

The Practical Guide to Ultraviolet Sterilizers



How to Select A UV Sterilizer for Well,
Spring, and Rainwater Disinfection

www.cleanwaterstore.com

Welcome to The Practical Guide To Ultraviolet Sterilizers

Our company [Clean Water Systems & Stores](http://www.CleanWaterStore.com) has been providing solutions for thousands of problem water wells since 1985. Many folks contact us regularly asking about UV sterilizers, which can be a great alternative to traditional chlorination systems for disinfecting well and spring water.

We created this guide to answer these questions in as simple as format as possible. Questions answered include:

- How does UV light disinfect water?
- How can I know if UV is right for my water application?
- Should the water be treated in any way prior to UV sterilization?
- When should I hire a professional to do the installation and maintenance?
- Is it possible to maintain it myself or do I need special training?
- What kinds of bacteria are killed by UV light?
- Is UV light effective at killing parasites, such as Giardia?

If you have any questions about the material in this guide, or want to offer us feedback please contact us!

Toll-free: 888-600-5426 Email: support@cleanwaterstore.com

Through our online support forum: <http://support.cleanwaterstore.com>

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Table of Contents

Bacteria & Drinking Water	4
Advantages of UV Light Sterilizers	5
How Ultraviolet Sterilizers Work	6
Factors Affecting UV Treatment	7
Pretreatment System for Hard Water	8
Pretreatment for Iron in Well Water	9
Pretreatment for Sediment in Well Water	10
Ultraviolet Sterilizers and Giardia	11
Microorganisms That Are Treated By UV	12
Choose Your UV Sterilizer	14
What Size Should I Choose?	14
Types of UV Sterilizer	15
Where to Buy?	16
How to Service an Ultraviolet Sterilizer	16

Bacteria & Drinking Water

Harmful bacteria can be present in many water supplies. Proper disinfection of drinking water is essential if bacteria, viruses or parasites are present.

Many well and spring waters are susceptible to contamination by bacteria, viruses and parasites such as *Giardia* and *Cryptosporidium*. Routine testing at least once a year for bacteria is recommended for most home water wells. The National Ground Water Association (NGWA) and the US EPA recommends yearly testing for coliform bacteria.



Ultraviolet sterilizers can be an alternative method of disinfection under the right conditions. While chlorine can effectively kill bacteria in water, it can have limitations and associated health risks. Unless used at high dosages with long contact times, chlorine is ineffective at killing *giardia* and *cryptosporidium*.

Ultraviolet sterilizers work by exposing the cell walls of organism to intense UV light which disrupts the genetic material and prevents the organism from reproducing. Ultraviolet light is split into several different ranges: (near the visible light range) UV-A, UV-B, UV-C, Vacuum-UV (near the x-ray range). The UV-B range is what causes sunburn on humans. UV water purifiers use the UV-C range because of its germicidal abilities. In this range the light will break molecular bonds in the DNA of viruses and bacteria, rendering them unable to reproduce and effectively killing them.

UV effectively destroys bacteria and viruses but is limited by the clarity of the water, it only works on water that is clear and has a high UV transmission rate. Unlike chlorine there is no downstream residual disinfection. **Pretreatment for iron, sediment and excessive hardness minerals is recommended.**



