UV Sciences Inc. *"USING SCIENCE TO IMPROVE UV TECHNOLOGY"*

Making UV Water Treatment Chambers More Efficient

Ultraviolet (UV) light, specifically the 254 nm wavelength, is a powerful disinfectant. The advantage of using UV for water treatment over other methods (specifically chemical) is that there is no residual chemical or hazardous by-product at the end of the process. UV is a *"natural"* choice for disinfection and purification of water. However, UV water treatment chambers suffer from the fundamental drawback in that ultraviolet light is absorbed by common materials, such as stainless steel.

Stringent quality and disinfection requirements for the production of water purification equipment offer the designer few choices regarding materials to use for the UV treatment chambers. UV light degrades and ages common polymers (polypropylene) to the point their use in treatment chambers is unacceptable. Stainless steel meets stringent quality and strength requirements, but it absorbs UV light energy. Non-metal UV resistant materials are exotic and expensive, or inadequate when subjected to intense UV energy found inside the UV water treatment chamber. Therefore designers make tradeoffs to ensure the integrity, unit life, and disinfection performance is maintained. These tradeoffs always come at the expense of efficiency.

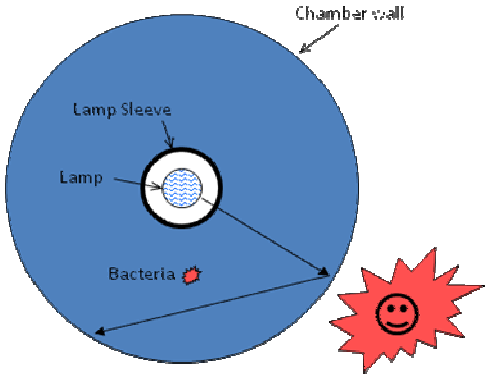
High quality water treatment chambers used in industrial/commercial applications such as, beverage manufacturing, semiconductor processing, and pharmaceutical manufacturing, are made from high grade stainless steel (SS316-L). And most of the UV light emitted by the lamp is wasted as it is converted to heat (a function of the UV light being absorbed by the stainless steel housing). The solution to this drawback has been to "pack" the UV treatment chamber with multiple UV lamps, as many as 44 in one treatment chamber. Additionally numerous chamber baffles are installed to ensure sufficient water mix for adequate UV light exposure.

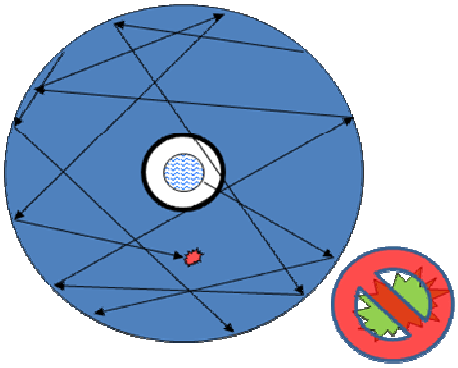
The down sides to this typical design solution is that the treatment chamber is very large (to house the large quantity of lamps), the energy costs associated with powering all the lamps is high, and the maintenance costs to replace the lamps is substantial. Improving the efficiency of the treatment chamber would deliver immediate benefits to the End User. Power consumption, operational and maintenance costs of their UV equipment would be greatly reduced. So, what IF the treatment chamber did not absorb most of the UV light, BUT reflected that light back into the water medium?

Ultraviolet Sciences Inc. (UVSI) has responded this question with the development of a water treatment chamber that does NOT absorb UV light. UVSI has been awarded United States Government Patent No. 7,511,281 for its highly efficient ultraviolet light treatment chamber. The patent is a result of nearly two years of scientific study and engineering development efforts to improve the efficiency of UV water treatment chambers.

Conventional Systems Compared to the Highly Reflective Chamber Design.

Conventional UV disinfection chambers lose nearly all (>90%) of their UV light energy into the outer wall of the treatment chamber. The UVSI disinfection chamber is different, its outer wall is highly reflective. This chamber design dramatically lowers the loss of UV light energy. See illustration below.

