EXTENDING LIFE OF LEL SENSORS IN FIELD CONDITIONS

It is well known that certain chemicals inhibit or poison catalytic bead in LEL (combustible) sensors, leading to partial or complete loss of sensitivity. Poisoning is defined as a permanent degradation, while inhibition is usually recoverable (for more, refer to RAE Systems Technical Note TN-144[1]). Even if an LEL sensor has not been exposed to flammable VOCs very often, with time its sensitivity decreases.

Correction Factor Drift

The problem of inhibiting isn't only a decrease in sensitivity, but a *non-uniform* decrease. LEL sensors can be used for the detection of a wide variety of combustible gases and vapors that exhibit different responses. Because LEL sensors use a diffusion barrier to limit the gas flux to the catalytic bead, they tend to have the greatest sensitivity to high-diffusivity compounds. Therefore, they are substantially more sensitive to small molecules like hydrogen and methane than to heavy components like kerosene.

The best way to calibrate any sensor to different compounds is to use a standard of the gas of interest. However, Correction Factors (CFs) have been determined that enable a user to quantify many chemicals using only a single calibration gas, typically methane or pentane. The Correction Factors developed and combined in the table of RAE Systems Technical Note TN-156[2] apply to new sensors. As a sensor becomes used and gradually loses sensitivity, the response to methane may decrease more rapidly than for longer carbon-chain hydrocarbons. In this case, the Correction Factors gradually decrease, and calibration with methane tends to overestimate the %LEL of the other gas. Changes in Correction Factors may be significant and differ by factor 1.5 to 2 from the new sensor estimate. Below are examples of the matured (partially inhibited) LEL sensor response in a MultiRAE Pro to 50 LEL% gases.

Gas	Concentration, LEL%	CF (TN-156) USA Regulation	Actual response, LEL%
Isopropanol	50	2.2	92
Acetone	50	1.9	81

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As mentioned before, catalytic bead LEL sensor poisoning causes a permanent sensor degradation and it cannot be recovered. Inhibiting effects at the same time may be mitigated by extended exposure of a running sensor to the air, though this effect is rather weak and does not help much with severe levels of inhibiting. Another way appears far more promising. Among hydrocarbons, methane has one of the highest ignition temperatures, 580^{O} C[3], so the temperature of a catalytic bead sensor has about the same temperature. If the sensor is exposed to a high concentration of methane for a short period (several seconds), temperature at the sensor will increase even higher than nominal and will burn the sensor-inhibiting remnants on catalytic sensor beads, recovering sensitivity.

Procedure For Extending The LEL Sensor's Life

Turn on the instrument (with the to-be-treated LEL sensor installed) in Diagnostic Mode, warm up the instrument and sensor for a couple of minutes, and then apply 99% (vol) methane gas for 2 to 3 seconds or 20% (vol) methane gas for 5 to 8 seconds (do not press any keys while the gas is supplied). A calibration cap with tubing can be combined with a constant-flow regulator for both diffusion and pump-type instruments. A demand-flow regulator can be applied for *pump* versions only. Diagnostic Mode is used to prevent the catalytic bead sensor from shutting off at exposures with gas concentrations above 100% LEL. This algorithm is used in the instruments to prevent sensor damage at exposures to the high VOC concentrations. Only short periods of exposure can work, because for catalytic burning of VOC on the sensor catalytic beads, oxygen is required. Wait for several minutes until sensor recovers, and then perform fresh air and span calibrations. Suggested treatment frequency is once every 3 to 6 months, depending on the field conditions or when the sensor passes fresh air calibration but not span delta calibration, whichever comes first.

Data of the sensors' test exposure per the procedure above are in the table below.

LEL sensor		Before Treatment (mature sensor)			After Treatment (mature sensor)		
Type, Testing Unit	Teatment Gas (CH4) % (Vol)	Raw Ct in Fresh Air	Raw Ct in 50% LEL (CH4) Gas	Span Delta Ct	Raw Ct in Fresh Air	Raw Ct in 50% LEL (CH4) Gas	Span Delta Ct
4R+ in MR2	99%	34719	34163	556	34844	27530	7314
	99%	35612	33625	1987	35620	29183	6437
	99%	35270	31549	3721	35315	28385	6930
	20%	34898	34358	540	34834	28211	6623
	20%	35033	33662	1371	35522	28637	6885
4R+ in AR2	20%	34346	32924	1422	34224	27731	6493
	20%	37010	34580	2430	36956	29622	7334
3R in QR3	20%	1277	1900	377	1263	760	503
	20%	1378	1185	193	1412	1052	360

- MR2 refers to the MultiRAE family of the instruments including MultiRAE Lite, MultiRAE, and MultiRAE Pro.
- AR2 refers to AraeRAE Plus and AreaRAE Pro instruments.
- QR3 is QRAE 3.

Note: Sensor exposure to a high concentration of methane or other hydrocarbon gases often may significantly decrease the sensor life.
Note: In very few cases, if the LEL sensor reading shows errors and cannot pass fresh air calibration, then the sensor may need replacement.

LEL sensor cleaning has a long-term effect (refer to the table below). Zero and span calibration within 5 and 11 weeks after treatment didn't show significant delta raw count degradation.

LEL Sensor	Treatment Gas	Before Treatment (mature sensor)	After Treatment (mature sensor)	5 Weeks After Treatment	11 Weeks After Treatment
Type, Testing Unit	(CH4) % (Vol)	Span Delta Count	Span Delta Count	Span Delta Count	Span Delta Count
4R+ in MR2	99%	556	7314	6013	6059
	99%	1987	6437	5600	5646
	99%	3721	6930	6072	5857
	99%	540	6623	5865	5732
	99%	1371	6885	5960	5910

- MR2 refers to the MultiRAE family of the instruments including MultiRAE Lite, MultiRAE, and MultiRAE Pro.

Sensor re-activation also leads to the Correction Factor recovery:

Gas	Concentration, LEL%	CF (TN-156) USA Regulation	Actual response, LEL%
Isopropanol	50	2.2	46
Acetone	50	1.9	45

With precautions and following the recovery treatment procedure, your Honeywell RAE Systems combustible sensors will operate reliably in Honeywell RAE Systems gas monitors. Follow the instructions in the instrument's User's Guide for routine maintenance. Always test gas monitors before use.

1 https://www.raesystems.com/sites/default/files/content/resources/Technical-Note-144_Handling-LEL-Sensor-Poisons_03-99.pdf
2 https://www.raesystems.com/sites/default/files/content/resources/Technical%20Note%20156%20Correction%20Factors%20For%20Combustible%20Gas%20LEL%20Sensorsnr%2002%2016.pdf
3 https://www.engineeringtoolbox.com/fuels-ignition-temperatures-d_171.html