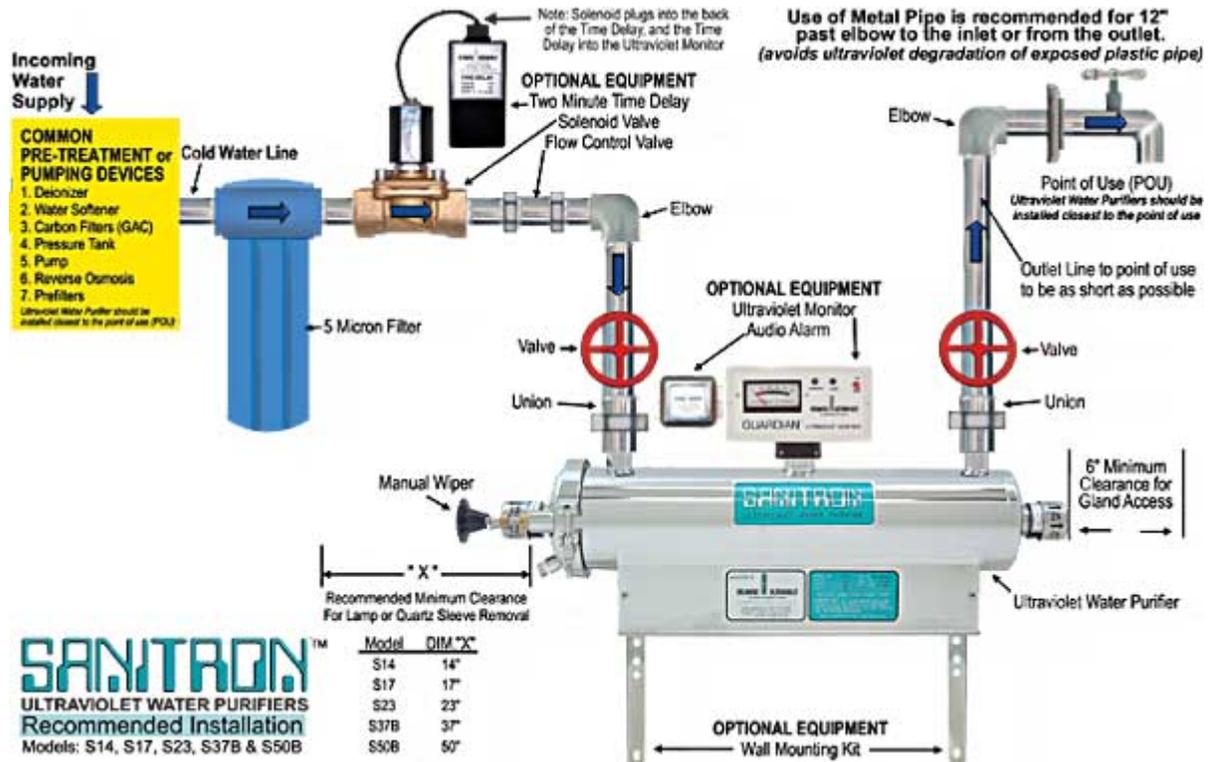
UV Sterilizers by Atlantic Ultraviolet



Wonder Light UV Sterilizers NSF

Advantages of UV Light Sterilizers

- Effective - virtually all microorganisms are susceptible to ultraviolet disinfection.
- Economical - hundreds of gallons are purified for each penny of operating cost.
- Safe - no danger of overdosing, no addition of chemicals.
- Fast - water is ready for use as soon as it leaves the purifier
- Easy - simple installation and maintenance. Compact units require minimum space.
- Automatic - provides continuous disinfection without special attention or measurement.



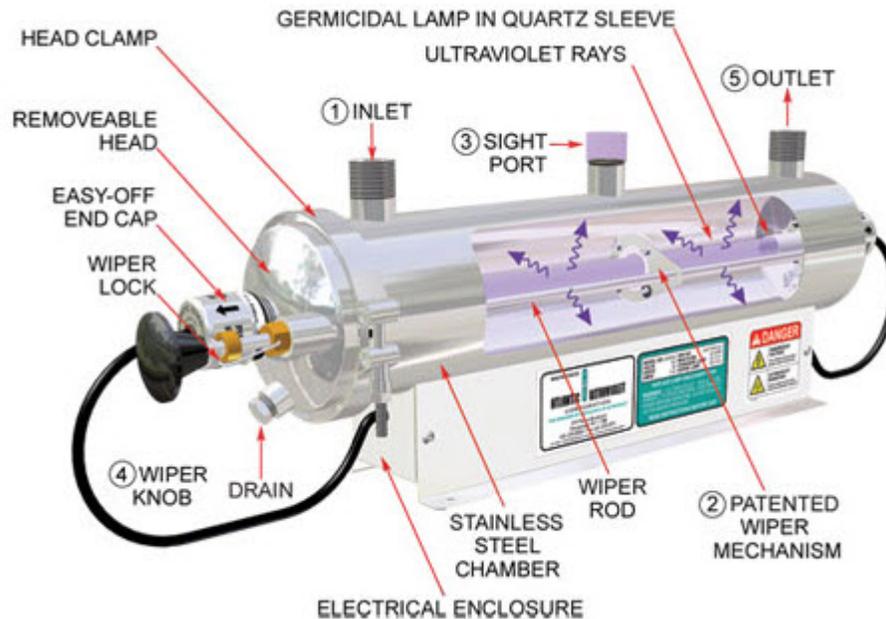
Courtesy of Atlantic Ultraviolet Corporation

<http://ultraviolet.com/sanitron-ultraviolet-water-purifiers/>

How Ultraviolet Sterilizers Work

Atlantic Ultraviolet

Sanitron® Principal of Operation



(1) The water enters the purifier and flows into the annular space between the quartz sleeve and the chamber wall.

(2) The wiper segments induce turbulence in the flowing liquid to assure uniform exposure of suspended micro-organisms to the lethal ultraviolet rays.

(3) Translucent sight port provides positive indication of germicidal lamp operation.

