THE USE OF OZONE AS A DISINFECTANT IN FISH HATCHERIES AND FISH FARMS

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Abstract

The ever increasing load on the environment calls for more intensive measures to maintain the natural equilibrium. This is especially the case when it comes to the different life forms in rivers and lakes.

In order to maintain indigenous fish populations it has become necessary in many countries to introduce stocking programs for coarse fish in addition to the ever increasing activities involving game fish. These demands have placed extreme pressures on hatcheries and farms already operating with limited facilities. The easiest way to increase production without vast capital outlay is to increase the number of fish being reared in a given volume.

It is obvious that when the fish density per cubic meter is raised the risk of infection increases proportionally. In order to maintain the survival rate as high as possible it is of vital importance to ensure that no water borne disease can enter the system - this applies to circulating systems as well as once through arrangements. An ideal method of disinfecting water is by ozonation in a contact tank prior to use. Ozone is a very powerful bactericide and viricide and, unlike other agents, it leaves no undesirable residues.

The latest available advanced ozone technology, which will enhance efficiency and be environmentally beneficial, now lies within the reach of all operators.

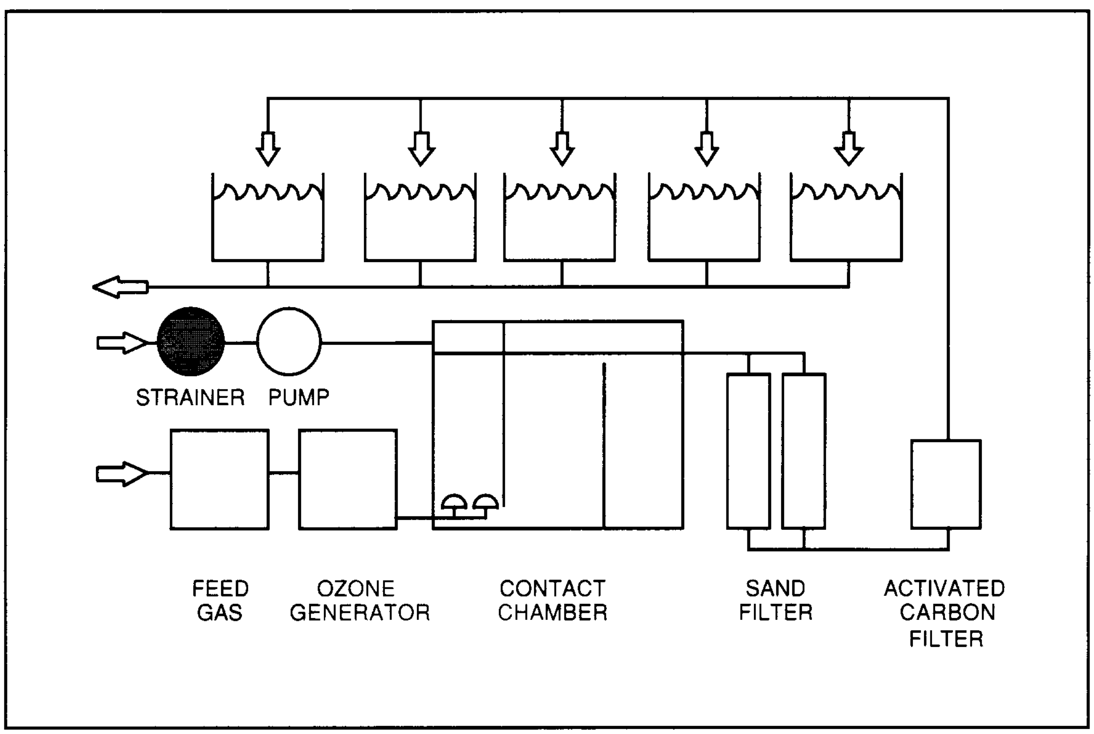
Introduction

In the modem world of today it is not unusual for man to give nature a helping hand to overcome certain difficulties in order to maintain a natural equilibrium. Over the last decades, pollution, mainly from industry, has taken its toll and some of the hardest hit resources are our lakes and rivers. One of the worst things that can happen to surface water is direct pollution - a typical example of this is the fire at Schweizerhalle in Basle, Switzerland and the result it had on the River Rhine. Even without direct pollution our waters are still subject to varying degrees of contamination that have a direct negative bearing on the life forms that these waters support.

