

Ozone Pilot Plant Design: Why Use Ozone?

The first step before considering building an ozone pilot plant, is, obviously, to determine that there is a viable need for ozone in the treatment facility under consideration. Below are some of the many reasons ozone would be chosen over other oxidants such as chlorine. If you have a reason to apply ozone as part of your water treatment project, you may be required to conduct a pilot study prior to installation of the equipment. In this article, many of the reasons to use ozone—as opposed to other oxidants such as chlorine—as part of your treatment project and the proper design of an ozone pilot plant will be discussed.

Ozone is a Powerful, Fast-Acting Disinfectant and Oxidizer

Ozone is the most powerful disinfectant available for drinking water; it readily disinfects bacteria and viruses and, unlike chlorine, it is powerful enough to deactivate the protozoan cysts *Giardia* and *Cryptosporidium*. Ozone readily oxidizes the troublesome trio: iron, manganese and hydrogen sulfide. Ozone also oxidizes many other substances including ammonia, cyanide, nitrite and tannins, as well as aromatic hydrocarbons, benzene, toluene and xylene. Because ozone reacts over 1,000 times faster than chlorine, contact time for oxidation and disinfection is much lower. A lower contact time requirement significantly reduces contact space requirements and costs.

Reduce Trihalomethane Precursors

Trihalomethanes (THMs) are a group

of disinfection by-products that can result from treatment of water with chlorine. THMs have been proven carcinogenic. Ozone will reduce the THM precursors. Oxidizing organic matter with ozone and filtering prior to chlorination reduces the THM precursors. This, in turn, reduces chlorine demand as just enough chlorine is added after ozonation and filtration to provide residual disinfection through the distribution system. On smaller treatment systems with shorter distribution lines, it is possible to eliminate the need for chlorine altogether.

Ozone is Safe

Ozone is a gas that is created by electricity and cannot be stored or transported; it must be generated on-site as it is being used. Because ozone is generated on-site and as needed, there are no chemicals to purchase, transport, handle or store. Ozone does not produce cancer-causing THMs and leaves no long term residual oxidant in the water to be consumed.

Why use an Ozone Pilot Plant?

Control of the Variables. A well-designed ozone pilot plant will give you individual control over each treatment process variable so you can “zero in” on the exact requirements to treat the water, thereby developing a design and cost of full-scale treatment. With a properly designed pilot plant you will be able to determine ozone and chemical dosages required to treat the water. You also will be able to determine optimal contact time and optimize filtration variables such as

the most effective media, throughput, backwash flow rate and frequency of backwash. Piloting also will allow you to account for other treatment variables whether they are source-specific variables such as water temperature, pH and turbidity, or a site-specific variable like humidity.

Provide Operator Education.

Although market demand for ozone is growing, it is a rare occasion when plant operators have pre-existing training or experience with ozone treatment. A pilot treatment plant gives operators that experience. They will be able to observe and learn the causes and effects of hanging variables in the treatment system.

Meet Regulatory Requirements.

Regulatory officials typically will require an ozone pilot study when treatment is proposed for drinking water. This is no different than when any other treatment is proposed for drinking water.

What to Consider in Your Ozone Pilot Plant Design

Purpose of the Pilot. When considering the design of a pilot plant, thought must be given to whether the pilot will be of a temporary nature, on-site for the duration of the pilot study only, or permanent, left on-site for future use. Pilot plants also may be portable, mounted in a self-contained trailer or installed directly in the existing treatment facility.

Expected Treatment Requirements. After careful analysis of the water

and determination of expected treatment requirements, build the pilot to operate within a range that would cover any expected variables in water quality or flows. Your pilot treatment plant may require more than ozonation and filtration. You also may need pH adjustment or a softener. If you need additional treatment steps, they must be designed into the pilot. Remember that the goal is to determine exactly what is needed to treat the water.

Pressurized vs. Atmospheric System

Consideration also must be given to whether the pilot will be a pressurized or atmospheric system. In a pressurized design, the ozonation system always is under greater-than-atmospheric pressure. In an atmospheric design, the system comes to atmospheric pressure usually during the contact phase of the treatment process. Each design will require a different design approach and has different advantages and disadvantages as shown in Table 1.

Filtration: A Vital Part of the Ozonation Process

The typical ozonation system employs media filtration after oxidation. A multi-media layered filter with garnet and sand on a support bed of gravel is very common. Other media filters include BIRM and activated carbon. Your pilot may employ simultaneous use of different media filters to allow examination of the effectiveness of different media.