(4) The wiper assembly facilitates periodic cleaning of the quartz sleeve without any disassembly or interruption of purifier operation.

(5) Water leaving the purifier is instantly ready for use.

Factors Affecting UV Treatment

Water to be treated by UV light should be clear and relatively low in minerals:

- Water should be low in hardness minerals: Less than 7 grains per gallon of hardness, or less than 120 PPM)
- Water should be free of color
- Iron should be less than 0.3 mg/L.
- Manganese should be less than 0.05 mg/L
- pH range should be 6.5 to 9.5
- Turbidity should be less than 1 NTU

Pretreatment Important Consideration

Water to be treated by UV light should be clear and relatively low in minerals. If the water is hard (over 5 – 10 grains per gallon of hardness) a water softener which will remove the hardness is recommended. If the water is high in turbidity or cloudy, it is essential to treat the water prior to treating with UV light.

The UVT or UV Transmission level should be low enough to allow the UV rays to penetrate the water. A 5 micron filter for pretreatment is recommended as a minimum precaution.

UV dosage is measured in microwatt-seconds per square centimeter area. From these units, it can be seen that UV dosage is a function of UV intensity (microwatts) and time (seconds). The industry standard of recommended UV dosage is 30mJ/cm² 30,000 μWt-secs/cm². This dosage is sufficient for most water-borne pathogens — 99.99 percent of E. coli will be removed with a dosage of 6-10mJ/cm² UV sterilizers are sized in gallons per minute, in order to properly dose the water with the minimum UV dosage of 30mJ/cm² 30,000 μWt-secs/cm².

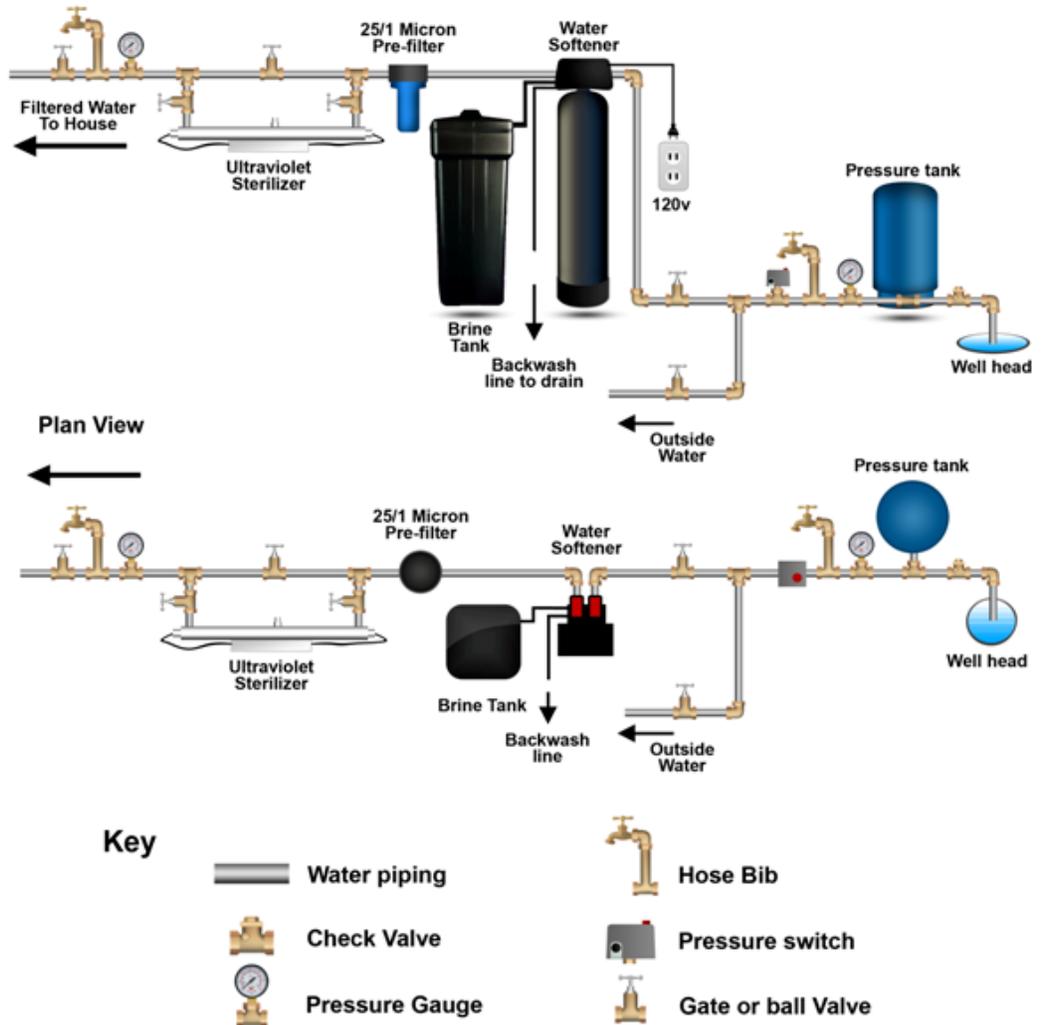
By following the recommended maximum gallons per minute, and assuring the water is properly pre-treated, the UV system will perform properly.

