What is a Zirconium Dioxide Oxygen Sensor?

The zirconium dioxide oxygen sensor does not measure oxygen concentration %, but rather it measures partial pressure of oxygen in a gas or mixture of gases.

The oxygen sensor employs a well proven, small zirconium dioxide-based element and its heart and due to its innovative design does NOT require a reference gas. This removes limitations in the environments in which the sensor can be operated with high temperatures, humidity and oxygen pressures all possible.

What is Zirconium Dioxide?

At high temperatures (>650^{0}C), stabilised zirconium dioxide (ZrO_2) exhibits two mechanisms:

1. ZrO_2 partly dissociates producing mobile oxygen ions and therefore becomes a solid electrolyte for oxygen. A ZrO_2 disc coated with porous electrodes connected to a constant DC current source allows ambient oxygen ion to be transported through the material. This liberates an amount of oxygen at the anode proportional to the charge transported (electrochemical pumping) which according to Faraday's First Law of Electrolysis is:

$$N = \frac{it}{zF}$$

N = Number of Moles of Oxygen Transported

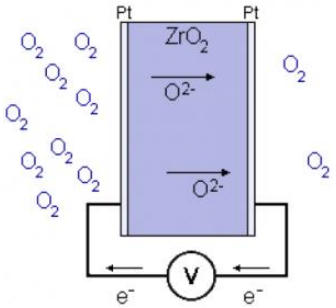
i = Constant Current

t = Time (seconds)

z = Ionic Valence of Oxygen

F = Faraday Constant = 96487 C/mol

2. ZrO_2 behaves like an electrolyte. If two different oxygen pressures exist on either side of a piece of ZrO_2, a voltage (Nernst voltage) is generated across it.



What is Nernst Voltage?

Two different ion concentrations on either side of an electrolyte generate an electrical potential known as the Nernst Voltage. This voltage is proportional to the natural logarithm of the ratio of the two different ion concentrations. Electrolysis is:

$$\Delta V = \frac{k_B T}{e_0} \times \ln\left(\frac{c_1}{c_2}\right)$$

kB = Boltzmann constant (kB = 1.38×10-23J/K)

T = Temperature in K

e0 = Elementary charge (e0 = 1.602×10-19C)

ci = Ion concentration in mol/kg

Either of these properties are used in many variants of oxygen sensors, however SST's oxygen sensors employ both principles simultaneously. This removes the needs for a sealed reference gas making the sensor more versatile for use in a range of different oxygen pressures.