UV Disinfection 101

(reprinted from the February 2002 Issue of National Driller)

Ultraviolet disinfection is a means of killing or rendering harmless microorganisms in a dedicated environment. These microorganisms can range from bacteria and viruses to algae and protozoa. UV disinfection is used in air and water purification, sewage treatment, protection of food and beverages, and other disinfection and sterilization applications. A major advantage of UV treatment is capable of disinfecting water faster than chlorine without cumbersome retention tanks and harmful chemicals. The focus of this article will be on water treatment.

Selecting the Proper Application for Ultraviolet Disinfection

It is very important to know quality of the water you are working with and also to define your desired result. UV is an option when there is concern about the microbiological integrity of the water. The best feature of UV is that it kills microorganisms without adding or subtracting from water chemistry. On the other hand, UV does not leave any measurable residual in the water; therefore it is recommended it be installed as the final step of treatment and located as close as possible to the final distribution system. Once the quality of your water source has been determined, you will need to look for things that will inhibit the UV from functioning properly (e.g., iron, manganese, TDS, turbidity and suspended solids). Some of you may be thinking this is too much preparation for an UV system. Let me ask you, as a water treatment professional, would you leave your customer's home without addressing these issues anyway? Iron and manganese both are capable of precipitating on the quartz sleeve and preventing the UV energy from transmitting into the water. Iron should not exceed 1.0 ppm. At that level additional maintenance is required to keep the quartz sleeve clean and transparent. It is recommended iron and manganese are removed from the water, or at least reduced to levels that eliminate the possibility of staining. Total Dissolved Solids (TDS) should not exceed 500 ppm; however, due to many factors, this number is nebulous at best. There are many factors that make up this equation such as distance between the lamp and wall of the UV chamber; the particular make-up of the dissolved solids and how fast they absorb the available UV energy; flow rate; output of the lamp; etc. Calcium, in high amounts, has a tendency to build up on the quartz sleeve, again impeding the UV energy from penetrating the water. Contact your supplier for details on the amount of TDS your equipment is capable of handling. The solution could be as simple as running your system slower for a higher dosage. Turbidity is the inability of light to travel through water. Turbidity makes water cloudy and aesthetically unpleasant. In the case of UV, levels over 1 NTU can shield microorganisms from the UV energy, making the process ineffective. Suspended Solids need to be reduced to a maximum of 5 microns. Larger solids have potential of harboring or encompassing the microorganisms and preventing the necessary UV exposure. Pre-filtration is a must on all UV applications.

General Installations

Once the aforementioned problems have been solved and you are convinced the water quality has been established to promote UV disinfection, you should find a location to mount the system that offers easy access for service. You will need to have access to the pre-filter, to the UV chamber for annual lamp changes (provided you're using a hard glass lamp), and regular maintenance on the quartz sleeve. The quality of the water will determine maintenance time schedule of the quartz sleeve. You will want to locate an electrical outlet. Note: using an UV system and a pump on the same electrical line may cause problems with and shorten the life of the UV lamp and ballast.

Types of UV Lamps

UV lamps are constructed from two types of quartz glass: a soft glass and a hard glass. Both are used in disinfection of water, however usable life of each type of glass varies. Soft glass lamps have usable life of 2,000 hours and are found in small non-critical devices such as fish aquariums, air purification and small counter top systems. Hard glass lamps have a usable life of 9,000 hours and are found in higher flow and higher output applications. The difference between the two types of lamps is quality of the glass used in their construction. A germicidal lamp is constructed of quartz glass, argon gas, mercury and the filaments used to ignite the mixture. When a lamp is lit and has achieved its ideal operating temperature of 104 degrees F, the mercury changes from its solid state into a gaseous state. While the lamp is in this operating state it imparts particles into the pores of the glass. This process is referred to as solarization. Solarization takes place in the hard glass lamp in about 9,000 hours due to its smooth and less porous surface (that's four-and-a-half times longer than a soft glass lamp). UV lamps may burn for many years, however solarization of the lamp will determine the UV energy output.

Dosage

Dosage is the most critical function of UV disinfection. It is the combination of the lamp intensity and the dwell time that makes up dosage. The equation is: Intensity x Exposure = Dosage. This is important to know when sizing equipment. Each manufacturer uses a different standard for sizing its equipment, but it comes down to this equation. For example, if your manufacturer values its equipment with a flow rate of 10 gpm at a dosage of 16,000 microwatt second per squared centimeter and you are working with an application that requires 32,000 mws/cm2, you would cut the flow rate in half to achieve the new UV dosage. Dosage is another reason to consider the difference between the higher outputs of a hard glass lamp verses a soft glass lamp. The purpose of the quartz sleeve is to help the lamp maintain its ideal operating temperature. It also is to isolate the lamp from the water. For the maximum UV transmission of energy, the quartz sleeve needs to be constructed of the same high-quality materials as the lamp. The quartz sleeve should be wiped down every three to six months, which is contingent upon quality of the water you are dealing with. It is recommended every UV application is inspected after three months time. This will give you an opportunity to monitor the effect the water chemistry is having on the quartz sleeve, and your maintenance schedule time frame can be modified from there. The sleeve should be wiped down with a soapy solution each time it is inspected. If there is a residue left you may need to use a non-abrasive cleaner that is formulated to remove iron and scale buildup. An abrasive cleaner could scratch the sleeve and make it unusable.

Applications for UV Disinfection

Applications include well applications point-of-entry; point-of-use; post mix vending machines; pharmaceuticals; cooling towers; boats and RV's; pre-and post-reverse osmosis; fish hatcheries; aquiculture; bottled water cabins; laboratories; hospitals; spas; boiler feed water; water softeners; and others.