

TOXIC GAS DETECTION IN THE REAL WORLD:

PRACTICALITIES AND PITFALLS

By Michael D. Shaw



Wouldn't It Be Nice?

So goes the 1966 Brian Wilson/Tony Asher-penned Beach Boys hit. Wouldn't it be nice if all we had to do was determine the gas or gases to be measured, buy a few sensors, string them together, hook them up to a panel and voilà—success!

As most of us know, though, it's never quite this easy unless we've done our homework. This article will help ease the pain of the homework.

PITFALL #1: THE WRONG PARADIGM

Within the field of scientific instrumentation, toxic gas detection has a relatively short history. Thus, it was only natural—if not helpful—to draw on experience thought to be relevant.

The most measured parameter, by far, is temperature, and accomplishing this is easy, cheap and usually trouble free. Significantly, there are no interferences that might affect the validity of the measurement to speak of. In fact, mention the word “interference” to an old instrument hand who has never been involved with TGD, and he may not even know what you are talking about!

Early gas detection instruments focused on oxygen and combustibles. These measurements usually resided in the percent concentration realm and little applications engineering was necessary. Things were simple, and people liked it that way.

Thus, when much of the best practices documentation was first being written on toxic gas detection, far too much emphasis was placed on experiences garnered in temperature, oxygen and combustible gas measurement. Sad to say, this misconception persisted well into the 1980s when I was on two ISA (Instrument Society of America) committees established to write guidelines for TGD instruments.

PRACTICALITY #1: TOXIC GAS DETECTION IS UNIQUE

In the usual application of occupational health/industrial hygiene TGD, we are dealing with this can of worms:

- Measuring reactive compounds
- Trying to detect them at very low concentrations (parts per million levels or lower)

- Monitoring them in the presence of other substances that may interfere with the measurement
- Calibration methods that can be difficult and/or expensive
- Results that may be influenced by many environmental factors

PRACTICALITY #2: PROPER CALIBRATION IS 90 PERCENT OF SUCCESSFUL TOXIC GAS DETECTION

Since all instrumentation methods of TGD are relative rather than absolute, all the detectors must be calibrated against a known source. For the most part, instrument manufacturers have not done a very good job of impressing the importance of calibration on their customers, mainly because it muddies up the otherwise clean, slick sales presentation.

Ask yourself just how important the quantitative results of your TGD measurement will be. Do you fear you are already close to the allowable time-weighted average? Will these results be reported to a regulatory agency? Will alarms be actuated at certain levels? There is simply no substitute for calibration with a reliable source, at intervals that will in all likelihood be more frequent than those recommended by the manufacturer.

PITFALL #2: MISPLACED FAITH IN YOUR CALIBRATION SOURCE

With the notable exception of carbon monoxide, most of the gases of interest are unstable and must be detected at very low concentrations. Thus, the easy answer of a conventionally prepared cylinder for your calibration standard is a non-starter.

Some time ago, high-loading balances were introduced, supposedly enabling specialty gas manufacturers to prepare their blends by taring the empty cylinder and then adding the components of the gas blend by weight. Little thought, however, was given to what might happen once the gases were inside the cylinder. Customers soon found that what was put in bore small resemblance to what came out. Many undesired reactions were occurring in the high-pressure environment of the cylinder, and strange cylinder wall effects were also noted.

While gas blend technology has improved over the years and excellent results have been obtained with specially conditioned aluminum cylinders, be wary of all claims and ask the supplier for multiple references.

Permeation devices, originally described in 1966 by O'Keeffe and Ortman (working at what was then called the Department of Health, Education and Welfare), offer a means for creating a predictable and recertifiable calibration source for hundreds of compounds. The permeation rate of the tube can be determined, at any time, by differential weighing.

It is noted that permeation devices tend to be dramatically affected by temperature. For best results, the devices must be used in conjunction with an apparatus that controls temperature and carrier gas flow rate. Certain modified devices purport to have far less temperature sensitivity but are not necessarily available for as many compounds.

Suffice to say that proper utilization of these devices can be cumbersome and expensive, especially if they must be deployed to calibrate a detector mounted in a remote field location. Still, there may be no suitable alternative.