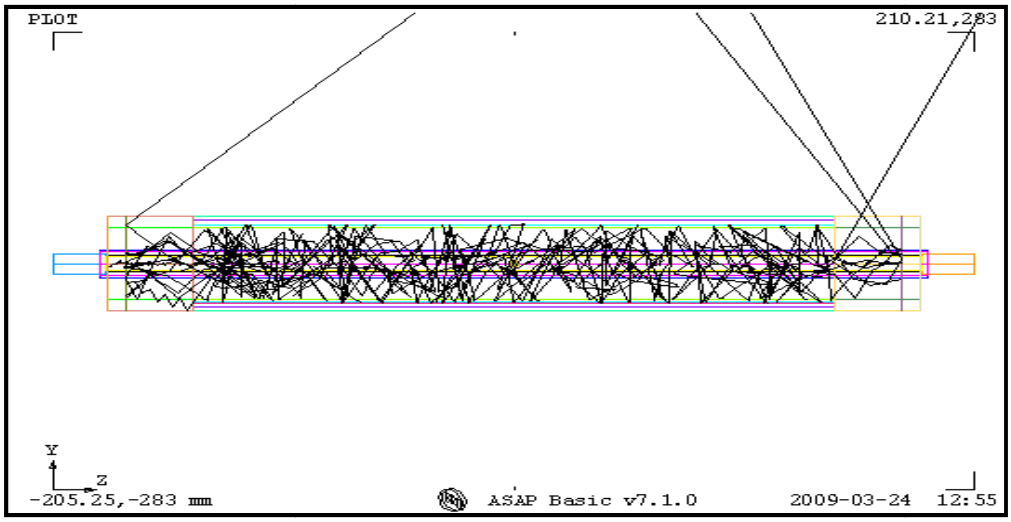




Conventional UV treatment chambers absorb much of the UV light energy. The UV light is typically absorbed into the outer wall after the first and second reflection. To prevent the microbe from escaping the chamber untreated, these UV systems are very large and must have many lamps.

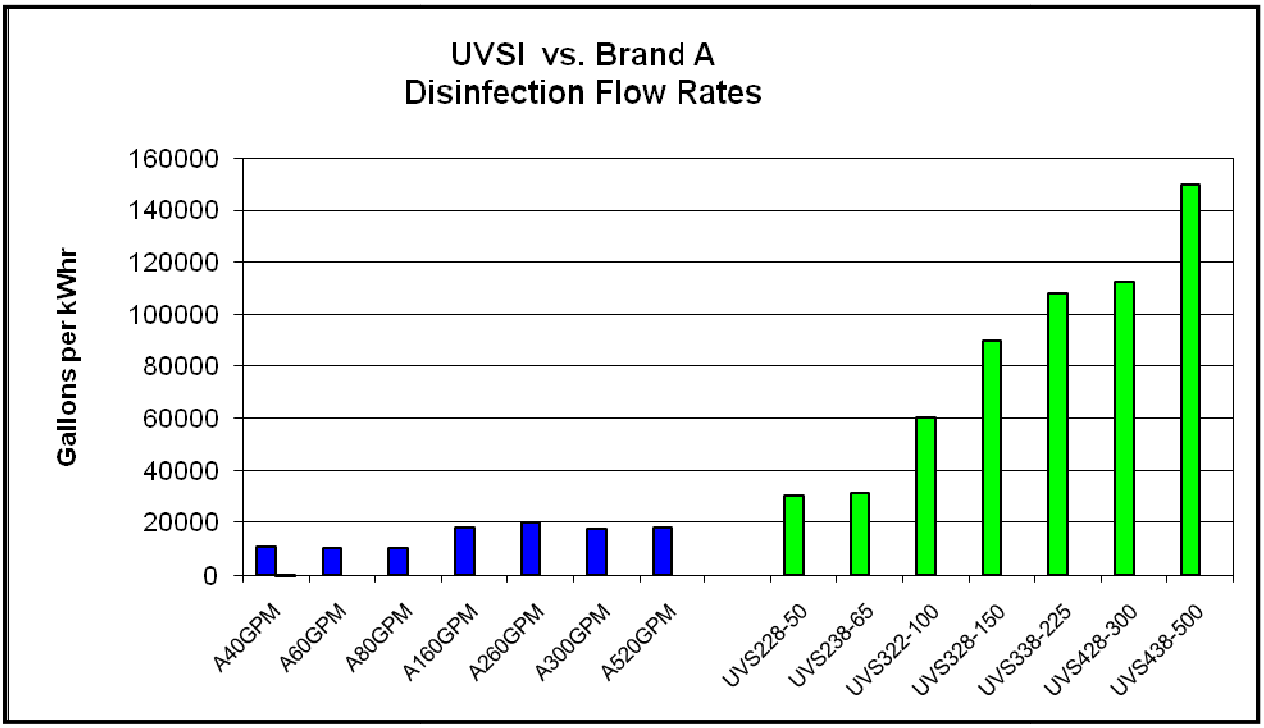
UVSI treatment chambers utilize a specially patented designed flow tube that is highly reflective to UV light. The UV light is NOT absorbed by the outer wall, but continues to reflect until it is finally absorbed by a microbe. The result is greatly improved efficiency and performance.

An added benefit of the highly reflective treatment chamber is that the UV dose is very uniform throughout the volume of water. Engineering models show how efficient this design is, using nearly all the UV light energy, and keeping it in the water flow tube. Computer ray-tracing simulation of only 10 rays (photons) shows the large number of reflections and subsequent increase in effective intensity of the light. See illustration below:



Efficiency Comparison (Gallons per Kilowatt-Hr.)

