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The Practical Use of Ozone for the Well Water Application

There are more applications for ozone in the water and air treatment industry than we have space here to discuss. For brevity I'll only mention the topics (see Table 1). For this article, we'll discuss the well ozone water treatment application. Each application is a potential business in itself, which means greater revenue and profit. All that is necessary from you is the motivation to boldly go where you have not gone before.

Iron, sulfur and manganese are the easiest water problems to eliminate when using an ozone system. This is made possible by the oxidation power of ozone. The ozone oxidation process takes place by sizing the system properly based on the amount of iron, sulfur and manganese, the gallons per minute (gpm) recovery rate of the well pump and the gallons per day (gpd) usage. There are other factors to consider but below are the Big Three.

- Which contaminants are in the water?
- What is the flow rate?
- How much water is being used?

To understand how ozone accomplishes this task, you must first understand what oxidation means. Oxidation means to change the form by combining with or adding oxygen and to increase the valence of an element by the loss of electrons. Valence is the combining power of an atom as shown by the number of its electrons that are lost, gained or shared in the formation of chemical bonds.

Ozone kills bacteria by oxidizing the organic material in bacterial membranes, which weakens the cell wall and leads to cellular rupture. This exposes the organism to the external environment, which causes almost immediate death of the cell. The process is similar to being cut open by a knife.

In Technical Terms...

Iron/iron bacteria. Soluble divalent ferrous iron is oxidized rapidly to trivalent ferric iron, which hydrolyzes and precipitates as ferric hydroxide. This insoluble form of iron then absorbs some polar organics in the coagulation process and can be removed easily with filtration.

Sulfur/sulfur bacteria. Odorous hydrogen sulfide, which is not filterable, is converted quickly into elemental sulfur, which is filtered easily. A portion of the sulfur is de-volatized and off-gassed. The iron or sulfur bacteria is killed (as described above) quite rapidly (if enough ozone is injected) then removed via filtration.

Manganese. Manganese is oxidized and filtered in the same manner as iron and/or sulfur.

Ozone and System Properties

The following is a brief description of what ozone gas is, how it is made and what other parts are needed to make up an ozone system.

Ozone is produced when air is passed over a high voltage electrical field such as lightning or a spark from a spark plug. You also can produce ozone by passing air between the lamp and the quartz sleeve of some UV lights. Ozone is a more active form of oxygen made of three atoms instead of two. The symbol for oxygen is O_2, whereas the symbol for ozone is O_3.

Lightning is nature's ozone generator. Every time you see lightning you are witnessing the generation of ozone on a massive scale. If you have ever noticed a clean/different smell after a lightning storm, then you have smelled ozone.

Table 1. Applications for Ozone in the Water and Air Treatment Industry

- **Well Water Treatment** for the removal of
  - Iron, iron bacteria
  - Sulfur, sulfur bacteria
  - Manganese
  - Bacteria
  - Taste/odor
- **Municipal Water**
  - Chlorine removal
  - Chemical taste/odor
  - Bacteria elimination/prevention
- **Bottled Water**
  - Bacteria elimination/prevention
  - Greatly extends shelf life to the bottled water
  - Improves freshness
  - Enhances taste
  - Bottle and cap sanitation
  - Chemical taste/odor elimination
  - Complies to: local, state, national Health Deptartment, and international bottle water regulations
  - Can be used as pretreatment or post treatment equipment
- **Swimming Pools/Hot Tubs/Spas**
  - Elimination/reduction of chlorine-type products for bacteria/virus control
  - Clarification
- **Cooling Towers**
  - Bacteria/virus elimination/prevention
  - Organic elimination/prevention
  - Clarification
  - Blow-down reduction/elimination
  - Bleed-off reduction/elimination
- **Livestock Water Use**
  - Eliminate the contaminant that interferes with the consumption of the water. Improved water consumption improves
    - * Weight gain
    - * Feed integration
    - * Nutrition absorption and utilization
    - * Immune deficiencies
    - * Drug interaction and absorption
- **Agricultural Water Use**
  - Oxidation and removal of iron, manganese and sulfur
  - Elimination/reduction of mold, fungi and bacteria that can kill young plants
  - Reduce maintenance on piping, sprayers and irrigators by improving water quality
  - Increase interaction between fertilizers and water by improving water quality

Definitions

Aeration – the elimination (off-gassing or venting) of ozone and other gases/odors such as sulfur.