Routine Testing

Water should be tested for coliform bacteria on a regular basis. Home test kits are available that can show if coliform is present or not.

Pretreatment System for Hard Water

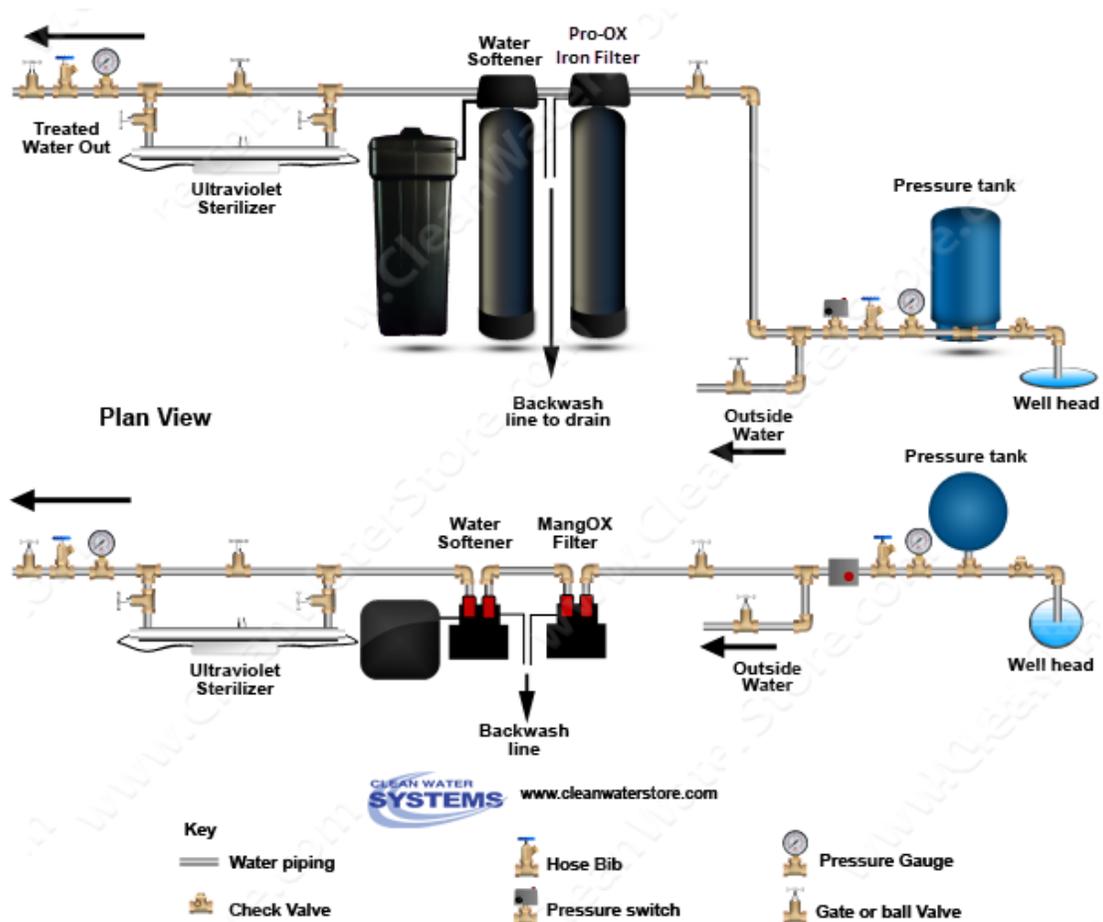
Water Softener > 25/1 Dual-Grade Filter > UV Sterilizer



Hardness (calcium carbonate) in water has a dramatic effect on how well UV sterilizers work. If the water is high in hardness (7 grains/gallon or greater) mineral scale will form on the quartz sleeve and prevent the UV light from properly reaching into the water.

