biosystems Application Note	**Life Expectancy of Gas Detection Sensors**	Date	1/19/05
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		By	Mike Burt

Biosystems gas detectors are equipped with one or more sensors all of which have a certain life expectancy. This application note will address the nature of life expectancy for the most common sensors when they are installed in a gas detector.

Oxygen Sensors

Oxygen sensors are consumptive sensors, meaning that something inside the sensor is used up over time when exposed to the target gas. Specifically, as oxygen enters the sensor and as it generates an electrical current in the gas detector circuit, a chemical reaction causes a metallic lead anode to be irreversibly oxidized.

$$2Pb + O_2 \rightarrow 2PbO$$

When all of the metallic lead is converted to the oxide, sensor current output will fall to zero and the sensor will need replacement.

Oxygen sensors installed in a gas detector circuit are always working, even when the detector is turned off. Therefore, if the detector is stored in air, oxygen sensor life will be steadily decreasing. The only ways to stop consumption of the lead anode (or slow it to a negligible rate) would be to either store the detector in an inert gas, or to remove the sensor from the gas detector and leave it open circuit. The former step is normally inconvenient, while the latter would result in long warm-up time (hours) once the sensor is re-installed in the detector circuit. Oxygen sensors installed in current Biosystems monitors are designed to have a working life of two years.

CO and H_2S Sensors

CO and H_2S sensors are non-consumptive, or catalytic, meaning that nothing is consumed by exposure to the gases they are designed to detect.

In theory, CO and H_2S sensors should last forever, however, other factors such as evaporation (drying out), leakage, catalyst contamination, etc. eventually limits the life of these sensors. The expected life of CO and H_2S sensors is between two to four years. However, depending on electrolyte reservoir size, general climate, as well as use and storage conditions, it is possible for these sensors to last in some cases five to eight years.

Combustible (LEL) Sensors

Combustible sensors are different from the other sensors in this application note as they are not wet, electrochemical, but rather solid state, catalytic.

Catalytic combustible gas sensors are designed around two porous ceramic beads, each encasing separate platinum wire coils. During operation they are powered at constant voltage to keep them at an elevated temperature. One of the beads contains a precious metal catalyst system designed to promote the oxidation of combustible gas/vapor that enters the sensor. This bead is referred to as the "active" bead. The other bead is chemically inert to serve as a thermal and electrical "reference".

In ideal conditions the LEL sensor can last for many years. In practice, LEL sensors have an expected life of two years and rarely last longer than four years. There are many factors that can cause the sensor to quickly fail or to gradually lose sensitivity to combustible gas.

Strong mechanical shock can break the fine platinum wire that suspends and powers the beads in the sensor chamber. This results in an immediate failure via a short circuit.

Combustible gas sensors require oxygen to oxidize or burn combustible gases & vapors. If a sensor encounters a fuel rich, but oxygen deficient environment, carbon, tars, and unburned fuel residue can build up on the active porous bead. Upon subsequent exposure to normal oxygen level air, the tars/carbon residue may explosively burn off the active bead causing it to crack open. This often results in a sensor baseline shift severe enough to render it unusable.

The precious metal catalyst supported on ceramic has a chemistry and structure very similar to catalytic converters used in automobile exhaust systems. As such, it can be quickly rendered ineffective when exposed to certain types of materials referred to as catalyst "poisons or inhibitors". These materials include but are not limited to: tetra-ethyl lead as found in "leaded" fuel, volatile silicone oils and silicone (RTV) rubber off-gas products during cure, halogenated hydrocarbons (Freons®, and common solvents such as methylene chloride, trichloroethylene and ethylene dichloride), as well as chronic/high concentrations of hydrogen sulfide and other sulfur containing gases.

When LEL sensors become poisoned, often the first gas that they tend to lose sensitivity to is methane. As such, the best way to check sensor performance is to regularly test them using calibration gas that is methane-based. In order to test sensors for poisoning while still allowing the sensor to be calibrated to a different sensitivity scale than methane, Biosystems offers methane-based LEL gas blends that are "equivalent" to propane (C_3) or pentane (C_5) sensitivities. Please refer to Biosystems Application Note "Use of Equivalent Calibration Gas Mixtures" for details on using methane-based calibration gas.

Age will cause the sensors to slowly lose sensitivity over time. The high surface area catalyst on the active bead will gradually lose active sites as it is exposed to trace environmental contaminants and some consolidation will occur after many power-up cycles.

Conclusion

The only way to be fully confident that sensors are functional and accurate is to periodically verify accuracy with known concentration calibration gas and calibrate when necessary. Please refer to Biosystems application note "Frequency for Verifying Sensor Accuracy" for details on how often to bump test and calibrate Biosystems monitors.

All gas sensors need to be replaced from time to time. The most commonly replaced sensor is the oxygen sensor as it has a finite life. LEL and toxic gas sensors generally do not need replacement as frequently as oxygen sensors, but anytime the sensor fails, it must be replaced.

Biosystems sensors have either a one or two year warranty. Sensors generally last beyond their warranty period, but in the case where it does not, Biosystems will replace the sensor at no charge. Arrangement for prompt replacement may be made via Biosystems' Technical Support at (800) 711-6776.