Air Dryer – equipment that removes humidity and moisture from the air prior to the ozonator.

Ozone Pump – a positive displacement injector that pumps ozone gas into the water.

Venturi – a device that restricts flow and pressure in order to produce a vacuum.

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The feed gas can be air or dry air. Air is the least costly method but produces the lowest concentration of ozone and possibly increased service. This is due to the combination of ozone and moisture/ humidity. There are some ozone generators on the market that only are slightly affected by the moisture. They are able to withstand moisture in the feed air/gas for years without any detrimental affects, while others can require constant cleaning and can suffer severe damage.

Air Dryers are options that reduce the maintenance of the ozone equipment. Air Dryers remove all of the humidity and moisture from the air prior to the ozonator. The air is dried to a minimum of -40° F dew point (absolutely dry/no moisture). Dry air increases ozone production compared to atmospheric/moist air.

The ozone must be injected into the water after it is produced. The following two methods are most commonly used.

- **Ozone pump** is a positive displacement injector that pumps the ozone gas into the water similar to a chemical feed pump for chlorine. There is no restriction of flow or pressure and it achieves the greatest volume of ozone injection. This factor is important when dealing with iron and sulfur at more than 3 parts per million (ppm).
- **Venturi** is a device that restricts flow and pressure in order to produce a vacuum. This vacuum device uses suction to pull the ozone gas into the water. The exact gpm flow rate and operating recovery pressure must be established before selecting the correct venturi. Improper sizing will result in insufficient ozone suction, which will cause insufficient oxidation resulting in carryover of what you're trying to remove. *(Important note: you cannot remove iron, sulfur or manganese that is not oxidized.)* Booster pumps are used to increase the pressure prior to the venturi, thus, increasing effectiveness. The disadvantage of the booster pump is the increased cost, increased electrical consumption and noise.

The Ozone Process

Notice that throughout the article the term "ozone system" and not just "ozone" is used. The reason is that ozone is merely a gas that accomplishes the oxidation process. Oxidation is the first step of three that must be followed in order to be successful.

The ozone process works in three simple steps.

- **Ozone injection/oxidation.** Ozone is triatomic oxygen (O_3) that has very high oxidizing power. It is a gas produced from air and high voltage electricity. The injection of the ozone into the water produces tiny ozone bubbles, which saturate every drop of water. At this point oxidation of iron, sulphur and manganese is immediate. (See Figure 1.)
- **Aeration.** The elimination (off gassing or venting) of the ozone and other gases/odors such as sulfur is known as aeration. This occurs by an ozone stripping action. As water flows down the off gas tank, ozonated water rises and strips any gas in the incoming water. There are two types of venting

devices on the market. Electric self-cleaning types and float types that only release gas. The float types tend to require more maintenance than the electric type. (See Figure 2.)

- **Filtration.** The final step for removing the oxidized material is filtration. There are several media on the market. The idea is to use a medium that has low water waste (backwash), high service flow and high removal capacity and requires no chemicals during regeneration. Mechanical filtration is all that is necessary, and Birm, Greensand, and Centaur typically are not necessary. (See Figure 3.)

Ozone Systems vs. Chlorination Systems

The ozoneprocess is very similar to the chlorination process except ozone greatly accelerates contaminant removal. Unlike chlorination systems, ozone equipment requires very little space and no ongoing chemical costs. The main advantage for the consumer using ozone over chlorine is the absence of hazardous chlorine byproducts, storage of hazardous chemicals, absence of chemical odors and the lack of constant replenishment of the chlorine feeder. Trying to oxidize/kill iron bacteria, sulfur bacteria or manganese (as well as any microorganisms) with chlorine is difficult and requires extreme amounts of free chlorine. This leads to dramatically increased ongoing costs as well as a highly toxic water value.