In an attempt to compensate the effects of our modem world, and to maintain indigenous fish stocks, it has become standard practice to introduce stocking programs for lakes and rivers that are in danger of becoming fishless. Depending on the water in question, these stocking activities can be anything from a short-term program lasting a few years until a water has re-established itself, or a permanent restocking program to meet commercial or sporting needs.

Methods

In the Canton of Zurich many different types of fish are reared to replenish stocks in the area's rich abundance of rivers and lakes. One of the hatcheries involved in these stocking activities is located in the village of Greifensee on the shore of Lake Griffin (translation of Greifensee) from which the water for the hatchery is drawn. The quality of the water contained in any lake or river is continually changing - this partly due to natural causes and partly to pollution. In order to achieve the highest possible efficiency it is essential that the inlet water to a hatchery be clean, free from contamination and micro-organisms that could damage the fish stock being reared. In the Greifensee hatchery the water has been treated with ozone for many years with excellent results. The basic layout of the hatchery is as follows:



Schematic diagram of the Greifensee hatchery

As already mentioned the hatchery water is drawn directly from the Lake Griffin and pumped into contact chambers - these were initially fitted with porous diffusers and later fitted with an apparatus very similar to a radial diffuser. Following ozonation in the contact chambers, the water is pumped through a sand filter in order to remove any fine materials carried along with the water flow and any precipitated or flocculated matter. Finally, the water is passed through an activated carbon filter in order to remove traces of residual ozone, biodegradable by-products and to adsorb non-polar substances. After treatment the water is pumped into the hatchery where it is distributed to the ova hatching trays and fry tanks.

The hatchery in Greifensee is in a position to rear virtually any type of freshwater fish depending on requirement. As a rule, however, the demand on the individual fish types by the professional fishermen and anglers determines the actual stocking program. The main species reared are:

Brown trout *(Salmo trutta fario)*
Powan (Coregonus lavaretus)
Pike (Esox lucius)

The cultivation process follows established methods in aqua-culture: selected rearing stock is caught during the spawning season. After stripping and fertilisation, depending on the type of fish, the eyed ova are placed either in hatching flasks, or on hatching trays, where they are incubated until hatching.

It is during this critical stage that the quality of the water is of primary importance - not only is it important for the actual efficiency with regard to the <u>number</u> of ova hatched but also to the <u>quality</u> of the fry produced.

Why ozone?

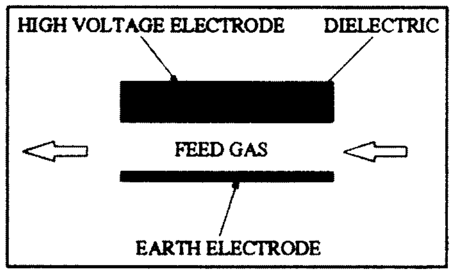
In general, the main reasons for using ozone in water treatment are:

- Partial or total oxidation of dissolved matter
- Precipitation of dissolved matter
- Micro-flocculation of organic matter
- Destabilisation of colloidal matter
- Disinfection

Unlike such agents as chlorine, or any of its derivatives, oxidation with ozone leaves no hard to handle or toxic residues requiring subsequent complex treatment. In practice, ozone immediately starts to attack the oxidisable components it comes into contact with - this property makes it a very powerful disinfectant. Because the process only leaves "oxygenated" products and oxygen it is particularly well suited for applications such as hatchery water where the presence of undesirable elements after treatment could have grave consequences.

Ozone generation

The traditional method of producing ozone is by means of Dielectric Barrier Discharge or so called Silent Electrical Discharge. Ozone generators working on this principle are basically arrangements of high voltage electrodes separated from the earth electrodes by gaps and dielectric layers:



Modem ozone generators using oxygen as the feed gas and, consequently, producing ozone at higher concentrations, are of particular interest to hatchery managers:

- The units themselves are more compact than generators using dry air as the feed gas.
- The controversial issue concerning nitrous oxides does not exist because there is hardly no nitrogen in the feed gas.
- If "Advanced Technology" dielectrics are fitted to the generator units, energy savings between 25% and 60% can be expected.

