

Chapter Twenty-Six

Ozone Generator for Water Treatment

This project, as shown in Figure 26-1, can very effectively purify water for use around the home or farm. The system will produce up to 5 grams per hour sufficient for swimming pools, laundries, and other medium-volume applications. The system covered here is shown in five different sizes and uses easy-to-construct modules requiring only a flow of air for operation.

This is an intermediate-level project requiring a basic electrical hookup. Expect to spend \$50 to \$250 depending on the size of the system chosen and the availability of the required air source. All parts are readily available, with specialized parts obtainable through Information Unlimited at www.amazing1.com, and they are listed in the parts list at the end of the chapter.

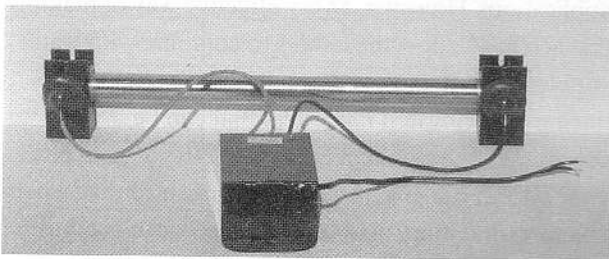


Figure 26-1 The water treatment system

Introduction to the Benefits of Ozone

Ozone is an unstable form of oxygen. Normal oxygen is diatomic (O_2), existing as two atoms of oxygen that form the molecule. Whereas ozone is tri-atomic (O_3), existing as three atoms of oxygen for the molecule. The tri-atomic form of oxygen is very unstable, wanting to lose the third oxygen atom and combine with whatever atom it can (oxidization). This property makes it the most active oxidizer known, with the exception of the very hazardous fluorine gas.

Ozone at normal pressures is colorless and produces a pleasing, fresh-air odor often like that after an old-fashioned thunderstorm. Under pressure, it becomes a bluish gas.

Ozone is also a very powerful bactericide. It is not affected by pH, as is chlorine, thus making it an excellent candidate for pools, spas, laundries, and general water treatment applications. It is many times more soluble in water, further enhancing its purifying effect. Ozone will combine with diatomic nitrogen N_2 , forming nitrous oxide, $2NO$. This oxide quickly combines with water, forming nitric acid, HNO_3 . This is often a very undesirable effect when used with straight air. Pure oxygen greatly minimizes this effect and is often required in many applications. However, those requiring a supply of concentrated nitric acid

for nitration may wish to consider ozone and air with a condensing apparatus to obtain this useful acid. A condensing apparatus takes vapor from the ozone gas along with water and nitrogen to form a liquid by contacting them with cooler surfaces. The liquid (now nitric acid) flows down into a collection container by gravity. In the same way the old timers made moonshine, this uses a simple and basic chemical reaction where $2\text{O}_3 + 2\text{N}_2 + 2\text{H}_2\text{O}$ yields $2\text{H}(\text{NO}_3) + \text{H}_2\text{O} + 2\text{NO}$.

Ozone for Water Applications

It is estimated that 20 percent of all ground water is contaminated by pesticides, benzene, and phenol derivatives along with other undesirable organic substances. Ozone can oxidize many of these compounds, along with deactivating many viruses and harmful bacteria. Ozone will also oxidize certain inorganic compounds, such as iron and manganese, making them more easily removable by filtration.

Chlorine and bromine are often the choice of disinfectant for swimming pools and spas. The effect of these halogens is often dictated by pH, temperature, and agitation. Extreme heat and agitation can produce chloroform, a very toxic carcinogenic. The *Environmental Protection Agency* (EPA) is already taking a look at these chemicals for this use.

Ozone-treated water will destroy fungus, mold, and many pathogens found in water when used for washing fruits and vegetables in packing lines. When discharged, ozone causes little change to the beneficial bacteria in sewage treatment facilities.

Additionally, freshly caught fish will last longer when washed with ozone-treated water, and ozone's oxidizing action can eliminate odors from stored cheese. Egg storage time is increased, and wine can be aged faster. The removal of odors produced by the bleaching of beeswax, starch, flour, straw, bones, and feathers are all aided by ozone treatment. Also, the grease and wax on cotton and wool fibers can be decomposed by ozone, and gray mold on the surface of fruits and vegetables can be controlled by ozone.

