

# NUTS & BOLTS

BY GENNY WEST

## Three steps to effective water disinfection in modern fish hatcheries

### Pre-filtration, ozone & UV

**B**iosecurity is crucial to the success of any fish hatchery. There are many different factors in preventing the ingress of pathogens into aquaculture facilities including husbandry protocol, equipment disinfection, quarantine facilities, tank and equipment layout and most importantly, water disinfection. The most common methods of treating water for pathogens in hatcheries are ozone addition and ultraviolet (UV) disinfection.

#### Filter first

Pre-filtration of the water is required before any disinfecting is done to eliminate larger particles of organic matter that can absorb the ozone or ultraviolet light and waste energy. These organics can inhibit the effectiveness of ozone and UV resulting in the potential for ingress of pathogens and also results in unnecessary energy costs. If particles larger than 30 microns can be removed the size of the disinfecting equipment can be greatly reduced and the abilities of the units can be optimized. Ozone does not discriminate; it will attack any organic in the water so the more particles that can be removed



Pressurized sand filters are available in a range of sizes.

prior to ozonation the better the opportunity for the ozone to neutralize all the pathogens that remain in the water and the less ozone that will need to be produced.

The removal of large particles is also important when using UV irradiation. Small pathogens can be shadowed and not treated if proper pre-filtration is not done. The UV energy will also be absorbed by any organics so pre-filtration is cost effective. Either sand-or drum filter can be used.



Small scale Trojan UV unit is available for a wide range of flow applications

#### Ozone options

Although ozone is a gas, when injected into water it creates chemical reactions that assist in disinfection as well as water clarity and odour control. Ozone is an aggressive and ecologically sound chemical oxidant that is highly effective as a disinfectant in aquaculture applications. Its effectiveness is dependant on the dosage, the length of contact time, and the presence of other materials that may consume the ozone. Ozone is O<sub>3</sub>, the third oxygen atom being attached to O<sub>2</sub> by a weak bond which makes it a powerful oxidizing agent. When the ozone molecule encounters an organic compound, the third oxygen atom is released from the O<sub>3</sub> molecule, and attaches to the organic particle causing damaging changes and thereby removing any pathogenicity.

Ozone gas cannot be stored because it is very unstable. It must be generated on site by an ozone generator. There are some human health hazards



Fungus (*saprolegnia* 5-25µ)



Large, Trojan open channel UV system. Usually used for very large flow systems.



Typical drum filter used for pre-filtration.

to be aware of when using ozone and safety procedures need to be implemented such as installation of an ozone gas monitor to detect any ozone in the air caused from leakage.

Since ozone at higher concentrations may cause fish health problems, it is important that residual ozone is not present after the treatment process. Depending on the amount of oxidative material present in the water, the ozone will decompose to oxygen in a matter of minutes or hours.

#### UV solution

Ultraviolet disinfection is another effective method of reducing the risk of bacterial disease, viruses and fungi damaging and killing fish stocks in hatcheries. It is clean and safe, leaves no residuals to cause problems and poses no possibility of overdosing. The only human health hazard is the possibility of direct exposure to the lit lamps, which should be avoided. UV is considered a physical method of disinfection because there are no changes to the water chemistry. UV light has a wide spectrum of wavelengths but the germicidal wavelength is 254 nm, which all low-pressure UV lamps produce. At that wavelength the light penetrates the cell wall of the pathogen and damages the DNA and RNA within, rendering the organism unable to reproduce and thereby inactive.

The sizing of UV equipment is based on flow rate, dosage

and the transmissivity (UVT) of the water. Dosage is a product of lamp intensity and the time the water is exposed to the light; it is expressed in  $\mu\text{Ws}/\text{cm}^2$  (Microwatt seconds/ $\text{cm}^2$ ),  $\text{mWsec}/\text{cm}^2$  (Milliwatt seconds/ $\text{cm}^2$ ) or  $\text{mJ}/\text{cm}^2$  (Millijoules/ $\text{cm}^2$ ). The transmissivity is the amount of light that can get through a set amount of water and still be strong enough to damage the target cells; i.e. if there are a lot of organics in the water the light will be absorbed more quickly and a higher dose will be required.

The UVT is usually measured as a percentage, e.g. raw seawater is assumed to have a UVT of 85% whereas clean, finely filtered water would be 95%. Turbidity and total suspended solids (TSS) do not necessarily relate to transmissivity. If the water is turbid with inorganic material the UV light will still pass by and be effective because it is not being absorbed. Alternatively, the water may appear clear, but have a high organic loading (which is not seen by the naked eye) and therefore have a low UV transmissivity. The UVT cannot be assumed by a visual inspection of the water but it can be measured at any water testing laboratory.

#### Combination system

The ultimate in water disinfection in aquaculture facilities is a combination of pre-filtration followed by ozone followed by UV. Prefiltration will remove larger

organic particles; ozone will clarify and disinfect the suspect water; and the UV, if placed in series after the ozone, can remove any residual ozone and produce a second barrier of disinfection. If UV is supplied at a dosage between  $60,000 \mu\text{Ws}/\text{cm}^2$  and  $90,000 \mu\text{Ws}/\text{cm}^2$  it will remove the dangerous ozone residual.

Both ozone and UV are very effective methods of disinfecting water at fish hatcheries in their own right, but when used together there is very little risk of pathogen ingress and very little risk of dangerous levels of ozone getting to the culture tanks and thereby killing fish. When both ozone and UV are used in combination, mortality rates caused by disease outbreaks are greatly reduced and higher density tolerances in culture tanks have been reported.

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