Monitoring for JP-8

1. Background

Biosystems uses an industry standard catalytic bead, or pellistor type, combustible sensor for the detection of lower explosive limit (%LEL) concentrations of combustible gases and vapors.

The working part of the sensor consists of two porous alumina beads, each one suspended on a platinum wire across a gap which constitutes the arm of a Wheatstone Bridge. One bead (the active one) incorporates an oxidation promoting catalyst. The other bead (the inert or reference one) does not have this catalyst system. The catalyst allows combustible gases and vapors to burn on the surfaces of the active bead at moderate temperatures in the presence of air containing at least 10% oxygen. This burning heats the bead causing an electrical resistance change in this arm of the bridge. The heat generated is directly proportional to the concentration of combustible vapors in the range of concern, up to 100%LEL. Gas detector electronics convert this change in the resistance into displayed %LEL values.

2. Combustible Sensor Response

Combustible gas sensors are non-specific and theoretically will respond to all combustible gases and vapors, including JP-8. The amount of heat produced by burning a particular gas on the active bead, however, varies between different combustible gases. For this reason, in part, %LEL readings can vary between equal volume concentrations of different combustible gases. The following table lists the relative sensitivities of the 4P-CiTipeL ® combustible sensor used in the PhD Plus and PhD Ultra to a series of alkane hydrocarbons. With the sensor calibrated to methane, the values below represent what the combustible sensor would read if it were exposed to an environment containing 100% LEL of the listed alkane.

Combustible Gas/Vapor	**Relative Sensitivity %LEL**
methane (CH_4)	100
n-propane (C_3H_8)	65
n-pentane (C_5H_{12})	50
n-hexane (C_6H_{14})	45
n-heptane (C_7H_{16})	40
n-octane (C_8H_{18})	40

What this table illustrates is that the choice of gas used to calibrate the sensor is critically important in obtaining accurate readings for the gas being measured!

3. Combustible Gas Calibration Mixes

Biosystems normally formulates our combustible gas containing calibration gas mixtures with methane. The rationale for this is discussed in greater detail in an article in the Bio Bulletin Vol. 2, No.4 titled "Calibrate more accurately with equivalent gas". To summarize from this article, in the event that a combustible sensor is "poisoned" or otherwise suffers a loss of sensitivity due to exposure to contaminants incidentally present in the atmosphere being monitored for combustible

gas, the effects are first seen in the sensor's ability to detect methane. There are two important benefits to using methane based "equivalent" calibration gas mixtures. The first is that the response of relatively nonvolatile materials can be reproduced without having the combustible component condensing out of the gas mix, or having to resort to short filling of cylinders (lower pressure fill). This is particularly true for materials used to simulate the behavior of heavier petroleum cuts such as pentane or hexane. More importantly, by calibrating to a material that is more difficult to detect in the case of poisoning, it is assured that the actual material encountered in the field will never respond less well than the methane equivalent. In other words, any error experienced will be on the safe side, a higher response than actual.

When a combustible sensor is calibrated to read on a direct scale for various gases/vapors, the calibration adjustment is done exclusively through the signal processing machinery of the detector. There is no change at all to the bead temperature or other physical operating characteristics of the sensor itself. Therefore it is possible to simulate the behavior of any combustible gas by using an experimentally determined amount of methane and electronically adjusting the signal gain accordingly.

4. Monitoring for JP-8

For heavier cuts of petroleum distillates such as the kerosenes used in aviation jet fuels, specifically Jet A or JP-8, with the most volatile hydrocarbon being C 10, Biosystems provides a calibration gas mix containing that level of methane designed to provide an equivalent response to 50%LEL of the fresh jet fuel vapor. This mixture is completely compatible with Biosystems' factory preset calibration set-point which allows for simple and direct automatic calibrations. In other words, to obtain accurate, direct readings for JP-8 simply calibrate the detector using Biosystems' JP-8 "Equivalent" combustible calibration gas!

5. Monitoring for petroleum distillates other than JP-8

Petroleum hydrocarbon distillates commonly used as fuels are mixtures or "cuts" rather than discrete chemical formulations. Since it is usually not possible to characterize the flammability of these non-discrete materials on an exact basis, choosing the most appropriate gas mixture to use for the purposes of calibration can be a difficult task. The more information you are able to obtain on the substance, the easier it is to make the most appropriate decision.

The first reference that should be consulted is the Material Safety Data Sheet (MSDS) for the specific formulation. Besides other safety factors such as toxicity, the MSDS will provide information directly related to flammability characteristics. The most pertinent information will be:

- Flash Point Temperature
- Volume % yielding 100% LEL
- Vapor Pressure at Temperature

The face page will also list the identity of constituents, carbon number range, and whether the mixture is aliphatic (saturated) or aromatic (unsaturated) in character. For questions about the best calibration gas for your application, calling Biosystems Applications Department with this information will allow our engineers to determine the most appropriate mixture.

For lighter cuts such as motor gasolines, Biosystems' "propane equivalent" calibration gas mix provides a close approximation to fresh gasoline vapors.

6. Detector Configurations

In cases where the gas detectors are to be used indoors, or where there are minimal concerns about water getting into the detector, the detector sensor cover should be used with no water barrier element in the removable cassette above the combustible gas sensor. This will help to provide slightly faster response time since the rates of diffusion for large molecules such as those present in JP-8 are relatively slow. A more unobstructed path to the sensor face helps to increase speed of response. (Note this is particularly the case for hydrocarbon mixtures having the mostly aromatic constituents such as toluene, xylenes and various alkylated benzenes)

When remotely sampling, it is best to use manual sample draw equipment rather than motorized pumps. The reason for this is that fuel vapors can be absorbed into the pump diaphragms and sampling lines yielding a depleted steam at the sensor face (results in erroneously low readings). Best results are obtained with high flow rates that can be achieved with a manual sample draw accessory. For example a squeeze bulb can easily deliver a 2 liter per minute flow versus 0.5 liter per minute for a motorized pump.

In the absence of Jet A or JP-8 equivalent calibration gas a combustible gas sensor can also be calibrated to read directly on pentane. Please note however that the combustible reading will be roughly half that for jet fuel. In other words, if the instrument is calibrated to pentane it will be necessary to double the displayed readings to compensate if the instrument is used for the detection of JP-8.

As a final piece of advice, whenever there is any doubt in the nature of the gas being measured, take action at a lower alarm set-point! Dropping the alarm set-point from 10% LEL to 5% LEL will sharply reduce the chances for dangerous error.

7. General Recommendations

If an instrument will be used exclusively for a single type of combustible gas, it is best to calibrate the detector to read directly to that particular gas scale. For example, in a situation where natural gas is encountered exclusively, methane can be used as a calibration gas. In cases where lighter petroleum distillates such as gasoline are encountered exclusively, pentane equivalent is a better suited calibration gas.

For general purpose use, Biosystems recommends propane equivalent. In fact Biosystems calibrates combustible sensors to 50% LEL propane equivalent in the absence of any other specific recommendation from a customer. A major reason is that propane falls in the middle of the relative sensitivity chart. Therefore most gases and vapors will respond equally well or better than propane. Also, in the new standard for "Permit Required Confined Space Entry" (29 CFR 1910.146) OSHA has determined that a combustible hazard exists whenever the concentration of combustible gas or vapor exceeds 10% LEL. Given that OSHA has changed the combustible alarm setting from 20% LEL to 10% LEL, the error in readings will be smaller at the lower concentration alarm set-point.

Please call Biosystems Customer Service at (860) 344-1079 if you have any additional questions.