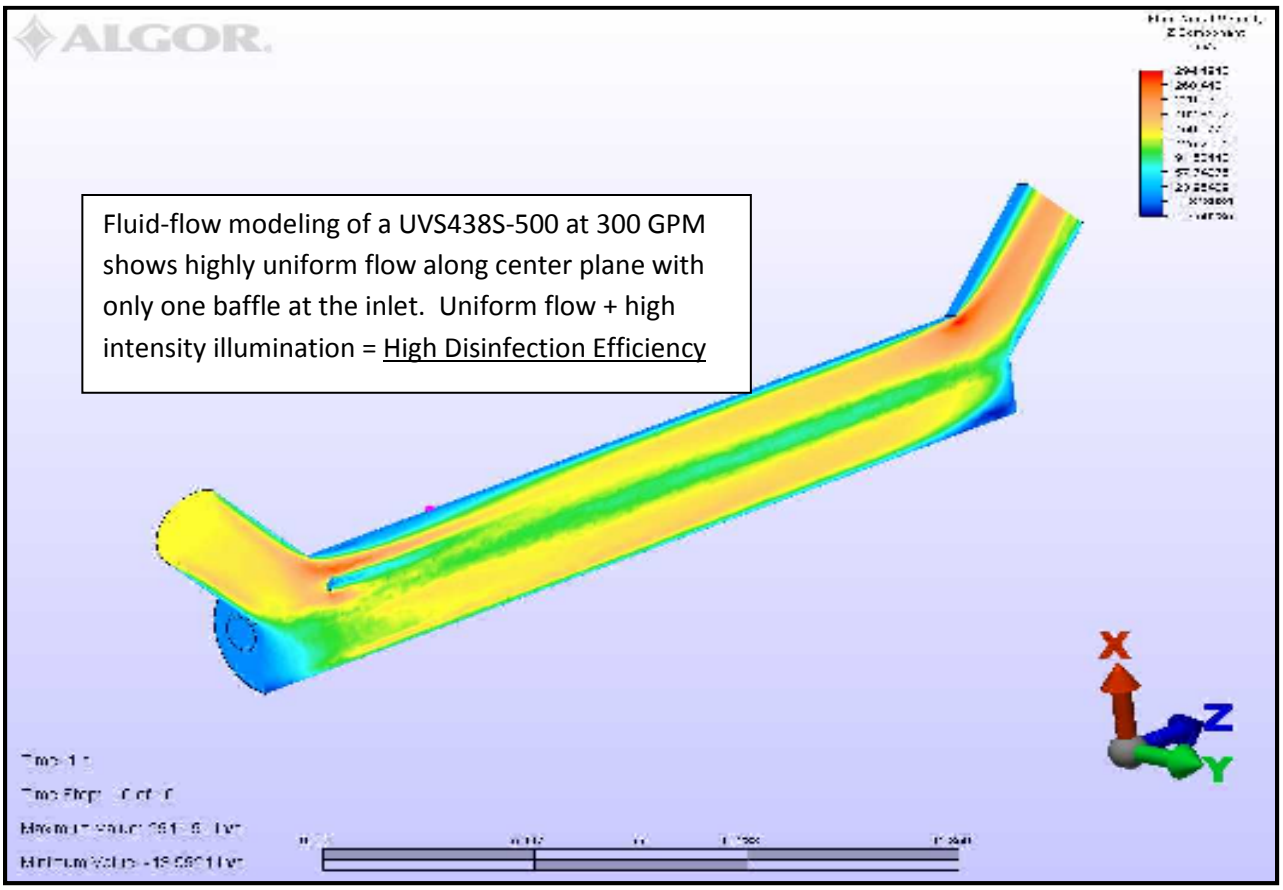
The result of the highly reflective chamber design is that the UV light energy (photon) remains in the water medium until it is finally absorbed by a microbe or chemical molecule such as chloramines. This "conservation of energy" results in a water treatment chamber that does not suffer from the efficiency drawback of conventional units. Chambers therefore, can be made smaller, with fewer and smaller UV lamps, delivering the same disinfection dosage of units much larger in size. Energy costs are significantly reduced in the process. The figure below illustrates the efficiency improvement of the UVSI treatment chambers (gallons of water disinfected per Kilowatt-Hr) when compared to conventionally designed water treatment chambers:



The net effect of the high reflective chamber is a 3X to 7X improvement in efficiency when compared to an equivalent flow rate system. Keeping the UV photon in the water medium, instead of turning it into heat as it is absorbed by the housing, delivers significant improvement in disinfection performance.

Uniform Flow is a Necessity to Ensure Proper UV Dosage.

Having a uniform flow pattern throughout the treatment chamber creates an optimal situation for delivering a predictable UV disinfection dose. UVSI used fluid dynamics modeling tools to optimize the flow tube annulus, designing a chamber that has a uniform flow rate. The relatively small size of the UVS chamber results in turbulent flow over a wide range of operating flow rates. Only a single baffle is needed at the inlet. This uniform flow rate coupled with our highly reflective chamber delivers a uniform UV dose throughout the entire chamber length. The illustration below is a 3-D model of the flow through our 500 GPM unit chamber, which is four inches in diameter and only 40 inches long.



Summary.

The highly reflective chamber results in significant benefits to the design of UV water treatment chambers. UV treatment chambers are now significantly smaller, they require fewer UV lamps and they use significantly less energy. This translates to huge savings in operating and maintenance costs, without compromising disinfection performance.