Pretreatment for Iron in Well Water

Iron Filter > 25/1 Dual Grade Filter > UV Sterilizer

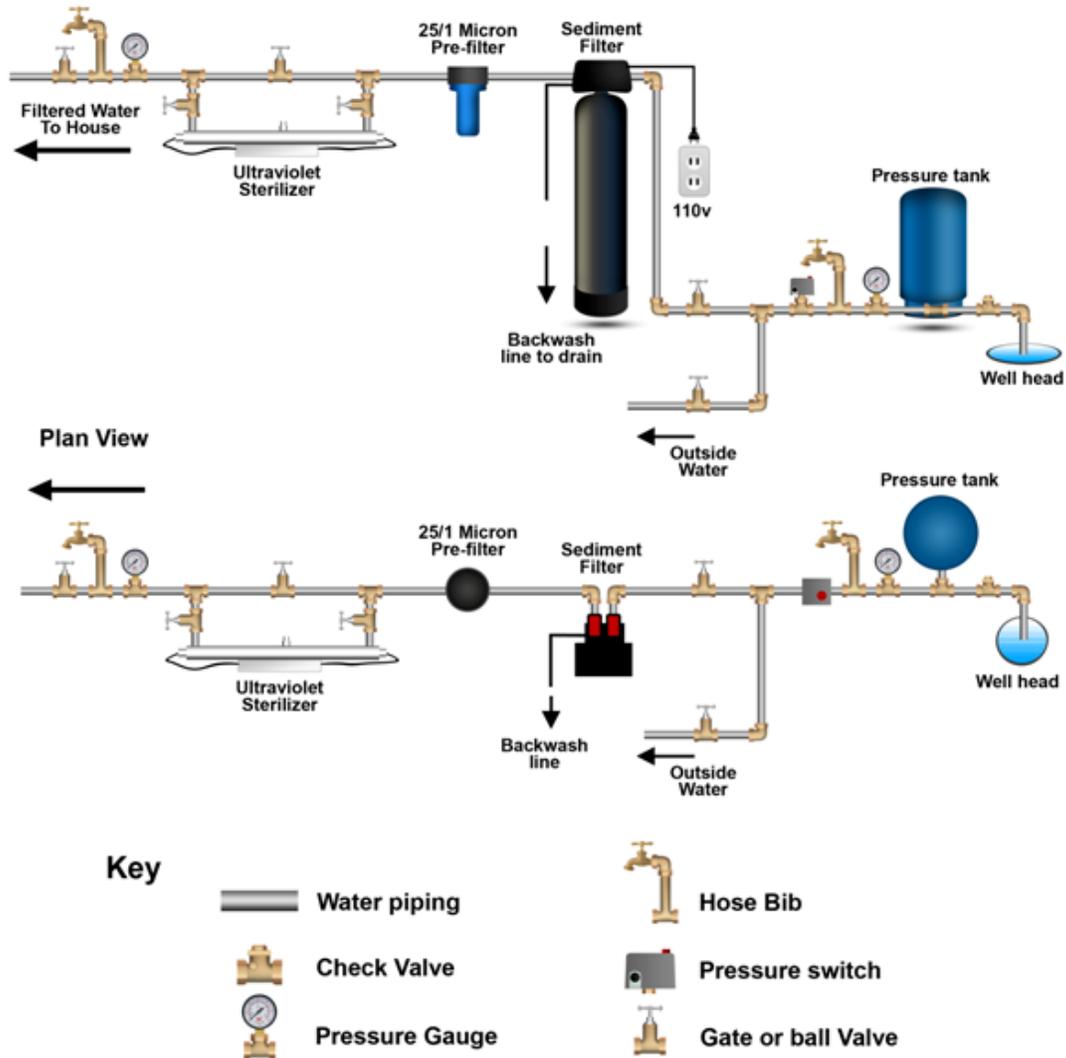


Iron is common in many well waters. If iron is present it will prevent the UV sterilizer from working properly.

If the water is high in iron (0.3 PPM or greater) rust will form on the quartz sleeve and prevent the UV light from properly disinfecting the water. Cloudy or rusty water will also inhibit UV transmission.

Pretreatment for Sediment in Well Water

Sediment Backwash Filter > 25/1 Dual Grade Filter > UV Sterilizer



Sediment, turbidity or cloudiness in water will affect how well the UV sterilizer can disinfect water. Sediment and/or cloudiness in water will prevent UV rays from reaching the edge of the UV chamber and reduce how well the UV can disinfect the water. For UV to work properly, water should be low in turbidity (less than 1 NTU) and free of sediment.

Ultraviolet Sterilizers and Giardia

Cryptosporidium and *Giardia* protozoa are present in many drinking water supplies across the world. The occurrence of *Cryptosporidium parvum* in drinking water sources is recognized as a significant threat to private and public water supplies throughout the world (Rose *et al.*, 1991; Lisle and Rose, 1995; Messner and Wolpert, 2000).



