3.0 Sensing Technologies Offered By RKI

3.1 Catalytic (For LEL Level Detection of Flammable Gases And Vapors):

A catalytic combustion sensor is typically used in situations where detection of flammable gases or vapors is required. The standard range of detection is 0-100% LEL, where “LEL” (Lower Explosive Level) is the minimum amount of the target gas or vapor that is needed to form a flammable condition in air. Catalytic combustion sensors consist of two small coils of wire. One coil (the “active” coil) is treated with a catalyst such as platinum or palladium, that help to initiate the burning reaction of flammable gases and vapors at concentrations lower than would normally burn. The second coil is treated with a non-catalytic coating, and it operates as a “reference” to counteract for the effects of temperature and thermal conductivity that would otherwise cause the sensor to be less accurate. Both coils are heated by passing a current through them. When the hot active coil encounters even small concentrations of flammable gases or vapors, it causes these to oxidize (burn). The heat of this combustion at the coil causes the temperature of the coil to increase, which in turn causes the resistance of the wire to increase. The circuitry measures the resistance change of the active coil, and interprets this signal as a measured amount of gas or vapor, based on the calibration of the system.

The catalytic sensor generally can respond to practically all flammable gases or vapors, allowing it to be calibrated to represent the danger present in a wide variety of applications. Catalytic sensors should not be used in applications where they will be exposed to known catalytic poisons such as Silicone vapors, lead vapors, chlorinated or fluorinated hydrocarbons, and to some degree, high or continuous H2S concentrations. (For such locations, it is recommended to use an IR sensor for LEL detection. See section 3.9.)

Catalytic sensors require Oxygen to operate. Oxygen concentrations of 10% or higher are generally considered necessary and sufficient to provide full LEL response on a catalytic sensor. However, significant LEL response can still be obtained for lower levels of combustibles (10% LEL) at levels even as low as 2% Oxygen for some flammables.

3.2 Catalytic With Molecular Sieve (For Hydrogen Specific LEL Level Detection):

RKI offers a very special Catalytic sensor for Hydrogen detection. This sensor is coated with a molecular sieve that significantly reduces the response from any other flammable gases or vapors. In particular, the response to IPA is practically eliminated. This sensor was developed for Semiconductor manufacturing applications where Hydrogen is desired to be detected, but where IPA is often used as a cleaning agent. Also useful in Hydrogen fuel cell applications in situations where gasoline or other flammables may exist, but a separate sensor is used for them.

3.3 Solid State (For PPM Level Detection of Hydrocarbons):

Solid State sensors can be used for low level (ppm level) detection of many solvent vapors or gases. A typical Solid State sensor consists of a heated element with a metal oxide coating. The metal oxide electrical resistance decreases when it comes in contact with certain gases, by the gases displacing Oxygen molecules within the metal oxide. The amount of resistance change is greater when the target gas concentration becomes greater. This type of sensor is not specific to any particular gas, but is a general hydrocarbon sensor. It should only be used when the only gas present besides fresh air is the gas you wish to detect. It can also be useful as a general hydrocarbon leak detector, for storage facilities of a wide variety of solvents or chemicals. The ppm level detection ability of the solid state sensor can provide detection of unsafe breathing levels of some solvents and gases, (as opposed to the much higher LEL levels normally detected by a catalytic sensor).

The Solid State sensor requires Oxygen in order to operate properly.

3.4 Solid State With Molecular Sieve (Hydrogen Specific, 0-2000 PPM):

RKI offers a very special proprietary Solid State sensor for Hydrogen detection applications where even a very small leak needs to be detected. This sensor has a molecular sieve coating on the sensing element, and this prevents any other gases from having an interference effect on the sensor. This sensor is typically used to detect Hydrogen over a range of 0-2000 ppm, with no response caused by IPA or other gases or solvents. This sensor does require an air background for proper operation. This Hydrogen ppm sensor is particularly useful in Semiconductor Fab applications, where it can reliably detect leaks 20 times smaller than a catalytic sensor.

3.5 Galvanic Cell (for Oxygen Detection):

The Galvanic Oxygen sensor is an electrochemical cell with a gel electrolyte and two electrodes. A membrane allows atmospheric contact with one electrode. Both electrodes are connected to an external meter or IC. Since normal atmosphere contains 20.9% Oxygen, a galvanic cell is always encountering Oxygen, and producing a voltage corresponding to the Oxygen level. An increase in Oxygen at the electrode causes increased electrochemical activity in the cell, producing a higher output voltage. Similarly, a decrease in the Oxygen that contacts the electrode will decrease the electrochemical activity, producing a lower output voltage. The output voltage is continuously measured, and voltage changes due to increases and decreases in Oxygen can be used to switch relays or other alarms.

Galvanic Oxygen sensors require periodic calibration and replacement, due to consumption of the electrode or drying out of the electrolyte.

3.6 Electrochemical Sensors (For PPM Level Detection of Many Toxic Gases):

The Electrochemical sensor offers reliable, accurate detection of a wide variety of toxic gases. The sensor contains an electrolyte, and electrodes (Counter, working, and reference electrodes). The electrodes are connected to a power supply and supporting electronic amplifier. A gas permeable membrane allows the sampled atmosphere to enter the cell. Toxic gas in the sample causes an electrolytic chemical reaction, allowing current to flow between the working and counter electrodes. The current flow is proportional to the gas concentration, and is measured and interpreted by the supporting electronics to provide readings and alarms.