Ways to Generate Ozone

Ozone can be produced by an electrical discharge or by a high-frequency electromagnetic wave. A high frequency requires the wave to be in the ultraviolet spectrum where Planck's energy formula, $W = hc/v$, starts to become effective. This is where energy in a wave packet in ergs is equal to Planck's constant times the speed of light in centimeters divided by the wavelength in centimeters. It is this energy that causes the stable O_2 to break up and recombine with other O_2 to form unstable O_3 . Germicidal lamps operating at 253.7 nanometers can produce ozone.

The method presented here utilizes the ozone-producing properties of an electrical discharge. We have all, at one time, smelled the by-products of ozone. After a thunderstorm, it can be detected, as well as on certain days where electrical activity is spawning a storm. A sparking electric discharge such as brushes on a motor will create ozone also.

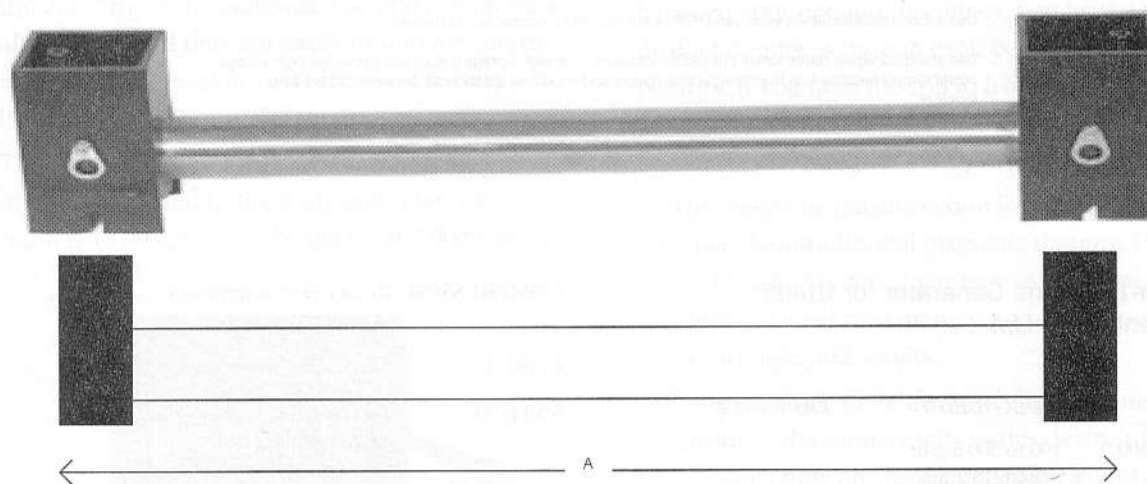
Our method uses a metal tube with a conductor running down the center. The conductor and the tube are insulated by one another and must support the high frequency and high voltage necessary to create a corona without breaking down into an arc. The ozone produced in the tubular cavity must be made to flow using moving air for cooling and replenishing air to be converted.

This method, while producing usable ozone, has several disadvantages. First, normal air contains nitrogen that likes to combine with the ozone to produce nitrous oxides. Second, air contains water in the form of moisture. Without getting into basic chemistry, we know that water plus nitrous oxide forms nitric acid, which is corrosive and undesirable for air purification applications. However, a very effective way of making this acid is to allow the oxides to combine with water vapor or steam and condense in a cooling tube, producing concentrated nitric acid that can be used in the manufacture of high explosives. The 5 gram per hour system can produce enough nitric acid that, when mixed with battery acid (sulfuric acid), can produce usable amounts of high explosives by the simple nitration of many organic compounds.

Select the system you require from Figure 26-2. Note that each is complete with the mating power supply.

Wire up the system as directed in Figure 26-3. Obtain a suitable air supply and connect up the hoses as shown. Use ozone-resistant material for connections to the cell.

