Technical Tidbit

LEL and 10% of LEL

A few common gases and liquids have IDLH values set at 10% of the Lower Explosive Limit (10% of LEL). IDLH is an acronym for Immediately Dangerous to Life and Health. These IDLH concentrations have been established by NIOSH (National Institute for Occupational Safety and Health) for several hundred chemicals. For most chemicals, the IDLH concentrations are based on toxicity if the chemical is inhaled. For a small number of chemicals, the IDLH concentration is set at 10% of the LEL even though toxicity information might allow for a much higher concentration.

An example is propane. Propane has a lower explosive limit (LEL) of 2.1% and an upper explosive limit (UEL) of 9.5% at room temperature. At elevated temperatures these numbers could be different. The IDLH concentration is 10% of LEL or 2100 parts per million (ppm). A 2.1% concentration of propane in air is equivalent to 21,000 ppm. Ten percent of 21,000 ppm is 2100 ppm, and this is the IDLH concentration.

Another example is methane. Methane is the primary ingredient of natural gas. Methane has a LEL of 5% and an UEL of 15% at room temperature. A concentration of 5% methane in air is equivalent to 50,000 ppm. An IDLH concentration set at 10% of LEL would be 5,000 ppm.

Butane has an IDLH set at 10% of LEL, or 1600 ppm. The LEL for butane is 1.6% (concentration of butane in air).

If the chemical is also toxic, the IDLH will probably be much lower than 10% of LEL. An example is benzene which has a LEL of 1.2% but the IDLH value is 500 ppm. Benzene is also a recognized carcinogen.

Gasoline is a complex mixture of about 200 different chemicals, many of which are toxic. The LEL of gasoline is about 1.3% or 1.4% overall. Some of the components of gasoline have lower LEL values and IDLH values less than 10% of LEL. A major component of gasoline is heptane which has an LEL of 1.05% (n-heptane) and an IDLH value of 750 ppm. Benzene is also found in gasoline. Because gasoline composition can vary, it is difficult to establish an IDLH number. Because gasoline components are toxic, if an IDLH number were established, it would probably be less than 10% of LEL.

Another problem that arises is the conversion of 10% of LEL to a value expressed as ppm (parts per million). The confusion comes from the fact that LEL is almost always expressed as volume % but IDLH is typically expressed as ppm (although for hazardous materials typically found in the form of dusts or particulates it may be expressed as mg/m^3).

Why the different units when expressing concentration values? Well primarily because volume % is used for expressing relatively high concentrations and ppm is used to express relatively low concentrations. Volume % can be thought of as expressing concentrations as parts per hundred vs. ppm expresses concentrations as parts per million.

So how do we convert from volume % to ppm? To convert the LEL to an IDLH value based on its flammability, we first have to figure out what the 10% of LEL value is in the units of

volume %. This is pretty straightforward, if the LEL is 5.5%, we just multiply the 5.5% by 0.10 or 5.5% x 0.10 = 0.55%. Now we need to convert the 0.55% (actually 0.55 volume %) to ppm.

Now we simply move the decimal point to the right four places, which is equivalent to multiplying 0.55 by 10,000, so 0.55 volume % becomes 5,500 ppm.

A simple way to keep all this straight is that 50% (volume %) is the same thing as 500,000 ppm and likewise 1 % (volume %) is 10,000 ppm.