UV Sterilizers: Improve Bacteria and Algae Control in Your Aquarium or Pond

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What does a UV sterilizer do?

A UV sterilizer is used to control infections by stopping the spread of microorganisms from one fish/coral/invertebrate to another through the water. It is also used in pond applications to control free-floating algae. When operated correctly, **free-floating** microorganisms will be killed by the UV light. Note that the organisms must be in the water that flows to the UV sterilizer. The UV light has no residual effect and will not kill organisms attached to fish (e.g., adult stage of ich) or rocks (e.g., algae).

How do UV sterilizers work?

The UV sterilizer utilizes a germicidal fluorescent lamp that produces light at a wavelength of approximately 254 nanometers (2537 Angstroms). The water with the bacteria/algae passes over the bulb (or around the bulb if a quartz sleeve is used) and is irradiated with this wavelength. As the light penetrates the bacteria/algae, it mutates the DNA (genetic material), preventing growth/multiplication of the organism.

What factors influence the effectiveness of UV sterilizers?

- Size and type of organism: Theoretically UV radiation can kill viruses, bacteria, algae, and protozoa. In general, larger organisms, such as protozoa, require a higher dose of UV radiation than smaller organisms, such as bacteria. But there are also differences between various organisms of the same type: some bacteria are more resistant to UV radiation than others.
- Power of bulb: The amount of UV light produced by the bulb is reflected in the wattage of the bulb. Bulbs with a higher wattage produce more UV light. The ability of the germicidal fluorescent lamp to produce UV light decreases with age, and in most cases, the bulb needs replacement every 6 months. UV light is best produced at temperatures of 104-110ºF; cooler temperatures will result in less output.
- UV penetration: If the UV light can not penetrate the water, it will not be effective. Higher water turbidity will decrease penetration. UV sterilizers should be placed after the biological and mechanical filters so the water is as clear as possible when it enters the sterilizer. Salinity also affects penetration; UV light penetrates freshwater better than saltwater. Finally, cleanliness of the lamp or sleeve is important. If a film or mineral deposit covers the lamp or sleeve, the light will be partially or totally blocked. The distance of the lamp from the water also influences the effectiveness. UV light will only penetrate clear saltwater to a depth of 5mm.
- Contact time: The longer the amount of time the water is being exposed to the UV light, the more killing power is available. The contact time, sometimes referred to as "dwell time," is influenced by flow rate of the water: slower flow rates increase contact time. The length of the bulb also affects the contact time; with a longer bulb, the water is in contact with the UV light for a longer period of time. Another variable to consider is the turnover time (amount of time required to have the entire volume of water in the aquarium pass through the sterilizer). Since the "sterilized" water constantly mixes with the water in the aquarium as it returns, it is impossible to "sterilize" all the water in the aquarium. That would only be possible if all the water would be removed, sterilized, and then returned to the aquarium at one time. This may result in sterilized water, but would certainly raise havoc with the aquarium inhabitants! Calculating turnover time is mathematically difficult, but can be approximated with the following formula:

  $$\frac{9.2 \times \text{gallons in tank}}{\text{flow rate in gallons per hour}} = \text{number of hours for one turnover}$$

- Temperature: UV light is best produced at temperatures of 104-110ºF; cooler temperatures will result in less output. Quartz sleeves help to insulate the bulb from the cooler aquarium water and thus maintain a higher UV output.

Organism*	Killing Dose of UV light (Microwatt seconds per square centimeter)
Viruses	15,000
Bacteria	15,000 - 30,000
Algae	22,000 - 30,000
Fungi	45,000
Protozoa	90,000

*Note: These are generalities; some specific organisms in these groups may require more or less of a dose than indicated.

In which types of systems should UV sterilizers be used and what are the benefits?

A UV sterilizer may be used in any aquarium, however, in smaller aquariums (less than 24 gallons), the cost of the unit may make it impractical. UV sterilizers are most helpful in multiple tank systems that share a common filter. In a single tank

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system, they are beneficial in controlling the spread of an infectious disease if one occurs. This is especially true in heavily stocked tanks and those with large amounts of live rock and corals that could make catching and isolating a diseased fish difficult, or the use of certain medications contraindicated. Disease control is especially important when adding new fish to an established aquarium, since 98% of the hobbyists do not use a quarantine aquarium.

In ponds, UV sterilizers are one of the best ways to control free-floating algae, allowing the pond owner to see and enjoy the fish. The UV sterilizer will also kill free-floating bacteria in the pond water.

What are the limitations and potentially harmful side effects of UV sterilizers?

UV sterilizers are NOT a replacement for good biological and mechanical filtration, regular water changes, and proper control of the nitrogen cycle. A UV sterilizer should be considered as an insurance policy.
UV sterilizers will be ineffective against string algae or other nuisance or disease-causing organisms that are not free swimming in the water.

