



Ozone Sensing and Leak Detection

Measuring ozone at a leak site is like eating Jell-O with chop sticks: you sort of know what you're doing, but it never seems to work as planned!

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Ozone is rapidly becoming the water treatment method of choice for bottled water, swimming pools, aquariums and many other water purification applications. In comparison to chlorine, it creates less, if any, toxic by-products, is generated on-site, and the finished water is generally more attractive.

Free ozone from leaks, however, is toxic, and safe workplace levels are specified by various government regulations. In most countries, including the United States, the limits are 0.05 ppm for continuous exposure and 0.1 ppm for short term exposure. (See Table 1 for common conversion factors.) According to the American Lung Association, ozone exposure at the 0.1 ppm level leads to decreased lung function due to the erosion of lung tissue and to the encouragement of various lung diseases.

The toxic borderline is hard to define. In the highlands of New Mexico, 0.05 to 0.08 ppm ozone levels are common as a result of the intense high-altitude sunlight's catalysis of hydrocarbons of pine trees. Yet for centuries people have boasted of their great longevity of life here.

How is ozone detected at hazardous levels? Many who work with ozone say that the "sniff test" is sufficient due to ozone's distinct odor, even at low concentrations. Leaks can be detected quickly and disaster

will be averted. The sniff test is not a responsible industrial safety practice, however. People who work around ozone often lose their sensitivity to its odor, at least at low levels. The sniff test is not an accurate means of locating leak sites in a maze of plumbing, or of determining whether the leak is increasing or subsiding. If there has been a major ozone area flooding, the sniff test doesn't indicate when it is safe to return to the work area.

Therefore, it is necessary to have an ozone sensor or monitor. Many are available on the market, ranging from several hundred to several thousand dollars. These instruments are also helpful for system engineering and management. They help trace the ozone flow from the generator to its emergence from the water, making sure that the whole transmission process is efficient. Ozone, which under the best of conditions has a half-life of hours, breaks down rapidly in confined spaces, valves, filters and hot and humid areas. Once the system is running, sensing instruments ensure that it continues to produce and properly deliver ozone.

Problem solved? Not quite.

Ozone sensing precautions

Measuring ozone at a leak is like eating Jell-O with chop sticks:

you sort of know what you're doing, but it never seems to work out as it should. Furthermore, modern instruments with digital readouts tend to lull us into believing that the reading is the truth.

Ozone does not instantly diffuse in air to create a uniform concentration for easy measurement. If you could see ozone, it might look like cigarette smoke, sort of swirling around according to various influences and then disappearing. (Ozone has a half-life as low as minutes in confined spaces.) When your trusty instrument reads 0.076, are you at the center of the swirl or off at a fuzzy edge? Is your instrument, which takes a certain amount of time to process the ozone, analyzing a transient and presenting the data as if it were a steady state, or is it missing a rapid change altogether?

There are some common sense things you can do to make more meaningful ozone measurements.

Getting a representative sample

As a start in good sampling technique, try to avoid drafts between the leak and the sensor. Even slight cross-path air movement can head the ozone off track. In the petrochemical industry where they check gas leaks at hundreds of valves per plant, they have learned by experience to bag the valves with canvas enclosures. You don't necessarily need to go to this extreme, but you can follow the same principle by shielding the ozone leak path with one hand while holding the instrument or probe with the other.

Table 1: Ozone concentration conversion factors

	Exposure	
	Continuous	Short term
ppm (parts per million)	0.05	0.1
ppb (parts per billion) (ppm x 1000)	50	100
$\mu\text{g}/\text{m}^3$ (micrograms per cubic meter) (ppb x 2.4)	120	240

Avoid chemical interferences

The pathway between the ozone leak and the measuring instrument must be free of VOCs (volatile organic compounds) and other chemicals that will reduce or eliminate the ozone. Ozone, after all, is used commercially to neutralize VOC-based fumes and odors. Among the VOCs that are so common that you might overlook their interference in the measuring process are after-shave lotion, perfume, cigarette smoke and various solvents.

While VOCs are generally reducing agents and will cause the sensor reading to decrease as they are oxidized by ozone, oxidizing gases such as chlorine and fumes of chlorine compounds will cause many ozone sensor readings to increase. This generally is the case for electrochemical and semiconductor sensors.

Be aware of the effects of materials

Ozone is unaffected by glass but will seem to cling to the surfaces of many plastics and fabrics. It chemically reacts with some metals such as brass, but is inactive in the presence of some plating materials such as nickel. Some common tubing materials are reactive with ozone; check

tubing material reactivity charts carefully before selecting one for your application. Ozone aggressively attacks and disintegrates rubber: this is the source of many gasket leaks!

Environmental issues

The great outdoors is a veritable witch's brew of influences on ozone measurement. Lightning and corona discharge can significantly raise ozone levels even when storms are miles away and when measurements are made hours later in dry climates.

Automobiles can significantly affect ozone measurements either way. The oxides of nitrogen emissions can be catalyzed by the summer sun to create the well-known ozone alerts. On the other hand, VOCs generated by automobiles can neutralize some of the ozone generated by the sunlight-catalyzed hydrocarbon emissions from evergreens.

The sun's intense ultraviolet energy can affect ozone sensors if it reaches the sensor's area of sensitivity. Heat and humidity reduce ozone's half-life and can also change readings, even if the ozone level didn't change. Before going outside, review the manufacturer's limits on the operation of their instrument.

Chlorine, chlorine compounds, acid gases and other industrial chemical emissions can be very persistent indoors and outside, and as discussed above, you should be aware of their presence and effects.

Instrument response times

Some ozone sensing and measuring equipment responds and comes to a full reading in a few seconds after exposure to ozone. Other equipment

takes a few minutes. Therefore, if you are moving around the ozone plumbing looking for leaks, a fast-response instrument would be best to detect the ozone and estimate its concentration. A slow response instrument would be better for continuous area monitoring where confusing ozone concentration measurements, caused by such influences as shifting air currents, would be averaged out.

Periodic sensing or continuous monitoring?

Another consideration is whether to check for leaks or changing ozone levels periodically (portable sensing) or continuously (monitoring). Periodic checks with a hand-held sensor scanned over potential leak locations are likely to find leaks not detected by fixed location monitors because ozone does not diffuse or propagate quickly or completely.

The fixed and continuous monitors, however, are useful to catch a leak developing in work areas with relatively untrained and unconcerned personnel, or in areas where no one is present for long periods of time. Table I illustrates the ozone concentration conversion factors

Meaningful readings

If the sensing precautions outlined above are followed when measuring ozone, a leak can be readily detected and measured. While the "sniff test" may work in isolated cases, a more accurate means of locating leak sites and measuring concentrations can be obtained with the proper ozone sensing or monitoring equipment.

Ozone monitoring can be simple and inexpensive, but before purchasing equipment it is important to analyze your ozone system and needs in order to specify the appropriate kind of sensor or monitor. Plan ahead for the most effective operation.

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