"Garbage in, garbage out" – George Fuechsel

Mastering the Fundamentals of Ozone: Feed Gas Preparation

By Bob Smith-McCollum

A closer look at the first basic element of ozone

In the March 2008 issue of Water Quality Products*, the IOA column discussed mastering the fundamentals of ozone and reviewed the four basic elements required to form fully functional ozone systems: oxygen/feed gas preparation, ozone generation, mass transfer and monitoring and control. This month, the series continues with a closer look at the first basic element: oxygen/feed gas preparation.*

For the purposes of this discussion, we will focus on ozone systems in which the ozone gas is dissolved into water and applied to the target application. This article will not cover gaseous ozone systems and applications.

Oxygen or Air?

One of the first questions one is often faced with in designing an ozone system is whether the application requires concentrated oxygen or simply clean, dry air. Ozone systems convert diatomic oxygen (O_2) from the atmosphere to ozone (O_3).

Nearly 21% of the air that we breathe is comprised of diatomic oxygen. Depending on the requirements of the application and the capabilities of the ozone system, the feed gas requirement may be met with clean, dry, compressed air.

Applications demanding high levels of ozone require that higher concentrations of oxygen be supplied to the ozone generator through an oxygen concentrator or bottled oxygen.

The answer to the air versus oxygen question will depend on the ozone demand requirements of the application, the ozone production capabilities of the ozone system and the project budget. Begin with an assessment of the ozone demand requirements and the specifications of the ozone generator you plan to use.

Many factors impact the demand for dissolved ozone in an application. The characteristics of the source water—the pH, temperature and concentrations of metals and organic materials—strongly influence ozone stability. The aggregate effect of the source water characteristics yields instantaneous ozone demand—the base level demand for dissolved ozone that must be overcome before the demand of the application for a residual level of dissolved ozone can be met.

Applications with high instantaneous ozone demand and high ozone residual concentration or output requirements may necessitate feed gas of higher oxygen concentration. Concentrated oxygen adds cost to the system, but that cost must be compared to that of switching to a more powerful ozone generator running on air.

How Clean? How Dry?

"Garbage in, garbage out." This maxim, coined in the early days of computing, can be applied to ozone systems as well. All ambient air contains moisture, particulates and other contaminants that can damage ozone generators. Whether your system uses air or concentrated oxygen, care must be taken to remove compressor oil, water and other contaminants from the feed gas. Dirty feed gas will ultimately reduce feed gas flow, damage the ozone reactor cell and reduce the effectiveness of the ozone system or shut it down entirely.

Compressed air is typically collected in a feed air receiver tank, passed through a coalescing filter to collect and remove droplets of oil and water, a desiccant to remove water vapor and a particulate filter. Ozone generator manufacturers typically specify the operational requirements for the feed gas supplied to their systems.

Moisture from atmospheric air condenses when the air is compressed and must be removed. The moisture content of the feed gas is specified by the dew point rating expressed in degree of temperature (centigrade or Fahrenheit). The dew point value is the temperature to which the air must be lowered to condense the small amount of water vapor remaining in the gas. Particulate filtration is expressed as the maximum particle size that the filter will pass in microns. Hydrocarbon contamination from compressor lubricants and the operating environment is expressed as milligrams per cubic meter (mg/m^3) or parts per million (ppm).

The ISO standard ISO 8573.1 was developed to help engineers globally specify air quality through Quality Classes for particulates, moisture and oil as shown in Table 1. A typical air

Table 1: ISO 8573.1 Air Quality Classes

	Solids	Moisture Dew Point		Hydrocarbons	
Quality Classes	Microns	°C	°F	mg/m^3	ppm$_{w/w}$
0	As specified	As specified		As specified	
1	0.01	-70	-94	0.01	0.008
2	1	-40	-40	0.1	0.08
3	5	-20	-4	1	0.8
4	15	3	38	5	4
5	40	7	45	>5	>4
6	—	10	50	—	—

quality requirement for ozone generators is ISO Quality Class 1.2.2, which is equivalent to 0.01 micron particulate filtration, -40°C (-40°F) dew point and 0.08 ppm (0.1 mg/m^3) hydrocarbon filtration. Requirements vary among ozone generator manufacturers. Check the specific requirements for the generator you plan to use.

Oxygen Concentrators

Oxygen concentrators remove nitrogen and residual water vapor by the cyclical processes of adsorbing and desorbing nitrogen on a synthetic molecular sieve material. Commercial oxygen concentrators sequentially pressurize and depressurize multiple beds of adsorbent to produce a continuous stream of concentrated diatomic oxygen (up to 95% O_2).

Water vapor, having a larger molecular size than oxygen, is adsorbed and desorbed much like nitrogen and is not passed to the ozone generator. As a result, oxygen concentrators can tolerate a higher level of water vapor in the input air. The air quality requirements for oxygen concentrators can typically be relaxed to 3°C (38°F) dew point, or ISO Quality Class 1.4.2. Again, requirements vary. Check with the manufacturer of the integrated ozone/oxygen system (an ozone generator with integrated oxygen concentrator) or stand-alone oxygen concentrator for specific operational requirements.

Continuously supplying poor quality feed gas to an oxygen concentrator can contaminate the adsorbent, decreasing the oxygen output of the concentrator and the ozone output from the ozone generator. Oil droplets and hydrocarbon vapor can foul the adsorbent beds, blocking the binding of nitrogen during the pressurization cycle of the concentrator. Excess water vapor is adsorbed during pressurization and exceeds the amount that can be desorbed during the depressurization cycle. Over time, the adsorbent beds become increasingly saturated with excess water vapor and the oxygen output of the concentrator decreases.

Flow Rate & Pressure

Two other air prep parameters that must be considered are the feed gas flow rate and feed gas pressure. The performance specifications of the feed gas system for these parameters must match those of the ozone generator. Inadequate feed gas flow rate and pressure will rob the generator of oxygen and reduce total ozone output.

The next installments of this series will discuss ozone generation and mass transfer. *wqp*

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