The Effects of Process Temperature on LFL Measurement

Flammability

Many industrial processes emit vapors that mix with air and have the potential for fire or explosion if the vapor concentration exceeds the Lower Flammable Limit[1] (LFL) and is exposed to a source of ignition. Combustible vapors must be kept well below their LFL to provide a margin of safety, often less than half their LFL or less.

Each type of combustible vapor has a unique LFL that is determine by laboratory testing. Differences in the experimental apparatus lead to variation in published LFL values – ten percent or more is not uncommon.

For example, the LFL of Acetone in air is 2.5% by volume. A concentration of 1.25% by volume is therefore 50% LFL.

Because concentrations at or above LFL are a fire or explosion hazard, flammability readings are shown as a percentage of the LFL, most often in a range from 0% to 100% LFL. Typically, alarms are set to trip at readings of 50% LFL or less.

Temperature Effects

Flammability is temperature dependent. Heated combustible vapor mixtures are more easily ignited. A lower concentration can support combustion, so the LFL is reduced.

For heated industrial processes such as dryers, ovens, and furnaces, the temperature effect is significant. Typically the LFL is determined at "room temperature" – either 20ºC or 25ºC. For higher process temperatures, flammability increases (and the LFL declines) as much as eight to fifteen percent or more for every 100ºC increase in process temperature.

For example, at 220ºC, the LFL of Acetone may fall to 2.1% by volume, so that 1.25% Acetone in air is therefore 60% LFL at 220ºC compared to 50% LFL at 20ºC, a significant difference.

Unless corrected, the temperature effect can cause readings and alarms to be inaccurate – the alarm may activate less promptly and at a higher concentration than is considered safe.

Margin of Safety

One of two methods should be used to preserve the margin of safety at higher temperatures: either alarm levels are lowered, or the analyzer readings are increased (re-calibrated).

Alarm Levels

In this method[2], the analyzer is calibrated for 20ºC LFL values and the alarm levels are decreased at higher temperatures to compensate for the temperature effect.

Calibration

In this method[3], the analyzer is re-calibrated to compensate for the temperature effect by increasing the calibration reading for higher temperatures, while the alarm levels remain unchanged.

Special Considerations

The rules for permissible alarm settings and for calibration adjustments vary between different authorities. Whichever method is used must be followed both for alarm and calibration settings, because together they establish the margin of safety.

For a mixture of combustible vapors, the calibration can be permitted to be an average response to each component. Alternatively, the calibration may be required to be for that vapor to which the analyzer is least sensitive, so all readings are at or above actual concentrations.

One method may allow higher alarm levels but has a stricter set of rules for calibrations. The other may require lower alarm levels but allow more calibration error.

Summary

Plant personnel responsible for LFL monitoring must be aware that it is necessary to apply a temperature compensation factor. This will increase accuracy of readings and alarms and preserve the margin of safety.

[1] Also known as the Lower Explosive Limit (LEL).

[2] Refer to EN1539 - Dryers and ovens, in which flammable substances are releasedSafety requirements.

[3] Refer to NFPA-86 - Standard for Ovens and Furnaces.