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Finally, some manufacturers offer a sensor exchange or factory recalibration service that can remove the burden of TGD calibration from the end user. In most cases, these factory calibrations are quite accurate but leave the end user with a problem: How does he know, or how can he demonstrate, that the TGD instrument is actually working if he has no calibration source on hand?

This is where the notion of a “bump” test comes in, but using a macro-level concentration to simply determine if an instrument responds to the gas is of limited value. After all, the sensor could be close to dead and still respond to the bump concentration, yet offer no protection at its intended sensitivity.

Our strongest recommendation is to be serious about calibration. Someone’s life may well depend on it.

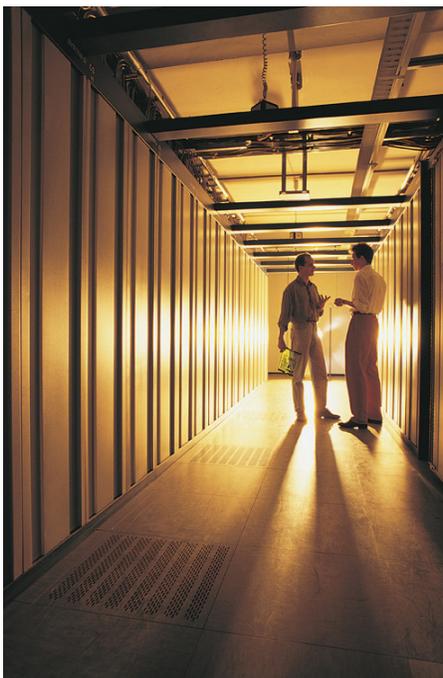
PRACTICALITY #3: DO THE APPLICATIONS ENGINEERING

Whether you are going to be surveying an area with a portable instrument, or will be installing a permanent, fixed TGD system, due diligence requires the following:

- Identify the target gas or gases of measurement
- Determine what other compounds may be present that could interfere with this measurement
- Make note of environmental conditions, such as temperature and barometric pressure; virtually all TGD instruments are affected by these parameters and corrections reflecting calibration conditions versus operating conditions will have to be applied
- Determine if the instrument will be used in an electrically hazardous area, and choose an appropriately certified unit
- Ensure that the measuring range of the instrument will allow sufficient sensitivity for the task at hand

PITFALL #3: INTERFERING GASES

Few if any analytical techniques are completely specific to the target compound of interest. This becomes a practical problem only when interfering substances are known to be present along with the target compound. Unfortunately, this happens fairly often in TGD applications, owing to the reactive nature of the gases and the limitations of most popular measurement technologies.



Responsible instrument manufacturers will detail all known interferences in their product brochures and Web sites. This should be a starting point. Examine their data for all the possible interferences on your desired measurement. If any of these chemicals might be present in your environment, you should consult the manufacturer to see if there is a solution to this problem before you purchase the instrument.

Any manufacturer who does not divulge interference information or offer assistance in this regard should be avoided.

PRACTICALITY #4: DECIDING BETWEEN PORTABLE VERSUS FIXED INSTRUMENTATION

Portable TGD units were the first to come out, and they still are far more popular than fixed systems. Why? Because they are cheaper to acquire and are easier to sell. However, the purpose of a portable instrument is to survey an area to determine if a hazardous condition exists. If it does, and it cannot be remediated, then a continuous system should be installed. There is simply no point in manually surveying an area again and again with a portable instrument.

Arguably, personal size units can be issued to all affected employees who might venture into the area, but this now multiplies calibration and maintenance problems. Moreover, these products are not available for hundreds of toxic compounds that appear in many industrial environments.

PITFALL #4: NOT BEING AN INFORMED TGD INSTRUMENT CONSUMER

It’s a fact of 21st century life that most products we purchase are technical and require some amount of care in their selection. The Internet has certainly made the information gathering aspect of product specification less arduous, but this has not relieved us of the responsibility of choosing wisely.

Be demanding of your prospective instrument vendor and be demanding of yourself. The employees you are charged to protect deserve no less. 

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