Using LEL sensors for compliance with the ACGIH® C1-C4 Aliphatic Hydrocarbon (methane, ethane, propane and butane) TLV®

The ACGIH® TLV® for C1-C4 Aliphatic Hydrocarbons (methane, ethane, propane and butane) specifies an exposure limit of 1,000 ppm as an 8-hour TWA.

Customarily, manufacturers and instrument users set the instantaneous low alarm at the TWA limit concentration. This is very easy to do with the GfG G450.

All you need to do is calibrate with methane, set the correction factor to pentane, and set the alarm at 4% LEL.

LEL combustible sensors have a higher relative response to methane than to the other three gases (ethane, propane and butane). That means if you set the hazardous condition threshold alarm at 1,000 ppm methane, the alarm will be activated before you reach the 1,000 ppm limit for the other three gases. Since these gases are frequently encountered as mixtures, with varying concentrations of the constituent gases; setting the alarms conservatively at the methane concentration limit makes good sense.

One thousand ppm methane = 2% LEL methane. While it may be possible to set the LEL alarm in an instrument that has been calibrated to a methane level of sensitivity at 2% LEL, it is not recommended. It is better to set the alarm at a slightly higher concentration. That way the instrument has more "step changes" in readings over which to resolve the measured concentration.

The relative response of the instrument to pentane is 50% (= 0.5) compared to the response to methane. So, when the instrument is calibrated to a pentane level of sensitivity, or when you pick "pentane" from the list of combustible correction factors in the instrument's on-board library; 1,000 ppm methane (= 2% LEL) produces a reading of 2,000 ppm (= 4% LEL) when the instrument is operated on the pentane scale.

GfG G450 and G460 instruments display LEL readings in 0.5% LEL increments over a full range of 0 – 100% LEL. On the pentane scale, each 0.5% LEL increment = 125 ppm methane. That's way below 1,000 ppm! Because the instrument has eight 0.5% LEL "step changes" between 0% LEL and 4% LEL, the instrument is able to provide a very solid and dependable reading at this alarm limit concentration.

This approach simplifies or eliminates concerns about which of the four gases, or what mixture of these gases, is causing the alarm. Setting the correction factor to pentane, and the LEL alarm to 4% LEL ensures that whatever gas or mixture of C1 – C4 gases is present, the LEL alarm will be activated at or below the TWA limit concentration. With this setting not only will the alarm go off at 1,000 ppm for methane, the alarm will go off before you reach 1,000 ppm for ethane, propane and butane.

Figure 1: : Calibrating catalytic G450 / G460 LEL sensors to a pentane level of sensitivity and setting the alarm at 4% LEL ensures that the alarm will be activated at the 1,000 ppm TLV® exposure limit for CH_4.

GfG Instrumentation

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The following chart helps to explain how this works:

Flammability Ranges and Toxic Exposure Limits for C1 – C5 Alkanes							
Gas	Response of sensor (calibrated to CH_4) when exposed to 1% LEL of listed gas	Response of sensor (calibrated to C_5H_{12}) when exposed to 1% LEL of listed gas	LEL (%VOL)	TLV® (8 hr. TWA)		LEL reading of pentane calibrated instrument when exposed to TLV® concentration of gas	True ppm concentration of listed gas when alarm activated at 4% LEL (pentane scale)
				in ppm	in % LEL		
Methane	1.0	2.0	5	1000 ppm	2 %	4.0 %	1000 ppm methane
Ethane	0.75	1.5	3	1000 ppm	3.34 %	5.0 %	850 ppm ethane
Propane	0.65	1.3	2.1	1000 ppm	4.76 %	6.2 %	670 ppm propane
Butane	0.6	1.2	1.8	1000 ppm	5.56 %	6.7 %	595 ppm butane
Pentane	0.5	1.0	1.5	600 ppm	4 %	4.0 %	600 ppm pentane

The last two columns in the chart are the most important. What the chart shows is that when the instrument is set to the pentane scale, a concentration of 1,000 ppm methane produces a reading of 4% LEL. A concentration of 1,000 ppm ethane produces a reading of 5% LEL. A concentration of 1,000 ppm propane produces a reading of 6.2% LEL; while a concentration of 1,000 ppm butane produces a reading of 6.7% LEL.

Another way of looking at the same issue is to calculate the ppm concentration necessary to activate the alarm when it is set to 4% LEL pentane. As can be seen from the values in the last column, while it would take 1,000 ppm methane to activate the alarm, it would only take 850 ppm ethane, 670 ppm propane, or 595 ppm ethane to activate the alarm.

If you set the instrument to the pentane scale, and set the alarm to 4% LEL, the alarm will always be activated at or below the TLV® limit for these four gases (or any combination of these four gases). As an added bonus, the alarm will also be activated at the TLV® limit for pentane.

Important note: The relative response values listed above are the values the manufacturer has established for the LEL sensors used in GfG instruments. While the relative response values for LEL sensors are usually quite similar between different brands of instruments; they may not match exactly. Alarm settings and take action criteria should always be based on the relative response values supplied by the manufacturer of the instrument used to obtain readings.

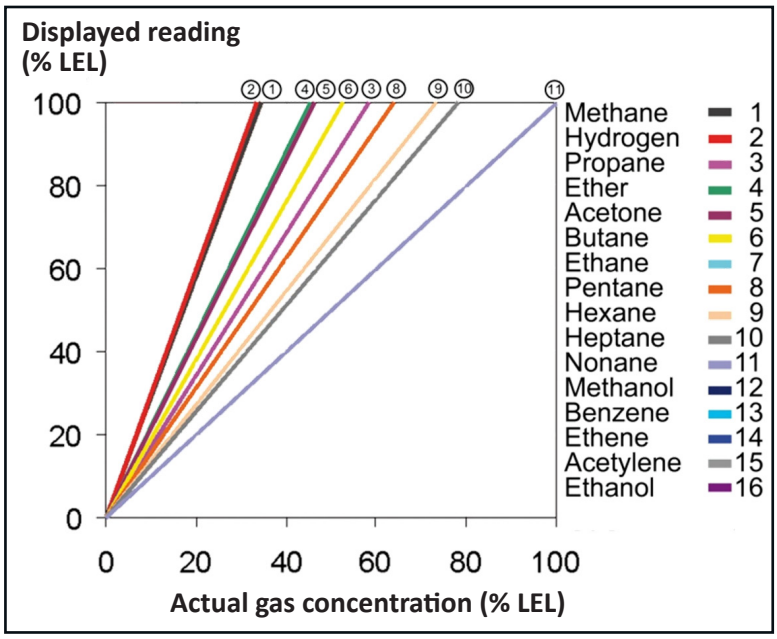

Figure 2: Catalytic pellistor LEL combustible gas sensor response curves. The smallest molecules (CH_4 and H_2) have the highest relative responses. The largest detectable hydrocarbon molecules (octane and nonane) have the lowest relative responses.

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