Giardia Protozoa

Water treatment plants usually cannot guarantee the removal of all *Cryptosporidium* because these tiny parasites are formed as cysts, called oocysts and are very small (four to five micrometers in diameter). They are resistant to chlorine and most other disinfectants. It is for this reason that many municipal treatment plants are installing UV systems.

A report published by the US EPA indicates that, "...*Cryptosporidium* is not only a surface water problem." In Canada and the US, 60.2 percent of surface water samples contained oocysts in a study done by LeChevallier and Norton in 1995.

The same report also mentions a study done by Hancock *et al.* (1998), reporting a study of 199 ground water samples tested for *Cryptosporidium*. They found that five percent of vertical wells, 20 percent of springs, 50 percent of infiltration galleries, and 45 percent of horizontal wells contained *Cryptosporidium* oocysts. The significance of this is that normal water testing does not test ground waters for oocysts.

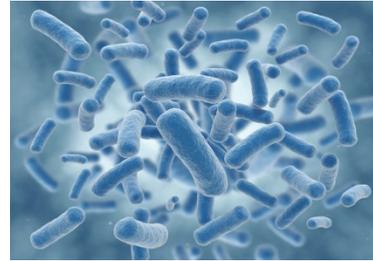
An absolute 1 micron filter, combined with UV is very effective at removing the oocysts and disinfecting surface and ground water supplies. When UV is used for surface water disinfection or in wells under the influence of surface water, a pre-filter system consisting of 5 micron and then 1 micron absolute filtration is recommended.

Ultraviolet [disinfection](#) of water consists of a purely physical, chemical-free process. UV-C radiation in particular, with a wavelength in the 240 nm to 280 nanometers range, attacks the vital [DNA](#) of the [bacteria](#) directly.

The radiation initiates a photochemical reaction that destroys the genetic information contained in the DNA. The bacteria lose their reproductive capability and are destroyed. Even [parasites](#) such as [Cryptosporidia](#) or [Giardia](#), which are extremely resistant to chemical disinfectants, are efficiently reduced.^[12] UV can also be used to remove chlorine and chloramine species from water ; this process is called photolysis, and requires a higher dose than normal disinfection.

For best results combine UV sterilizer with an absolute 1 micron filter, or a finer filter such as Ultra-Filtration or Reverse Osmosis. Install the UV sterilizer as a final stage, after pre-treatment and filtration and/or softening.

Microorganisms That Are Treated By UV



Bacteria	UV Dose	Bacteria	UV Dose
<i>Agrobacterium lumentorum</i> 5	8,500	<i>Pseudomonas aeruginosa</i> (Environ.Strain)	10,500
<i>Bacillus anthracis</i> 1,4,5,7,9 (anthrax veg.)	8,700	<i>Pseudomonas aeruginosa</i> (Lab. Strain) 5,7	3,900
<i>Bacillus anthracis</i> Spores (anthrax spores)*	46,200	<i>Pseudomonas fluorescens</i> 4,9	6,600
<i>Bacillus megatherium</i> Sp. (veg) 4,5,9	2,500	<i>Rhodospirillum rubrum</i> 5	6,200
<i>Bacillus megatherium</i> Sp. (spores) 4,9	5,200	<i>Salmonella enteritidis</i> 3,4,5,9	7,600
<i>Bacillus paratyphosus</i> 4,9	6,100	<i>Salmonella paratyphi</i> (Enteric Fever) 5,7	6,100
<i>Bacillus subtilis</i> 3,4,5,6,9	11,000	<i>Salmonella</i> Species 4,7,9	15,200
<i>Bacillus subtilis</i> Spores 2,3,4,6,9	22,000	<i>Salmonella typhimurium</i> 4,5,9	15,200
<i>Clostridium tetani</i>	23,100	<i>Salmonella typhi</i> (Typhoid Fever) 7	7,000
<i>Clostridium botulinum</i>	11,200	Salmonella	10,500
<i>Corynebacterium diphtheriae</i> 1,4,5,7,8,9	6,500	<i>Sarcina lutea</i> 1,4,5,6,9	26,400
Dysentery bacilli 3,4,7,9	4,200	<i>Serratia marcescens</i> 1,4,6,9	6,160
<i>Eberthella typhosa</i> 1,4,9	4,100	<i>Shigella dysenteriae</i> - Dysentery 1,5,7,9	4,200
<i>Escherichia coli</i> 1,2,3,4,9	6,600	<i>Shigella flexneri</i> - Dysentery 5,7	3,400
<i>Legionella bozemanii</i> 5	3,500	<i>Shigella paradysenteriae</i> 4,9	3,400
<i>Legionella dumoffii</i> 5	5,500	<i>Shigella sonnei</i> 5	7,000
<i>Legionella gormanii</i> 5	4,900	<i>Spirillum rubrum</i> 1,4,6,9	6,160
<i>Legionella micdadei</i> 5	3,100	<i>Staphylococcus albus</i> 1,6,9	5,720
<i>Legionella pneumophila</i> (Legionnaire's Disease)	12,300	<i>Staphylococcus epidermidis</i> 5,7	5,800
<i>Leptospira canicola</i> -Infectious Jaundice 1,9	6,000	<i>Streptococcus faecalis</i> 5,7,8	10,000