It is of significant advantage to use

Table 1: Pressurized vs. Atmospheric Ozone Systems

	Pressure Systems	Atmospheric Systems
Concept	<ul style="list-style-type: none"> The treatment system remains under pressure during the entire treatment process 	<ul style="list-style-type: none"> The treatment system comes to atmospheric pressure at some point during the treatment process
Cost	<ul style="list-style-type: none"> May be less expensive (especially where the water to be treated is relatively clean and the volume of water to be treated is low) 	<ul style="list-style-type: none"> May be less expensive where water is very dirty (especially where the volume of water to be treated is over 10 gpm)
Suitability	<ul style="list-style-type: none"> Most suitable in residential treatment systems treating less than 10 gpm and where there is at least an 80 gallon pressure tank 	<ul style="list-style-type: none"> Suitable for any size treatment system
Advantages	<ul style="list-style-type: none"> Simple design. Requires only one pump Lower system space requirements 	<ul style="list-style-type: none"> Flexible treatment design. Can incorporate multiple injection points Easier to control ozone residual levels. Can use smaller ozone generator with recirculation through the contact tank.
Disadvantages	<ul style="list-style-type: none"> Single injection point May require a larger ozonation system for single point injection. The system pump may need to be larger to insure the pressure differential across the venturi injector is maintained during the entire pump cycle 	<ul style="list-style-type: none"> More complex design Generally requires larger space for treatment system Requires more than one pump

a clear filter tank. A clear tank provides dramatic visual evidence of what is going on inside the filter. You will be able to visually observe what your instruments and gauges are indicating is happening inside

the filter (e.g., performance and loading) and things that are not so easily measured such as the results of different backwash flow rates and media re-stratification. If treating surface water or ground water,

under the influence of surface water it may be necessary to employ a filter that is approved for the reduction of cysts. Cyst filtration, if required, is

continued on page 14

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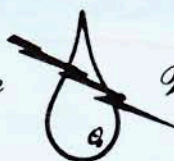
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continued from page 13

a second line of defense if something should go wrong with the ozone system and may be required as part of the final treatment system design but not as part of the pilot.

Flexibility

The pilot plant must be flexible. The ozone generator in your pilot treatment plant must provide for variable ozone production and you must have a chart or some other means of determining what the output of ozone is at various settings. This chart is available from your ozone generator manufacturer. The design of the pilot also must include a means for variation of the contact time. Typical contact times range from less than one minute to four minutes, with times as high as 20 minutes. In cases where there are high levels

of organics, it may be necessary to ozonate and filter twice. In a two-step ozonation system, the first step is to use the ozone as a flocculation or coagulation aid prior to filtration. This would reduce the organic load prior to the second step where the ozone is used for disinfection and is followed by final filtration.

Sample Taps

It is important to provide water sample taps for proper measurement and analysis. Sample tap locations should provide for sampling the raw water, results of chemical injection, ozone injection, ozone contact time, post each filter and additional treatment steps and the final product.

Functional Tidbits

The Work Station. It is important to provide a proper "work station"

for sample testing and analysis. The work station must provide adequate lighting and space as well as a power source for testing, analyzing and computing equipment.

Safety. Safety of personnel must be kept in mind at all times during the ozone pilot plant design. The pilot plant must be built to meet local electrical and plumbing codes. A well-designed pilot will have all components and the direction of flow clearly labeled.

How Long Should a Pilot Study Last?

The length of time required for a pilot depends. You must satisfy regulatory requirements in the district where the pilot will be located. Often the requirement is one year to cover seasonal changes in the source water supply. If the purpose

of the pilot is to "demonstrate" the speed and effectiveness of ozone, a pilot of a few hours or days may be all that is needed. •

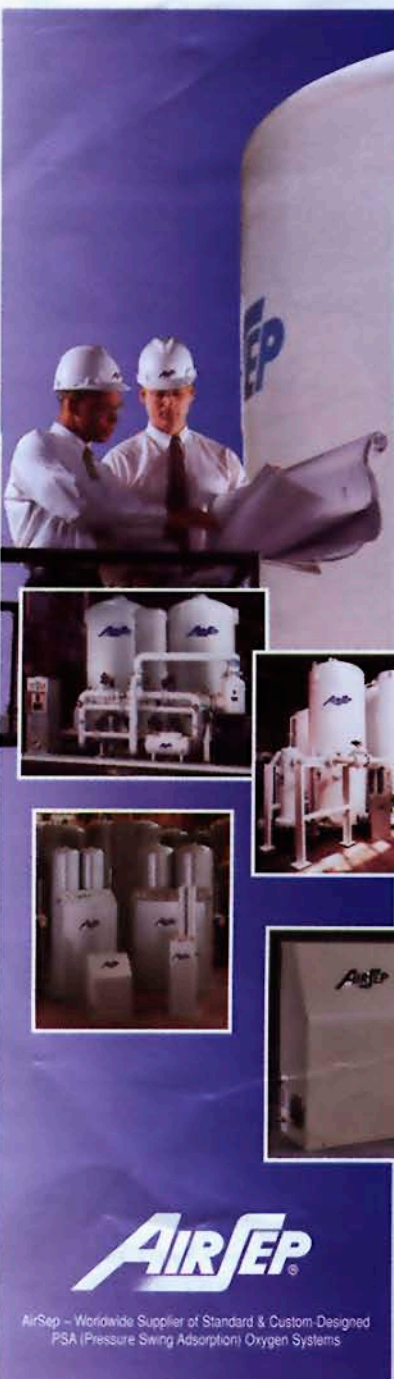
About the Author:

Gabe Ergler, CWS-III, is the owner and ozone application specialist with O3 Water Systems, LLC. Ergler is a graduate of Central Washington University with a degree in Business Administration. He is a WQA certified water specialist in disinfection and filtration.

O3 Water Systems, LLC, Snohomish, Washington, is a distributor of ozonation and filtration equipment.

Ergler may be reached at 360-794-9511, or visit the company's web site at www.o3water.com.

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