Ozone Systems vs. Air Injection Systems

Air injection is fraught with difficulties. While it is an inexpensive treatment method, it cannot be used on high iron and sulfur amounts and when iron or sulfur bacteria is present. Iron and sulfur bacteria will grow in the presence of air. This leads to pipe, media and equipment clogging. Manganese is more difficult and far more resistant to air oxidation.

Figure 1. Ozone Injection/Oxidation

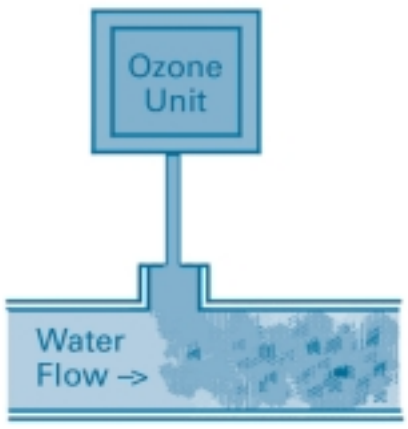


Figure 2. Aeration

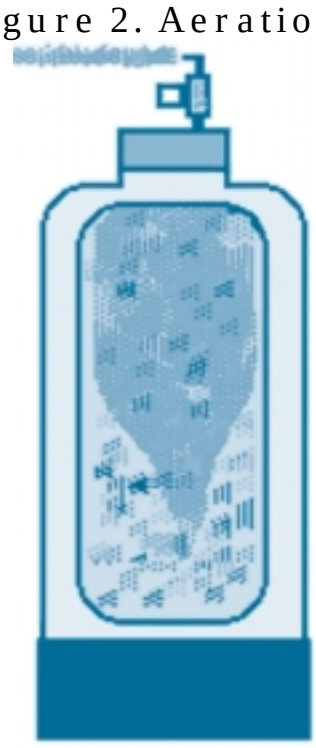
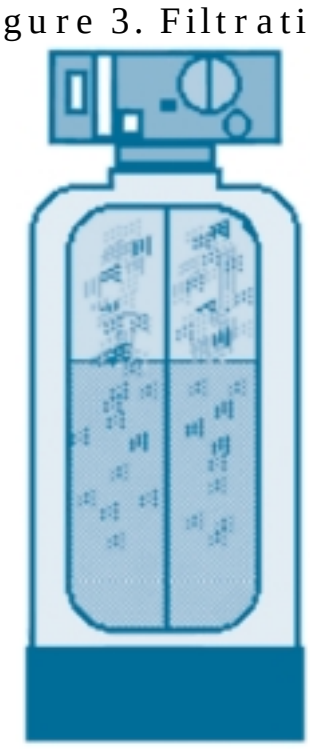


Figure 3. Filtration



Safety is another issue. How can you determine that the air you're injecting into your customers' water is safe? You cannot when using a simple air injector system. Anything in the air (dust, dirt, mold, bacteria, odors, etc.) around the injector will be suctioned or pumped into the water. Ozone is a sterilizer, and it will kill any airborne microbes prior to being injected into the water.

The main advantage for the dealer when using an ozone system is the reduced service calls, complete and immediate oxidation, complete and immediate removal of the iron, sulfur and manganese and increased profitability.

Ozone systems show the highest profit of all the iron, sulfur and manganese removal systems on the market. Most ozone dealers more than double their cost when selling ozone systems. The typical ozone system cost starts at $900 to the dealer. This system will remove up to 5 ppm iron, sulfur and manganese. Some ozone systems are of a simple technology that is easy to understand, size, install and service. However, some ozone systems are more complicated and require more maintenance and service necessary for home use. The main idea is that ozone systems vary between manufacturers in size, price, design, performance and required maintenance. Pick the one best suited for the application and to your understanding and abilities.