<i>Leptospira interrogans</i> 1,5,9	6,000	<i>Streptococcus hemolyticus</i> 1,3,4,5,6,9	5,500
<i>Micrococcus candidus</i> 4,9	12,300	<i>Streptococcus lactis</i> 1,3,4,5,6	8,800
<i>Micrococcus sphaeroides</i> 1,4,6,9	15,400	<i>Streptococcus pyrogenes</i>	4,200
<i>Mycobacterium tuberculosis</i> 1,3,4,5,7,8,9	10,000	<i>Streptococcus salivarius</i>	4,200
<i>Neisseria catarrhalis</i> 1,4,5,9	8,500	<i>Streptococcus viridans</i> 3,4,5,9	3,800
<i>Phytomonas tumefaciens</i> 1,4,9	8,500	<i>Vibrio comma</i> (Cholera) 3,7	6,500
<i>Proteus vulgaris</i> 1,4,5,9	6,600	<i>Vibrio cholerae</i> 1,5,8,9	6,500
Molds	UV Dose	Molds	UV Dose
<i>Aspergillus amstelodami</i>	77,000	<i>Oospora lactis</i> 1,3,4,6,9	11,000
<i>Aspergillus flavus</i> 1,4,5,6,9	99,000	<i>Penicillium chrysogenum</i>	56,000
<i>Aspergillus glaucus</i> 4,5,6,9	88,000	<i>Penicillium digitatum</i> 4,5,6,9	88,000
<i>Aspergillus niger</i> (bread mold) 2,3,4,5,6,9	330,000	<i>Penicillium expansum</i> 1,4,5,6,9	22,000
<i>Mucor mucedo</i>	77,000	<i>Penicillium roqueforti</i> 1,2,3,4,5,6	26,400
<i>Mucor racemosus</i> (A & B) 1,3,4,6,9	35,200	<i>Rhizopus nigricans</i> (cheese mold) 3,4,5,6,9	220,000
Protozoa	UV Dose	Protozoa	UV Dose
<i>Chlorella vulgaris</i> (algae) 1,2,3,4,5,9	22,000	<i>Giardia lamblia</i> (cysts) 3	100,000
Blue-green Algae	420,000	Nematode Eggs 6	40,000
<i>E. histolytica</i>	84,000	Paramecium 1,2,3,4,5,6,9	200,000
Virus	UV Dose	Virus	UV Dose
Adeno Virus Type III 3	4,500	Influenza 1,2,3,4,5,7,9	6,600
Bacteriophage 1,3,4,5,6,9	6,600	Rotavirus 5	24,000
Coxsackie	6,300	Tobacco Mosaic 2,4,5,6,9	440,000
Infectious Hepatitis 1,5,7,9	8,000		
Yeasts	UV Dose	Yeasts	UV Dose
Baker's Yeast 1,3,4,5,6,7,9	8,800	<i>Saccharomyces cerevisiae</i> 4,6,9	13,200
Brewer's Yeast 1,2,3,4,5,6,9	6,600	<i>Saccharomyces ellipsoideus</i> 4,5,6,9	13,200
Common Yeast Cake 1,4,5,6,9	13,200	<i>Saccharomyces sp.</i> 2,3,4,5,6,9	17,600

Choose Your UV Sterilizer

Identify Pipe Sizes

For residential applications, it is useful to know the size of your incoming pipes. For instance, say you decide you want to install an ultraviolet sterilizer. They come in different pipe sizes, such as ¾" pipe, 1" pipe etc. Generally, you want to make certain you get a system that will not restrict the water flow or pressure, so if you have a 1" pipe, you would want an iron filter that has 1" pipe connectors. Knowing what size piping you have solves this problem.

It is easy to check the size of your pipes. First, check on the pipe itself, often it will be labeled or written on the side. If not, the string method which measures the circumference is probably the best way to determine your pipe size. Circumference is the distance it takes to go around the pipe once.

Remove any insulation from the pipe. Using a piece of string about 6" long (or a cloth tape measure) wrap the string around the pipe once and measure to the nearest 1/8 of an inch... Once you have found the circumference, use the chart below to find your pipe or tube size.