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While the UV sterilizer will usually do no harm, it should not be used when first cycling the aquarium, as it may kill beneficial bacteria before they attach to the bio-media or gravel.

Many medications can be "denatured" by the UV light, so the sterilizer should be turned off when using medications, especially chelated copper treatments. The UV light will "break" the bond of the chelating agent, and the aquarium will have a sudden, lethal concentration of ionic copper.

The UV sterilizer can be used to control parasites, but the flow rate required is so slow that it is somewhat impractical on larger aquariums, unless larger (40W+) UV systems are used.

UV sterilizers can heat the water as it passes through, especially if the unit is larger than necessary for the tank size. A chiller may be necessary to keep the aquarium water at the appropriate temperature.

What styles of UV sterilizers are available?

The styles of UV sterilizers relate to their orientation when in use (horizontal or vertical) or their position in the water flow (in-line or hang-on). All vertical units must be used vertically, while some of the horizontal (Rainbow) units can be used vertically as well as horizontally. Some styles can be used in-line or hung on the back of the tank. Specialized units are designed to be used in outdoor/pond applications.

A newer style of UV sterilizer, called the "double helix," increases the contact time between the water and the UV light because the water makes a double spiral pass over the tube.

Models may or may not have a quartz sleeve. Those with a sleeve are sometimes called "dry bulbs." Cold water systems must have a quartz sleeve to maintain the proper output of UV light. A sleeve makes periodic cleaning and bulb replacement easier.

According to Robert Fenner, a well-known aquarist, author, and speaker, features of a good UV sterilizer include:

- A separate (remote) ballast unit that can be positioned in a place free of heat and water damage
- An indicator light to check for "on" operation
- An "automatic on" feature to turn the UV unit back on in the event of a temporary power loss
- Couplings that are easily fitted to your system
- A quartz or teflon sleeve at little or no additional cost
- All noncorrosive water-contact surfaces
- Acceptable guarantees and warranties

How is the correct size of a UV sterilizer determined?

This is about the only "complicated" part to the use of a sterilizer. For proper use, the UV sterilizer must be matched to the proper flow rate to ensure an efficient "kill dose" for the organisms you wish to eliminate. This flow rate must be matched to the size of the aquarium to ensure the proper number of "turn-overs" of the water. Most manufacturers will provide a table that recommends the maximum aquarium size and appropriate flow rate for each model they make. When comparing manufacturers, realize ratings may differ as to whether they take into account:

- Bulb efficiency: Some use 100% efficiency, others a lower efficiency (e.g., 60% observed towards the end of the bulb life)
- Organism to be killed: Bacteria/algae or protozoa
- Water clarity: Clear or turbid
- Transmission loss through the quartz sleeve

These differences make it very difficult to provide general rules of thumb. Check with the manufacturer if you are unsure on how the ratings are calculated.

The table at the right compares several

		Maximum	Maximum

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manufacturer's recommendations, which vary considerably. The wattage recommended by Emperor Aquatics are dramatically higher because they apply a 0.45 absorption coefficient factor for water clarity, factor in a 20% transmittance reduction for the quartz sleeve into the formula, and represent the lamp's operating performance when new and at the end of useful life (60%). This compensates for loss of UV radiation traveling through turbid green water and the sleeve's glass, while also taking into account lower efficiencies of older bulbs.

Manufacturer/Model	Watts	Maximum Gallons	Maximum Flow Rate
Aqua Ultraviolet	15	500	700
Angstrom 2537	30	500	750
Double Helix	36	500	500
Emperor Aquatics	65	400	952
Emperor Aquatics	80	400	1049

How is a UV sterilizer installed?

The UV sterilizer should be the last piece of equipment in the system before the water is returned to the aquarium. It should be preceded by the biological and mechanical filters, and any chemical filter or heat exchanger in the system. Follow the manufacturer's directions on installation. Most units use hose barb connectors to attach to the appropriate water pump or are designed to allow add-on connectors as a PVC slip fit or hose barb attachment.

What is the proper maintenance schedule for UV sterilizers?

The quartz sleeve will need to be checked monthly and removed and cleaned with rubbing alcohol. Some larger UV sterilizers have wiper mechanism units installed for easier maintenance.

For most units, the UV bulb will need to be replaced after 6 months of continuous use, however, this time may vary so be sure to follow the manufacturer's recommendations. When installing or changing a bulb, never look directly at the bulb when the unit is turned on. Doing so can result in permanent damage to your eyes. (The damage can occur without you feeling any discomfort.)

Always disconnect the unit from the electricity when performing maintenance to protect against possible shock. When turned on, the bulb becomes especially hot when in the air and submerging it in water may cause it to break.

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