To review the overall process … ozone creates larger particles of iron, sulfur and manganese by means of oxidation. The larger particles become insoluble (separated from the water) and are filtered. Off gassing releases the excess ozone, air and odors. Filtration is the last step necessary for removing the oxidized particles. Without proper filtration, the entire system's performance will be compromised. Many manufacturers and dealers put too much emphasis on the ozone equipment and disregard normal, tried-and-true water treatment principles. This can lead to poor performance immediately or in the future for which the equipment sometimes is blamed.

Ozone is the most powerful, natural oxidizer and disinfectant of practical use known to us. It is easy and safe to use and can be applied by simply using existing water treatment equipment and technology. There are manufacturers of ozone water treatment equipment that have been successful for more than 20 years. Search them out, test their knowledge and equipment and don't miss out on adding a whole new profit potential you may have before never realized. WQP

About the Author

Roger Nathanson is president of Ozone Pure Water, Inc., Sarasota, Fla. Ozone Pure Water has been a full service ozone/water treatment supplier since 1980. Nathanson heads the system design, system allocation and R&D departments. His background includes mechanical engineering, plumbing/pipe fitting, swimming pool remodeling/repair, sales and marketing. He holds a U.S. patent on a proprietary ozone unit/ozone generator design. Nathanson can be contacted at 800-633-8469 or 941-923-8528; fax 941-923-8231; opw01@acun.com; www.ozonepurewater.com.

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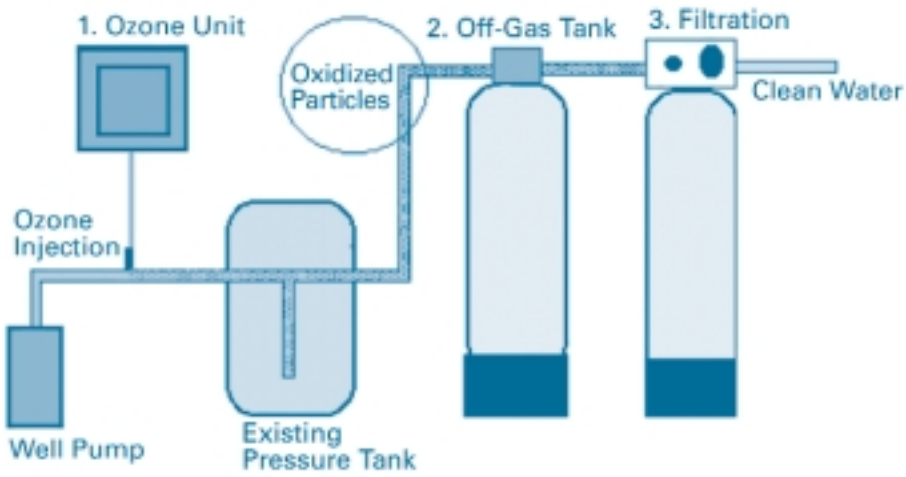
Facts About Ozone

- Ozone oxidizes faster than chlorine or air.
- Ozone oxidizes iron, sulfur and manganese as well as kills their bacterial form.
- Ozone requires no detectable ozone residual to oxidize iron, sulfur and manganese.
- Ozone systems work in three steps/phases: Injection, Off Gas Filtration.
- Additional oxidative/catalytic media are not necessary with the proper use of ozone.
- Ozone systems take up less room than chlorination systems.
- Ozone systems require less maintenance than chlorination systems.
- Ozone systems are far more effective and achieve complete oxidation as apposed to partial oxidation with air injection.
- The WQA, EPA, AWWA, NSF and many health departments recognize ozone systems as a viable means of oxidation.
- Ozone systems yield one of the highest profit margins of all water treatment equipment in the market.

Figure 4. Ozone System Operated by the Well Pump's Pressure Switch



This schematic depicts a basic ozone system that is operated by the well pump's pressure switch. It is important to note that the ozone injection point is between the well pump and the pressure tank. This setup is crucial when using the pressure switch to activate the ozone unit.