NUTS & BOLTS

UV Disinfection
of Influent Water

By Genny Fraser

The first step to disease prevention in fish hatcheries is often the disinfection of influent water. Water from aquifers and deep wells is often pathogen-free, but surface water, particularly from streams or rivers with natural fish populations may not be so. Effective influent water treatment can prevent catastrophic mortalities or deformities in fish hatcheries. Thus the quality of the water entering the facility dictates the type of treatment required. Some of the more common and often necessary treatments required for influent water are gas balancing, solids filtration and disinfection. No matter the origin of the water, whether from a well, a stream, ground water or a seawater source, disinfection should be included to deal with dangerous microorganisms such as parasites, bacteria, viruses, mould and fungi.

Example of a single bulb rack for a multi-rack, modular open-channel system.

Benefits of UV for Influent Water Disinfection

UV is a clean, safe and environmentally-friendly method of disinfection. It is harmless to the fish, easy to use and maintain, and very effective for ridding the influent water of almost any pathogenic organism. There is no risk of damaging the fish with toxic by-products or residuals as no chemicals are required. Ultraviolet disinfection is an effective treatment for influent water, recirculation system water, and effluent discharge.

How it Works

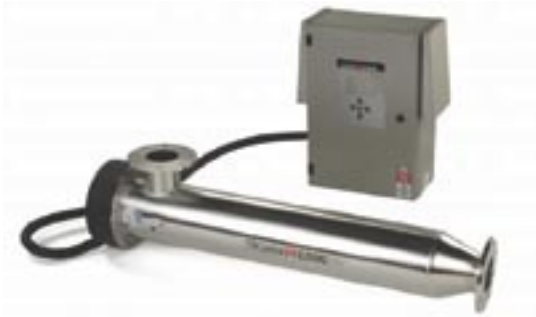
Ultraviolet disinfection works by producing electromagnetic energy from a mercury arc lamp that penetrates the cell wall of the organism. This disrupts its genetic material (RNA and DNA) and destroys its ability to reproduce. Different organisms require different dosages of UV. Elimination of some organisms requires a high intensity UV discharge, some a long exposure time, whereas others may require a combination of high intensity and extended contact time. The size and type of UV system is ultimately determined by the facility's specific protection requirements.

Determining How Much UV is Needed

When determining how much UV is required, there are three fundamental questions that need to be answered:

- What is the flow rate to be treated?
- What UV dosage is required?
- What is the UV transmissivity of the water?

Flow rate is usually pre-determined by the fish production goals and the amount of water available. Dosage is the amount of UV required to inactivate an organism, which varies with the type of organism to be inactivated. Each pathogen requires a specific dosage; the product of UV light intensity and exposure time. Specifications for UV systems list the dosage in microwatt seconds per square centimeter



In-line UV system of the type often installed or retrofit into aquaculture systems (different sizes can handle from small flows to quite large flows)

($\mu Ws/cm^2$) or milliJoules per square centimeter (mJ/cm^2). The dosage given by the UV system supplier or design engineer should be listed as that at the end of the lamp's life (EOL). UV lamps degrade with time so the dosage is calculated at the end of the lamps' designed life to ensure that the system never falls below the minimum dosage required. This prevents any organism passing through without adequate exposure.

A very important water parameter when sizing a UV system is the UV transmissivity. This is a measure of the ability of the light in the germicidal wavelength (optimally 250-270 nm) to pass through the water. Transmissivity is determined by passing light from a known source through 10 cm of the water in question, and then measuring the percentage that is received by the sensor. Because it is such an important factor when sizing a system, UV providers such as Trojan Technologies offer free transmissivity testing. Transmissivity can radically affect the sizing of the system; for example, to maintain the same dosage in T60% water as in T70%, the number of lamps may have to be doubled. Pre-filtration may be in order.

Installed banks of Trojan UV 3000+ UV racks in an open channel (before water was introduced) at Mainstream's Boot Lagoon salmon hatchery in BC.

Since UV works best when the water has a high transmissivity, if there are solids or heavy organics in the water, better results are usually obtained when some form of pre-filtration is included. The method chosen depends upon the types of solids present in the untreated water. The two most common methods of pre-filtering water for UV treatment are micro-screen- and sand filtration. If there is a lot of silt or algae present along with many other types of solids, then sand filtration has proven to be very effective. However, sand filters require high pressure and, therefore, pumping. If silt is not present, then a micro-screen drum filter can be very effective. The State of Utah recently conducted a pilot study testing sand filters and drum filters as pre-filtration for UV treatment of influent water. The study was performed to identify the appropriate treatment of influent water infected with whirling disease. The drum filter system was much less expensive both in upfront- and operating costs, and proved to be effective as a pre-filter for the ultraviolet disinfection system.

UV Lamp Types and Vessel Styles

UV lamps work using mercury gas contained within the lamp. Both low-pressure and medium-pressure lamps are available. Low-pressure lamps are very efficient at converting electrical power input to germicidal-range UV output; however, the output from low-pressure lamps is less than that from medium-pressure lamps. These provide a much higher UV output, but require much more electricity. Fewer medium pressure lamps will be required for the same dosage but the lamp cost is much greater and lamp life is significantly shorter.

There are two main styles of UV vessels: inline, where the lamps are enclosed in a flanged tube through which the water flows, and open channel, where the lamps are submerged inside an open-top channel. The inline style of UV unit is perfect for retrofitting into existing treatment systems and is very common in fish hatcheries for both influent system and recirculating system disinfection. Most inline UV units can operate with very low water pressure. They have a very broad flow range (from under-the-counter residential use to large, commercial applications) and come in a variety of materials: stainless steel, HDPE or PVC. For larger flows, open channel systems are often used (see photo). The lamps are held in place on a rack that hangs inside a channel, either constructed of concrete or fabricated from metal or FRP. Open-channel systems are often modular in design and can treat very large flows.

Ultraviolet disinfection is now commonly used for influent water treatment, and is also popular in a recirculation side- loop to prevent bacteria, viruses and fungi from threatening valuable fish stocks. This prevention can help produce healthy fish, and happy fish producers and consumers.

Genny Fraser has worked in aquaculture system design for 10 years, and is both Sales Manager and a design technologist for PRAqua Technologies Ltd. For more information, contact her at +1 250 714 0141 or genny@praqua.com.