With ever-increasing demand placed on plant safety, you need to ensure you are within compliance in the event that something goes wrong. In water treatment facilities, there may be various amounts of toxic and combustible gases, such as chlorine, hydrogen sulfide, sulfur dioxide, chlorine dioxide, hydrogen peroxide and methane. All of these can cause harm and even death in the event of a catastrophic failure. Many failures start as a small leak and with the right conditions, can turn into a major release.

The 411 on Gas Detection

By Michael Moore

Analyses of common sensor technologies

In the past, we relied on our senses to detect these leaks, but we quickly learned our senses became insensitive to some of these gases, not to mention the harm that it was causing to the body. This is where gas detection becomes your best friend. If you do not know what you are against, though, it may become your worst nightmare.

It is fair to say that instruments are only as good as the sensor installed. For example, if you take two temperature probes from your local retail store and look at the displays, you will soon discover that you will have two different temperature readings. Which one is right? Because this is ambient temperature, it may not matter too much because they are only a couple of degrees off.

Gas detection is no different. Being a few parts per million (ppm) off, however, may mean the difference between life and death. This is why it is critical to understand gas monitors and how they function.

When you break down the gas monitor into its main components, two essential parts are visible: the electronics and the sensor.

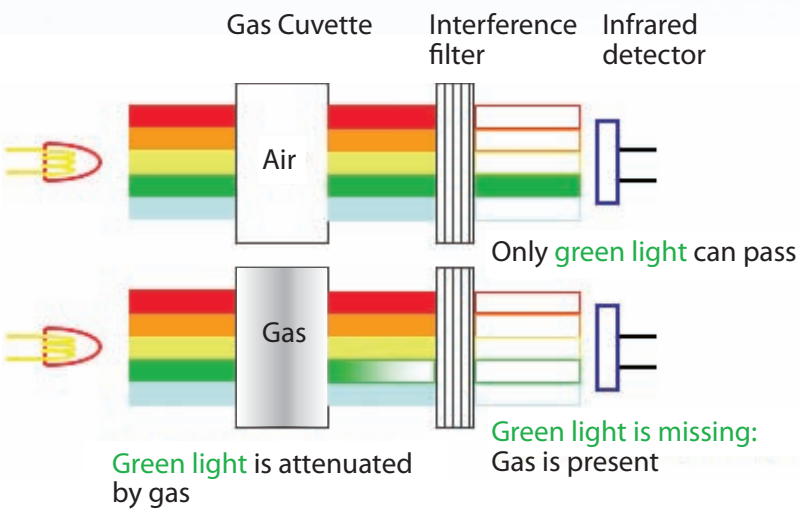

Figure 1. The principle behind the infrared sensor is that a gas will absorb a particular wavelength of light preventing it from being detected by a sensor. When the sensor fails to sense the lack of this light, the unit goes into alarm.

Electronics. The electronic portion of the detector does nothing more than amplify the signal from the sensor and display a value. Companies may have several different features built into the main electronics—relays, communication protocols and remote control access, for example. The primary function of the electronics, though, does nothing more than convert the sensor signal into an understandable reading. If the electronics fail, then the gas monitor fails. One of the most common failures can be linked to the installation process. Others may include water ingress, high or low temperature and operator abuse. The only way to prevent these failures is to review the recommended installation procedures and make necessary corrections. If the main electronics are in good working order, then the only other component is the sensor.

Sensor. The sensor is the most important component of the gas monitor. There are several different types of sensors used in today's water industries. Picking the correct sensor is not an absolute science, but you need to ensure you use the right sensor for the right gas. This article will educate you on common sensor technologies: catalytic bead, semiconductor, electrochemical and infrared. Strengths, weaknesses and functionality will be examined, along with some common issues to help determine if you are using the right monitor and sensor in the right application.

Catalytic Bead Sensor

Often referred to as the cat bead sensor, this sensor is typically used to monitor for combustible gases in air. This sensor is ideal for the monitoring of methane gas, which may be found in or around digester ponds, lift stations and pump houses. The sensor is composed of an internal platinum wire that is coated by a catalyst. This configuration, in conjunction with the reference side, forms a wheat-stone bridge. When a combustible gas comes in contact with the catalyst, a small "combustion" takes place. This reaction raises the temperature of the resistors in proportion to amount of gas present (see Figure 1).

The strengths of this sensor are its long life (approximately five years), durability and ease of use. The major weakness is its inability to be gas-specific (i.e., it is only for combustible gases). Because this sensor detects combustible gas, any combustible gas may cause this sensor to respond. When maintenance is performed on a nearby pump or compressor, oftentimes the hot oil vapor may cause this sensor to respond.

The sensor is subject to poisoning, which means there are several gases that may destroy the catalyst coating within the sensor. This will make the sensor inoperable, so be certain these types of gases are not present. Consult with the manufacturer to determine if these poisoning gases are present. When it comes to maintenance, this sensor is fairly reliable, and upon following the manufacturer's recommendation on calibration, it should provide trouble-free operation.

Solid State Sensors

The principle of operation for the solid state sensor is similar to the cat bead described above. There is a thin electronic film that coats a silicon chip. This film, when exposed to gas, changes the electronic characteristics of the silicon chip. The chip then undergoes an algorithm, which sends a signal to the main electronics displaying the concentration of gas (see Figure 2, page 32). In principle, this sensor is measuring the thermoconductive properties of the target gas.

