Types of lambda sensors

Lambda sensors, also known as oxygen or O2 sensors, have evolved in design as better control is required and newer technology is developed. NGK/NTK describes the types used to date.

Zirconia Binary Type

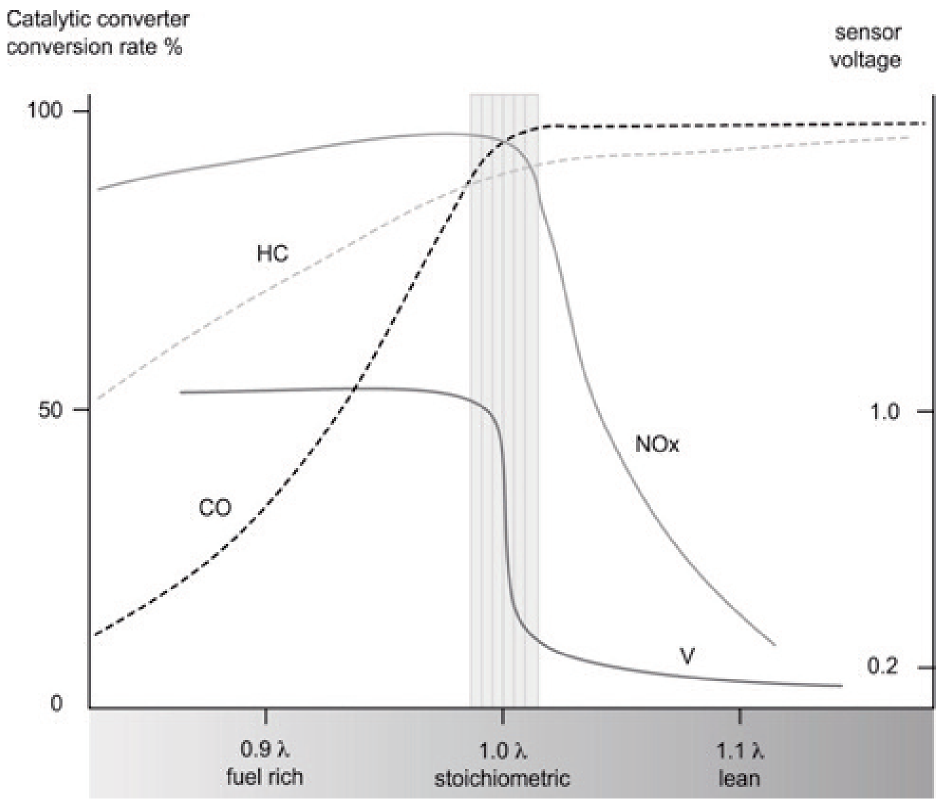
Under the metal protective end of the sensor, there is a hollow thimble shaped ceramic body made from zirconium dioxide. The protective metal shell has specially designed holes to allow the exhaust gases to come into contact with the outside of the ceramic element. Both sides of this ceramic element are coated with a thin micro porous layer of platinum. These layers are the electrodes that carry the sensors signal to the wire cables. Over the outside electrode, a thin additional layer of porous ceramic is added to protect the platinum from erosion by the exhaust gases. The inside of the thimble is hollow and is used to hold ambient air as a reference gas.

At temperatures in excess of 300°C, the zirconia element possesses a property that causes a transfer of oxygen ions. This movement creates a voltage. The greater the difference of oxygen concentration between the exhaust gas and the ambient reference air in the centre of sensor thimble, the higher the voltage produced. The voltage produced in the fuel lean position should be approximately 0.1 volt and in the fuel rich position approximately 0.9 volt. The very useful part of this function is that at around the stoichiometric point, there is a relatively large change in voltage. This allows the sensor to keep the engine emissions within strict limits by constantly switching between a fuel lean or fuel rich position to retain the stoichiometric mixture. The time taken to switch from fuel lean to fuel rich is approximately 300 milliseconds.

Because this switching process will not occur until the sensor is up to working temperature, there is a period of time after starting the engine during which the fuelling system is not being controlled as strictly as we would like and may increase unwanted emissions. To combat this delay, heated exhaust gas oxygen (HEGO) sensors are used. These sensors have a heating element installed in the centre of the thimble, which rapidly brings the sensor up to operating temperature, and therefore strict fuelling control can start very quickly. During periods of idling, exhaust gas temperature can drop significantly; heated sensors ensure that this drop in temperature does not affect the stable operation of the sensor.

Titania Type

Externally, these sensors look similar to the zirconia type however the sensor body may be generally smaller. These sensors do not generate a voltage as in the zirconia type, but the electrical resistance of the titania changes in relation to the oxygen content of the exhaust gas. If there is a surplus of oxygen in the exhaust gas (fuel lean) the element resistance rises. As the concentration of oxygen decreases (becoming fuel rich) the resistance falls. In a similar way to the zirconia sensors there is a large change in voltage when the stoichiometric point is reached the titania sensor element has a large change in resistance at the stoichiometric point. As there is no need for a pocket of air as a reference gas, and due to certain other design differences, the sensor can be smaller, stronger and have a faster reaction time. The control system for this type of sensor is very different to that used for the zirconia type. All titania type sensors have internal heating elements.



Lambda sensor voltage, or resistance, changes rapidly on either side of the correct air/fuel ratio, making it ideal to very accurately control fuel delivery

ZFAS-U Type (Air/Fuel Sensor)

Also known as a UEGO, wide band or linear sensor, the easiest way to identify this type of lambda sensor is by the number of lead wires - they usually require at least five and are always heated types. The sensor is of layered construction with two ceramic substrate components, a Zirconia detection element and an Alumina heating element. No external reference air is required as the sensor generates its own. The detecting cavity is exposed to exhaust gas through a gas diffusion layer. Put very simply, the sensor tries to maintain a stoichiometric air/fuel ratio in the detection chamber by pumping oxygen in or out of the chamber. The value of the pumping current required to achieve this corresponds to the air fuel ratio of the exhaust gas. Not only does this type of sensor have an extended window of measurement, and can be used successfully where lean burn strategy is employed, it also provides exceptional accuracy around the stoichiometric point which is useful in the quest for emission reduction. This type of sensor will also be used in conjunction with diesel engines as they operate with an excess air factor.