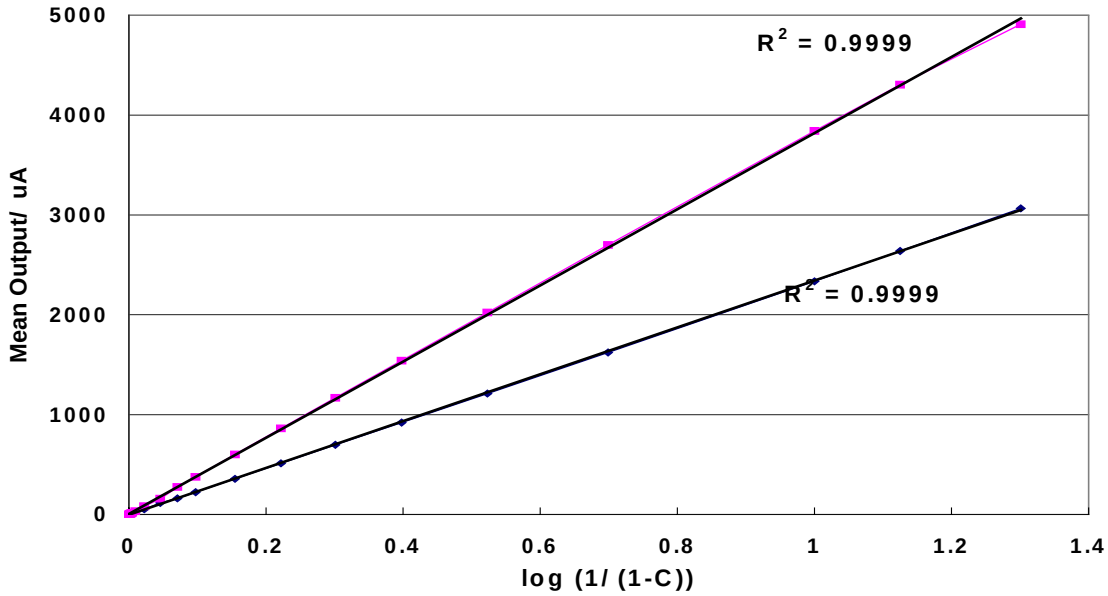

Figure 3 Linearised output for mass flow oxygen sensors: compare with figure 1.

Summary

1 The small non-linearity shown by Alphasense mass flow control oxygen sensors at normal oxygen concentrations can be ignored.

2 For sensors calibrated at 20.9% oxygen, the non-linearity is worse at half range: 10% oxygen.

3 If you wish to compensate for this non-linearity, then use either the log formula shown above or an equivalent polynomial expansion.

4 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.

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