True UV Performance

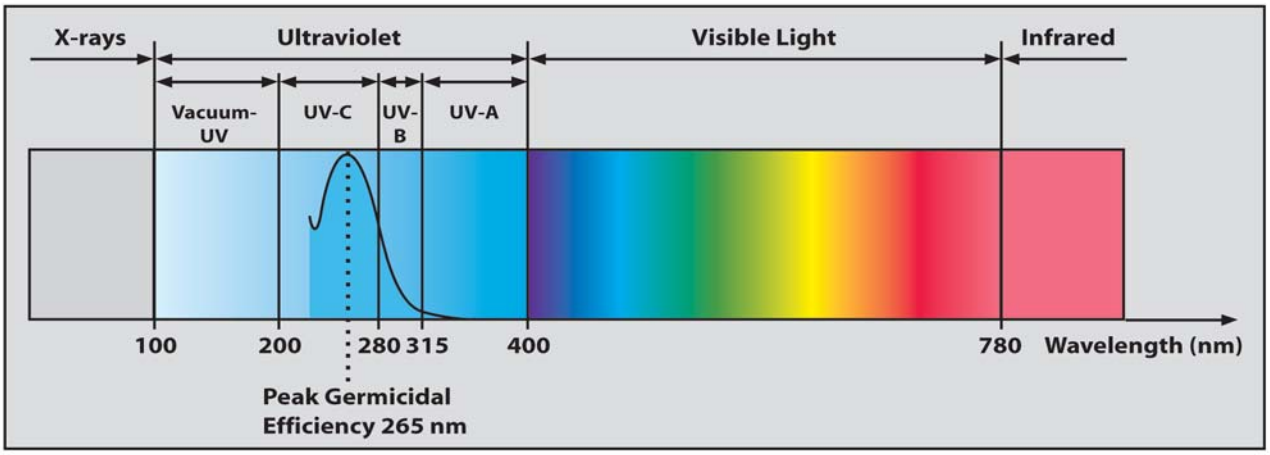
by Steve Zimmer, President of Emperor Aquatics, Inc.

While many of the people associated with water gardening, either for hobby or business use, would consider themselves knowledgeable towards UV, there are still many who find the topic very confusing. Few would disagree that the current marketing trends within today's water gardening market are no different than most other markets; essentially, advertising is selling the public on what they most want to believe, regardless of whether the information presented to them is substantiated or not. Unfortunately in the water gardening market today there is no governing organization like the EPA or NSF that oversees the claims that are made by manufactures and their equipment. Until some type of standard is formulated in our industry some companies will continue to confuse or mislead uninformed consumers with unsubstantiated UV information. It is this article's intent to dispel the misinformation and give the consumer a clear basic guideline to make an informed UV purchase.

Regardless of whether you chose to label a UV a Clarifer or a Sterilizer, the same design, performance and operating principals apply. Successful UV operation means destroying the targeted microorganism. There are five main factors that determine the ability of a UV to achieve this desired effect.

1. The type of lamp used in the application, low-pressure or medium-pressure.
2. The length of the lamp being used, also known as ARC Length.
3. The physical design of the UV's water exposure chamber. The distance the UV light energy has to travel from the surface of the lamp to the inner wall of the UV's water containment vessel is the primary design criteria that will determine the unit's "UV dose rate" at any given water flow rate.
4. The condition of the water to be treated. The term used to express the ability of a body of water to be effectively treated by a UV light source is known as percent (%) transmittance. This is a value expressed in percent (%), which is used to indicate the quality of the water to be treated. The higher the % transmittance the easier the UV Sterilizer will be able to treat the water at a given flow rate.
5. Water flow rate through the UV's contact chamber. The amount of water that is passed through the UV filter will ultimately determine the unit's actual UV dose rate which is expressed in microwatts per second per square centimeter or (u-watts-sec/cm2).

To best understand what UV is, we must first define it. UV is a spectrum of light that is just below the visible range to the human eye (below the blue spectrum of visible light, see the chart below). Ultraviolet light is divided into 4 distinct spectral areas, Vacuum UV (100 to 200 nano meters), UV-C (200 to 280 nano meters), UV-B (280 to 315 nano meters), and UV-A (315 to 400 nano meters). The UV-C spectrum (200 to 280 nano meters) is also known as the Germicidal Spectrum because it is the region that contains the peak germicidal wavelength (264-nano meters). It is this wavelengththat is most lethal to microorganisms.

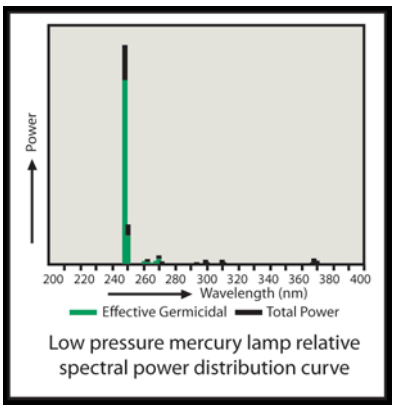


UV-C-Radiation used for disinfection is most effective at a wavelength of 265nm.