Contacting system

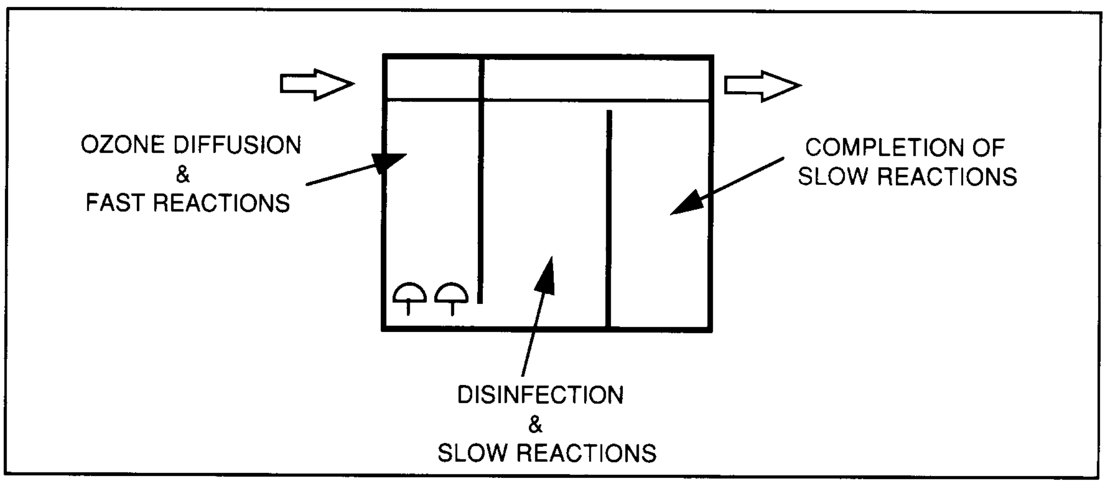
Apart from the ozone generator proper, the next most important part of any ozone plant or ozonation system is the equipment that brings the ozone in contact with the medium to be treated. The purpose of the contacting or diffusion equipment is to create a large gas / medium contact area so that, under specific conditions, the highest possible mass transfer is achieved. Basically, there are 3 methods of achieving this effect:

- *Porous diffusers* — probably the most popular method of introducing ozone
- *Radial diffusers* — specially designed equipment for use in restricted areas
- *Venturi injectors* — simple means of introducing ozone with a high transfer efficiency

Ozonation in aqua-culture is unique because it is a rare application where living creatures are exposed to disinfected water more or less immediately after it has been disinfected. Because of this, hatchery operators have to be particularly careful how they introduce ozone to the medium being treated - one of the major problems encountered with the contacting system is fry mortality caused by the overaeration of the hatchery water.

Because of this problem, operators have to look for a system that will ensure the maximum mass transfer (ozone to water) without introducing large quantities of non-ozone gas to the water. Of the 3 popular methods of diffusion only 2 come into question for this application: the **porous diffuser** and the **radial diffuser.** The **venturi injector,** although it has a high transfer efficiency, is unsuitable because it introduces large quantities of ozone generator feed gas to the water that could cause fry mortality.

A typical contact system for hatchery application will have 3 chambers. The first chamber is a counter flow diffusion chamber where the ozone is introduced. In this chamber the fast oxidation processes, i.e. the oxidation of dissolved matter such as iron and manganese, and a fraction of the slow reactions takes place. The second reaction volume, without diffusers, is designed for the disinfection and the slow chemical reactions. The last chamber is where the slow reactions are completed and a major portion of the residual ozone decomposes.



Typical ozone contacting system

Conclusion

Experience gained over the years with numerous plants have provided a better understanding of the criteria relating to applications in aqua-culture. In the future an increase in the use of ozone is expected not only in fish hatcheries but also in:

- Farms where fish are reared to a certain size and then culled for culinary purposes
- Salmon smolt stations
- Large domestic and zoo aquariums
- Tanks for other aquatic species such as dolphins, seals, etc.

Ultimately, circulating closed systems will become the norm and the ecological loading sometimes associated with fish farming will also be avoided.

Keywords

Ozone, Advanced Technology, Disinfection, Aqua-culture, Hatcheries, Porous diffuser, Contacting system.

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