RKI offers many different electrochemical sensors for different gases. The chemistry of the sensor determines what gases it will respond to, so different electrode materials and different electrolytes are utilized to create a wide variety of sensor offerings. Although sensors can be highly sensitive to the target gas or target family of gases, they are not completely specific for an individual gas, so consideration must be given to any other possible interfering gases that may be present in the test area or sample stream. Later in this manual are provided typical “interference gas” charts to help determine the suitability of a sensor for a particular application.

3.7 Pyrolyzer With Electrochemical Sensor (For PPM Level Detection of NF3, R-123, And Others):

Some gases cannot be readily detected due to their chemical nature not being conducive to creating a chemical reaction within an Electrochemical sensor. In some cases, if these gases are superheated, it will chemically break down (or burn) the gas into smaller compounds or other constituents which may be more readily detectable. A pyrolyzer is a heated chamber which the sample is passed through to be “pyrolyzed” or converted by the extreme heat. A pyrolyzer is not actually a detector, but is a sample conditioner, and it is used to treat the sample before it enters a detector. For NF_3 detection, the pyrolyzer breaks down the NF_3 in air to form other compounds such as HF, NO, and NO_2. RKI utilizes a pyrolyzer in conjunction with an NO_2 sensor for very reliable detection of NF_3. This same method can be used for detection of certain refrigerants such as R-123, which produces HF after being pyrolyzed, and the HF can be detected with an electrochemical sensor.

3.0 Sensing Technologies Offered By RKI

3.8 Pyrolyzer With Ionization Chamber (For PPM Level Detection of TEOS, TEOA, TMP, TMB):

Another combination detection technique is to use a pyrolyzer in conjunction with an Ionization chamber. Gases such as TEOS are not easily detected at low levels by other methods, but if the TEOS is passed through a hot pyrolyzer, it will burn and create SiO_2 particulate, which is a smoke that can then be detected by an ionization chamber, as described above.

3.9 Infrared Sensor (NDIR):

Most gases (except hydrogen) will absorb infrared (IR) light over certain wavelengths. The wavelengths absorbed by a particular gas, and the intensity of the absorption , are very distinct for each gas, sort of like a “fingerprint” for the gas.   An Infrared gas sensor makes use of this physical aspect of gases. An infrared sensor typically consists of a chamber which the sample gas is passed through. At one end of the chamber there is an IR source, which is a amp bulb or heater which produces IR energy. At the other end of the chamber is an IR detector element. This IR detector measures the amount of IR energy that reaches it, and produces a signal output proportional to the amount of this energy. Generally there is an IR filter in the IR path, which allows the detector only to look at a particular wavelength region of IR energy. If gas which absorbs this particular wavelength or IR energy is present in the sample flowing through the detection chamber, it will reduce the amount of IR energy that reaches the detector. The measuring circuit compares this IR energy to the energy that is present when fresh air is in the chamber (or when the IR source is turned off), and interprets the signal and processes it as a measured reading of the detected gas. An IR sensor is useful for LEL detection in applications where a catalytic sensor will be poisoned such as a waste water treatment plant, or factories where silicon vapors are present. RKI offers IR sensors for LEL detection, CO2 detection, and Freon detection.

3.10 Thermal Conductivity (For Volume % Detection of Methane or Hydrogen):

Every gas has a physical constant known as its “Thermal Conductivity” (or TC). This is a measure of the ability of the gas to carry heat away from a hot object. Some gases, such as Hydrogen, have a great capacity for transferring heat, and so have a high thermal conductivity. If the thermal conductivity of a gas is different than that of air, either higher or lower, then this physical aspect of the gas can be used to detect it. A TC sensor consists of two small elements of wire that are heated by passing a current through them. One of the elements (the active) is placed in the gas stream, and the other (the reference) is sealed so that the gas sample does not contact it. When the active comes in contact with a gas concentration that has a TC that is different than air, it will cause the element to either cool down or heat up. This temperature change of the element changes the electrical resistance of the element, which is then measured by the supporting circuit and interpreted as a known gas reading.

3.11 Paper Tape Method:

A “Paper Tape” is a tape material that is impregnated with certain chemicals that sensitize it and cause it to change color when it becomes exposed to specific gases. The chemically treated paper tape is fed through a chamber where it is exposed to the sampled atmosphere. If the target gas is present in the sample, it causes the tape to darken, or “stain”. The tape is exposed to the sample for a specific amount of time, and then the stain darkness is measured with a photocell. The stain darkness is proportional to the gas concentration present, and the photocell signal interprets this to provide a reading of the gas level.

RKI utilizes the paper tape method for detecting very low levels of certain gases. It can be highly specific for the target gas, and can provide very low level, specific detection of certain gases that no other method can achieve. The paper tape method is used in our models FP-250FLW, FP-260, and FP-270 series instruments for detection of many toxics including many metallo-organics, Formaldehyde, H2S, Hydrazine, Phosgene, C4F6, and many semiconductor gases.

In a paper tape machine, the tape is automatically advanced periodically, so that the gas sample can be exposed to a new section of tape. Tape cassettes generally hold enough tape to last about 30 days.