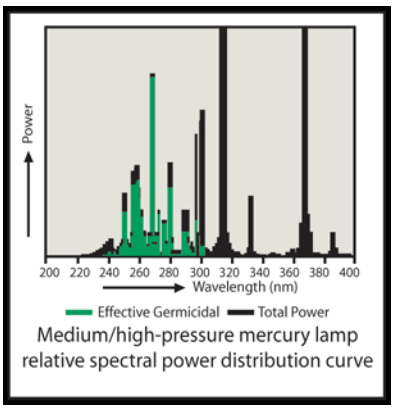
Now armed with the knowledge of where the most lethal wavelength to microorganisms is in the UV light spectrum, we can properly select the appropriate UV light source and design our UV's water containment vessel around the lamp selected.

Types of UV light sources. There are two primary types of UV light sources in use today. The first and most widely used are the low-pressure class of lamps that produce virtually all of their UV output at a wavelength of 254-nano meters, which just happens to be very close to the maximum peak germicidal effectiveness curve of 264-nano meters. These low-pressure classes of lamps generally can convert up to 40% of their input watts into usable UV-C watts. I.e. a 150-watt low-pressure lamp will have approximately 58-watts of UV-C power. Low-pressure lamps are typically run at low input power currents, 200 to 1,500 milliamps and operate at temperatures between 100 and 200 degrees F. This class of lamp generally has a useful life of 8,000 to 12,000 hours, depending on operating current of the lamp.

The second type is known as the medium and high-pressure class of lamps. This class of lamps produces a very wide range of wavelengths, 100-nano meters to greater than 700-nano meters, which is well into the visible light spectrum. These types of lamps are very poor producers of usable germicidal wavelengths; they generally only convert up to 7% of their input watts into usable UV-C watts. I.e. a 175-watt medium-pressure lamp will have approximately 12-watts of UV-C power, while the remaining 163-watts are converted into heat and visible light. Medium and high-pressure lamps are typically run at high-input power currents of 2,000 to 10,000 milliamps, and operate at temperatures between 932 and 1,112 degrees F. This class of lamps generally has a useful life of only 1,000 to 2,000 hours, depending on the lamps operating current.



Low pressure mercury lamp relative spectral power distribution curve

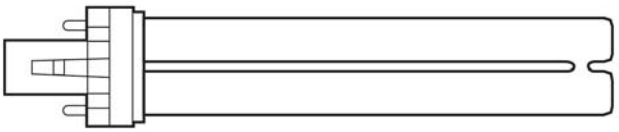


Medium/high-pressure mercury lamp relative spectral power distribution curve

As we can see from the comparisons between the two classes of UV light sources used today, the low-pressure class of lamps are without a doubt, best suited for use in water sterilizer applications.

175 Watt Medium Pressure UV Lamp
Input Watts: 175 Watts
UV-C Output Watts (250-280 nm): 12 Watts
Arc Length: 1.25"
Useful Lamp Life: 1,000 hrs. @ 80%

36 Watt Low-Pressure TUVPLL36W UV Lamp
Input Watts: 36 Watts
UV-C Output Watts (250-280 nm): 12 Watts
Arc Length: 15.16"
Useful Lamp Life: 8,000 hrs. @ 80%



150 Watt G64T6LHO UV Lamp
Input Watts: 150 Watts
UV-C Output Watts (250-280 nm): 58 Watts
Arc Length: 57"
Useful Lamp Life: 9,000 hrs. @ 82%

The length of the lamp being used. The low-pressure classes of UV lamps are manufactured in many different styles and lengths. As a general rule the longer the lamp is, the greater the time the water will be exposed to the UV source; therefore, increasing the "UV Dose" that the water will receive. (Longer is better).

The physical design of the UV's water exposure chamber. This is an area of design that is completely overlooked by some manufacturers. When selecting a UV Sterilizer for your application look for these important features:

- Make sure that the UV lamp is positioned between the water inlet & outlet ports of the unit's water containment vessel. If the lamp is not positioned between the water ports, the portion of the lamp that is not between the ports is wasted. A unit that has its lamp positioned outside of the water ports is of a poor design and should be discounted as a viable water treatment device.

