Sampling manifold with five detector tubes

Based on practical experience in the field, a combination of direct-reading detector tubes and portable electronic instruments has proven to be suitable to allow fast and reliable detection and measurement of both toxic industrial chemicals and chemical warfare agents. User-friendly evaluation charts will guide the user to properly evaluate the different colour stains in the detector tubes. Comprehensive information in the display of a portable instrument gives a clear picture about the kind of chemicals being present and their concentrations in conjunction with audible and visual alarms in case certain levels have been passed.

Strategic Approach
In general industry we find about 5,000 to 6,000 different chemicals that are in daily use; some in small quantities, some in larger quantities. In the case of a chemical accident, whether this is a spill, an explosion or a fire, we should be prepared to determine within 15 to 20 minutes which chemicals are present. There is no single instrument available that could detect all 5,000 chemicals in one unit. Because of the large variety of different chemical behaviours, we need a strategic approach. Nobody is willing to carry a whole bunch of detection equipment in the field to be prepared for everything. Despite budgetary questions, there will always be an issue of having very limited time.

There are three essentials to follow:

a. The better our knowledge of the present chemicals, the better and easier we can be prepared to select the proper detection equipment and, of course, also the protection equipment.

b. If we do not know what is present in the case of unknown chemicals or warfare agents, we need a strategic selection of detectors based on the statistical evaluation of chemical accidents. This limits the number of necessary equipment drastically.

c. Besides the selection of instruments, we

Detecting Unknown Chemical Hazards

In many cases, first responders have to deal with unknown chemicals, which can be either toxic industrial chemicals (TICs), or chemical warfare agents (CWA). Under all circumstances there is only limited time to determine which chemicals are present, otherwise even more important actions would be neglected. The necessary equipment should not be too complicated in use or too bulky.
need regular trainings. This way, each and every individual first responder feels comfortable with his or her equipment and knows very well how to use it and how to evaluate the results in a limited period of time in the field.

**The Tubes Approach**

Direct-reading detector tubes have the big advantage of allowing the measurement of a large variety of different chemicals. A length-of-stain type discolouration of the reactive chemicals inside the tubes is a measure of the concentration. Based on printed-on scale marks or a full scale in parts per million (ppm) the concentration can be evaluated directly in the field. No calibration is required by the user. Ambient air is drawn through an opened tube by means of a manually operated bellows pump; no battery is necessary. The tubes can be used at any time without preparation by the user.

In order to save valuable time in the field for first responders, there are detector tubes available consisting of five tubes per manifold. They can be used at the same time. Thus, the measurement time is reduced by the factor of five. So, we observe five results in the measurement time of one.

There are three different simultaneous test kits available; they are utilised to measure the following toxic industrial chemicals. The tubes inside the kits have been selected based on the statistical evaluation of accidents where individual chemicals could be identified.

**Kit 1:**
1. Acid Gases (Hydrochloric Acid, Nitric Acid, etc.).
2. Hydrocyanic Acid.
3. Carbon Monoxide.
4. Basic Gases (Ammonia, Butyl amine, etc.).
   Nitrous Gases (NO + NO₂)

**Kit 2:**
1. Sulfur Dioxide.
2. Chlorine.
3. Hydrogen Sulfide.
4. Carbon Dioxide.
5. Phosgene

**Kit 3:**
1. Ketones (Acetone, Methyl Ethyl Ketone, etc.).
2. Aromatics (Benzene, Toluene, etc.).
3. Alcohols (Methanol, Ethanol, etc.).
4. Aliphatic Hydrocarbons (Hexane, Octane, etc.).
5. Chlorinated Hydrocarbons (Perchloroethylen, Trichloroethylen, etc.).

As we can see with the above mentioned three simultaneous test kits we can measure TIC’s toxic industrial chemicals. They are either used as bulk chemicals for example, hydrochloric acid and vinyl chloride, which are released during spills such as hydrocarbons, or those that are formed as decomposition products during fires, as in the case of hydrocyanic acid from plexiglass, hydrochloric acid from polyvinylchloride, and phosgene from chlorinated hydrocarbons. In case we detect the group of chemicals similar to the representative chemicals in kit 3, the tubes are typically calibrated with the most toxic chemicals.

With the combination of these three simultaneous test kits plus one electronic portable instrument to measure combustibles, first responders are prepared to detect 85 percent of unknown chemicals in the field.

We strongly recommend using a continuous monitor to detect explosives or flammables as they are very common. In addition, while utilising a multi-gas instrument, the rescue team would also have the ability to monitor for oxygen deficiency and carbon monoxide, which can be particularly importance, particularly inside buildings or confined spaces.

But, what about the remaining 15 percent?
Well, the one particular group of chemicals being left out so far is CWAs. Typically when talking about chemical warfare agents, we talk about the following substances:

- **Nerve Agents**: Sarin, Tabun, Soman, VX.
- **Blister Agents**: Mustard Gas, Lewisite.
- **Blood Agents**: Hydrogen Cyanide, Cyanogen Chloride.
- **Lung Agents**: Phosgene, Chlorine.

For the fast detection of CWAs, there are other kind of sampling manifolds available with five tubes each. Similar to the simultaneous test kits for TICs, each sampling manifold comprises five different direct-reading detector tubes. With two kits, we cover all groups of CWAs. As a convenience for the user, the tubes are available in rugged transportation cases which can be taken anywhere in the field. The case also contains evaluation charts to determine the concentration of individual warfare agents conveniently.

The sampling manifolds allow for a fast detection of CWAs using the same bellows pump as mentioned for the simultaneous test kits. No calibration or charging of batteries is required.

**Detection of Fire Accelerants**

Not all fires happen by accident, some of them are man-made utilising fire accelerants such as petrol. After ignition with they create large flames and a huge fire, particularly inside buildings. To evaluate the reason for a fire after it is finally extinguished, it is often helpful to use a very sensitive instrument. This way, it is possible to detect low concentrations of volatile hydrocarbons that may have been used as a fire accelerant by means of a photoionization detector. The working principle of a photoionization detector is the forming of ions by means of UV-radiation inside this instrument. These ions form an electric current that is detected within the instrument. The strength of this current is a measure of the concentration of a volatile organic compound (VOC).

Due to their working principle, photo ionization detectors (PID) cannot be substance specific. If there is an investigation in a building after a fire, the rooms may be screened as a final step with a PID. It helps find locations of where fire accelerants have been used to intentionally ignite the fire. As a subsequent analysis, we could draw an air sample with an activated charcoal tube for subsequent laboratory analysis to determine qualitatively and quantitatively of the composition of the fire accelerators.

**Conclusion**

The combination of direct-reading detector tubes and portable electronic instruments allows for fast detection of unknown chemicals, TICs as well as CWAs. This makes it a vital equipment for first responders. Third-party validations have proven sensitivities, response times, and specificities as well as the practicability in the field with limited training required. The photo ionization detector is a major step forward to determine small concentrations of fire accelerators inside a building.

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**Wolfgang J. May** is Asia Pacific Regional Marketing & Application Manager at Draeger

For further information, go to www.draeger.com