Turn on the air supply and note a bubbling from the output hose immersed under the water. Apply power to the high voltage and note a distinct smell coming from the hose when pulled out of the water. Reinsert and rig the hose end to stay under the water. The unit is now ozonating the water.

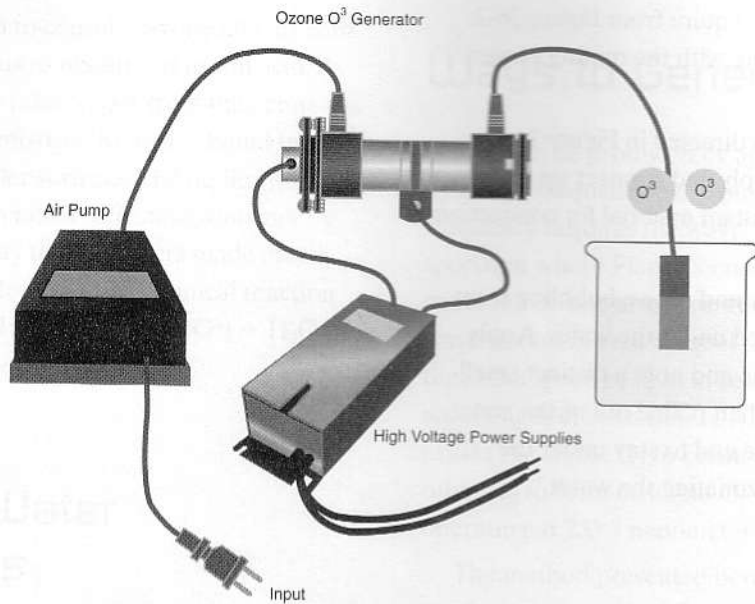


DATA BASE#	LENGTH A	OZONE OUTPUT/HR	AIR/O3 FLOW/MIN	INPUT V	INPUT I
OZONE300	182mm	100-500 mg/hr	.25-.55 CFM*	115 Vac	.2 Amps
OZONE800	282mm	500-1000 mg/hr	.35-.7 CFM*	115 Vac	.6 Amps
OZONE2000	382mm	1000-2500 mg/hr	1-1.5 CFM*	115 Vac	.9 Amps
OZONE5000	482mm	2500-5000 mg/hr	1.5-3 CFM*	115 Vac	1.2 Amps

* Multiply CFM by 28.3 to get Liters per minute

Each DATA BASE# system is complete with a matching power supply and ready to connect up as shown on figure 26-3

Figure 26-2 System selection specifications



The high voltage power supplies used in these systems operate from normal 115 Vac 60 Hz. They are listed with the appropriate ozone cell on figure 26-2

The air pumps used can be that appropriate for the volume of the particular system. A flow meter should be used when first setting up the system to verify proper air flow. Pure oxygen works the best and is available in cylinders with regulator valves and optional flow meters. Large aquarium air pumps may be used with the smaller systems while rotary vane air compressors are suggested for the larger systems. Note to multiply cubic feet per minute (CFM) by the factor 28.3 when converting to liters per minute.

Use ozone resistant tubing such as VITOR or HYPALON for connection to the cell

Use standard wiring codes for all 115 vac connections. The high voltage output wires from the high voltage power supply must be free from conductive objects and should be as short as possible. Do not twist together.

Figure 26-3 Ozone system diagram

Table 26-1 Ozone Generator for Water Treatment Parts List

Ref. #	Description	DB Part #
OZONE300	100 to 500 mg/hr system/182 mm/ 115 VAC @ .2 amps	DB# OZONE500
OZONE800	500 to 1,000 mg/hr system/282 mm/ 115 VAC @ .6 amps	DB# OZONE800
OZONE2000	1,000 to 2,000 mg/hr system/382 mm/ 115 VAC @ .9 amps	DB# OZONE2000
OZONE5000	2,500 to 5,000 mg/hr system/482 mm/ 115 VAC @ .2 amps	DB# OZONE5000
HOSE	Connecting hoses, use ozone-resistant VITOR or HYPALON	

- COMPRESSOR Rotary vane compressor at required airflow
- CORD1 Three-wire power cord
- SWITCH Two switches to control air compressor and high-voltage supply