This type of sensor has a very low production cost and, therefore, a low selling cost. This is perhaps the reason why it has emerged as an industry favorite. The low replacement cost seems to catch everyone's eye, but ask yourself if you should purchase something because it costs less or because it is reliable.

This sensor is not selective, and it will react to other gases, so it may give false or nuisance alarms. In the event of a large leak, this sensor may not recover and will require replacement. When this sensor is idle for some period of time, it may "fall asleep," which means

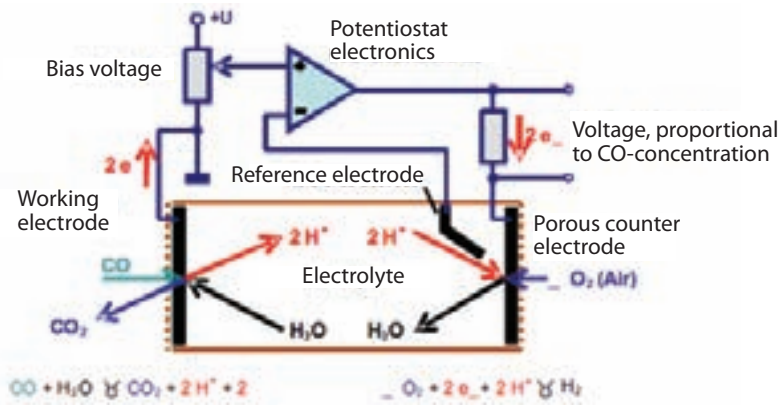

Figure 2. A brief illustration of the electrochemical sensor. As gas enters into the sensor, it reacts with the electrolyte. This reaction produces a small electrical current which is proportional to the concentration of gas.

it may require additional time to respond to a gas leak, which could become a hazardous situation. If the sensor has become idle and a leak occurs, this sensor may not respond for several minutes; this slow response time may be the difference between a good system and a lawsuit. Most manufacturers suggest frequent calibration of the sensor to keep it active, so the response time is kept to a minimum. With frequent calibrations, however, comes a higher maintenance budget.

Infrared Sensors

One of the most reliable and maintenance-free sensors on the market is an infrared gas sensor, which has no moving parts. The technology has been around for many years, proving its worth. It is fairly costly, but when adding up the amount of time and money spent on maintenance, it will soon outweigh other types of units. The principal of operation is simple: A light source with a specific wavelength is directed into the detection chamber of the unit. When gas is present, the gas absorbs some of the wavelength, limiting the amount of light that makes it into the detection chamber. The amount of light not present (or absorbed) is proportional to the gas concentration.

This type of unit can be set up or purchased to be gas-specific. Every gas has its own infrared "fingerprint," and with the right configuration, this sensor can be set to monitor for the gas of choice. Typically, the infrared sensors are for the detection of combustible gases, but other gases can be detected. Consult with the manufacturer on other gases that can be detected. The sensor sports a long life (more than five years), and in most cases it is durable in harsh environments. In some cases, this sensor may carry an NFPA 820 rating (IP 67), which means it can be submersed for a period of time with no harm to the unit. Manufacturers recommend a "bump" test at least once per year to ensure that the sensor responds accordingly. Outside of this, the unit requires little or no maintenance.

Electrochemical Sensor

Electrochemical sensors have been available for more than 30 years. This technology is proven to be reliable in most applications. It is primarily for the detection and monitoring of toxic gases and oxygen. The principle of operation is an oxidation-reduction chemical reaction between an electrolyte and the target gas. Gas enters the chamber of the sensor, where it combines and reacts with the electrolyte. This reaction produces a small electrical charge, which is compared to a reference electrode. The voltage difference is proportional to the gas concentration. For toxic gas and oxygen applications, this is the sensor of choice. The e-chem sensor has evolved to become reliable, low-maintenance and affordable.

The expected life of the sensor varies from about 12 months to as much as five years, based on the manufacturer. Each time the electrolyte is exposed to a target gas, some defined amount of electrolyte is spent. When the electrolyte is used up, then the sensor will fail to respond and a replacement will be needed. Most of the e-chem sensors have very specific operating parameters such as temperature, humidity and pressure. It is recommended that conditions are kept within these requirements, as environmental conditions will affect the sensor's performance. Otherwise, there are no real setbacks to the sensor. It is built to provide reliable service as long as its calibration is kept current. Most manufacturers recommend a calibration every six months.

Putting It All Together

Determine the most important factors in the selection process, such as how much you want to spend, how reliable the unit is and how long it will last. Sensor replacement cost has the biggest impact on the cost of ownership. Do you spend $500 on a sensor that may last five years, or do you spend $250 on something that will last two years? Remember that you will need to add the administrative and maintenance cost to this and justify the expense.

Ask the manufacturer to compare its sensor to the competition. Once you have this information, call the competition and have them make the same comparison. Once you think you have made a decision, see what the warranty is. Compare, compare, compare. Finally, the most important factor is plant and personnel safety, so insure your current monitors provide this. A routine function test and simple preventative maintenance will go a long way. WWD

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