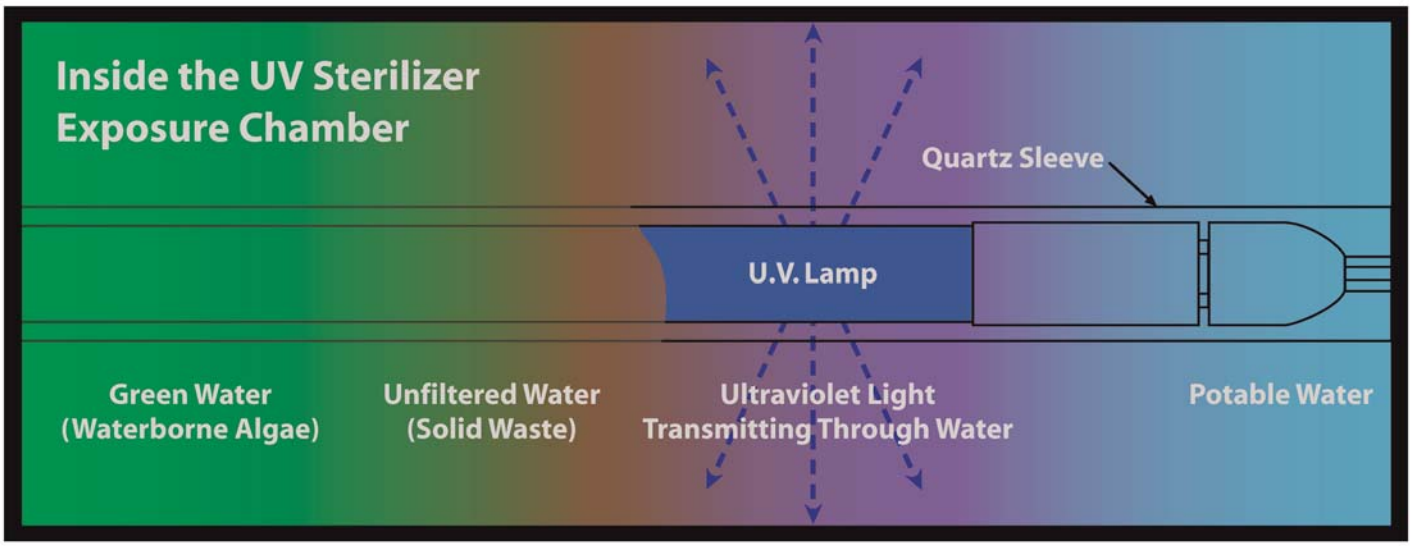
- Select a unit that has the largest diameter water containment vessel in the wattage that you are considering. A unit that has a larger diameter will always have a greater contact time. I.e. a 25-watt model that has a 3" diameter housing will be able to flow more water than a 2" housing model.

- Make sure that the unit you are considering uses a Quarts Sleeve. The quartz sleeve is used for two reasons. First, to isolate the UV lamp from the water as to avoid a short circuit path for the lamp's electrical power. And second, to allow the lamp to operate at its optimum temperature. (The quarts sleeve acts as an insulator for the lamp.)

- Are the manufacture's water flow rates listed at the end of lamp life rating? Most UV manufacturers give a water flow rate but do not indicate whether they are for when the lamp is new or at the end of its useful life. Try to find a manufacturer that lists the water flow rate at the unit's end of lamp life rating. The end of lamp life rating takes into account the lamp losing UV-C output due to age, and is a more realistic ability of how the unit will perform.

- Do the manufacturer's water flow rates take into account the reduced effectiveness that the UV light will have when treating green water? This would be listed as some type of % transmissibility rate or absorption coefficient. Units that take this factor into account will have lower water flow rates.

The condition of the water to be treated. This is one of the most critical factors when trying to determine the ability of a UV Sterilizer to treat a given volume of water, and is also the most overlooked factor by many manufacturers. Regardless of the type of UV light source used, any body of water with impurities will adsorb UV energy. The impurities of interest to us in the pond hobby are algae and waterborne microorganisms. Green water, as it is known, will absorb the UV energy emitted by our UV light source in proportion to its density (how green the water is). The greater the amount of algae in the water, the greater the reduction in percent (%) transmittance. It is this reduction in % transmittance of the UV light that will determine how effective the UV Sterilizer will be in dealing with the algae problem. If the UV sterilizer's water flow rates have not been calculated with a reduced % transmittance rate then the unit will have considerable trouble dealing with a pond that is suffering from an algae bloom.



Water flow rate through the UV's contact chamber. As mentioned earlier there are many criteria that should be considered when designing a UV Sterilizer. The basic criteria for a sound design of UV Sterilizers, revolves around a careful selection of lamp type, lamp length, lamp position, and body diameter. These factors coupled together with the intended water flow rate, % transmittance of the water to be treated, and the required UV dose rate to kill the targeted microorganism, should be the basis for your decision when purchasing a unit for your pond. When you are researching which type of UV Sterilizer to purchase, remember the criteria laid out in this article, read the manufacturer's literature, ask questions, but most of all ask yourself, does this information make sense? If not, consider another UV manufacturer.

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