Copper Pipe or PEX tubing

2.75" (70mm) = ¾" pipe
3.53" (90mm) = 1" pipe
4.32" (110mm) = 1 ¼" pipe
5.10" (130mm) = 1 ½" pipe

Steel Pipe or PVC Plastic Pipe

3.25" (83mm) = ¾" pipe
4.00"(102mm) = 1" pipe
5.00"(127mm) = 1 ¼" pipe
6.00"(152mm) = 1 ½" pipe

Flexible (usually black) Polyethylene Pipe

2.96-3.33" (75-85mm) = ¾" pipe
3.74-4.24" (95-108mm) = 1" pipe
4.90-5.57" (124-141mm) = 1 ¼" pipe
5.70-6.28" (145-160mm) = 1 ½" pipe

What Size Should I Choose?

Ultraviolet sterilizers are sized in advance for you and rated based on gallons (or liters) per minute. For example a UV sterilizer model will have a rated flow rate of 12 gallons per minute ("GPM"). This means that the UV will work well as long as the water flowing through it is 12 gallons per minute or less.

Say you are filling a 5 gallon bucket with a garden hose and you time how long it takes to fill, and find out it takes one minute. In this case you then have a flow rate of 5 GPM, since 5 gallons of water filled in one minute.

Size the UV based on your well pump output:

If your water source is from a well or spring, you can find out the maximum output in gallons per minute of your pump, and select a UV sterilizer that is rated to accommodate this flow rate. For example if your well pump can develop 10 GPM maximum flow rate, a 12 GPM rated UV sterilizer would work fine.

Common sizing and flow rates:

1 bathroom 1 – 2 person home: 6 GPM

1 – 2 bathrooms 2 – 4 persons in the home: 12 GPM

2 – 4 bathrooms 4 – 8 persons in the home: 20 – 25 GPM

Types of UV Sterilizer

UV sterilizers are typically manufactured of stainless steel and include quartz sleeves and good quality lamps.

Options to look for include optional wiper to clean quartz sleeve (not necessary if the water is properly pretreated); timer showing how many hours the UV lamp has been on; fail-safe alarm and sensor that measures the intensity of the UV radiation.

Many basic UV models have no sensor or alarm, but as long as the UV system is properly sized to begin with, and adequate measures have been taken to pre-filter the water if needed, and the lamp is properly serviced, then many UV light owners have excellent service and experience with the lower cost no-frills UV systems.

Hire a Contractor or Buy Yourself?

You can start by consulting the Water Quality Association website www.wqa.org for help in locating a Certified Water Treatment Professional in your area. WQA certified professionals pass rigorous certification exams and conform to a code of ethics. Recommendations and quotes from local water companies usually include installation, as most water treatment dealers and contractors prefer to install the system for you and offer you routine service for an additional cost. See the chapter: “Hiring a Professional Versus Doing it Yourself”.

There can be advantage to hiring a qualified local water treatment contractor as long as they are certified and bonded and have the experience to solve your water problem. If you plan to save money on the installation and equipment costs and do it yourself, you can buy it yourself and hire a plumber to install it, or install it yourself following the instructions that come with the UV sterilizer.

Where to Buy?

Online websites such as, www.cleanwaterstore.com and hundreds of others allow you to compare costs and features of the various systems. If you do basic plumbing or are willing to hire a plumber you can often save hundreds of dollars and end up with an excellent system.

Hardware stores, Big Box stores such as Home Depot, Lowes, Sears and many others sell water treatment equipment. Often these stores have limited selection and cannot treat complex or difficult water problems, but they can be a quick and easy solution for simple water problems for small homes and businesses.

Plumbers and plumbing wholesale distributors often sell water treatment equipment direct to the public with often limited selection and choices. Water treatment dealers will sometimes sell their equipment directly, but typically they will want to offer a total package of installation and service.

How to Service an Ultraviolet Sterilizer

Many UV systems have built-in hour counters, and alarms that will signal when it is time to change the lamp. Most UV lamps are left on continuously 24 hours a day, 365 days a year.

Change the UV lamp once a calendar year to be safe, as after about 9000 hours or a little over one year, the glass of the UV lamp can become solarized and not produce the radiation like a new lamp.

In addition to changing the lamp once a year, the quartz sleeve should be removed and cleaned. Once the quartz sleeve is removed, clean with alcohol or a mild, non-abrasive detergent. Stubborn stains usually can be removed with a dilute hydrochloric acid. **However if there is pre-treatment, there should be no significant stains on the UV quartz sleeve.**

If you have any questions about the material in this guide, or want to offer us feedback please contact us!

Toll-free: 888-600-5426 Email: support@cleanwaterstore.com

Through our online support forum: <http://support.cleanwaterstore.com>

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