RAMSAY WRIGHT ZOOLOGICAL BUILDING
DE-CHLORINATING WATER SYSTEMS
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Preface

To understand the need for water filtration in the Ramsay Wright Zoological Labs, one must understand the causes of death and disease in fish and invertebrates. In natural water, fish and invertebrates are subjected to seasonal temperature changes, bacteria, pollutants and parasites.

In order to raise a stable fish population in a closed environment all toxic metabolites must be removed and the water temperature must be maintained reasonably constant. If these conditions are not maintained the fish population will be subject to many biological causes of death, such as osmotic imbalance, thermal shock, and partial asphyxiation. The above deterioration in environment can also cause lower disease resistance, stunting, and loss of fecundity.**(1)**.

Municipal Water Filtration and Treatment

Municipal water supplies are filtered and treated with chemicals to kill pathogens and parasites. The City of Toronto has been using Chloramine as an alternative to Chlorine disinfection and its by-products for the last 14 years. This is done mainly for two reasons: First, chloramines control bacterial growth, both in the plant and the distribution system; and second chloramine disinfection replaces chlorine disinfection and reduces the formation of trichalomethanes (THMs) that result when chlorine reacts with naturally occurring organic matter.

Chloramines exist in the water in three forms - monochloramine, dichloramine and trichloramine. The particular chloramine that is produced depends upon the pH levels and the chlorine to nitrogen (Cl:N) ratios in the water. At low pH levels (around 4) with Cl:N ratios, the primary reaction product is trichloramine. At a pH level above 4 but less than 5 and a moderate Cl:N ratio, dichloramine formation will occur. Finally, when the pH levels exceeds 6, monochloramine formation will occur.

Since the pH of most drinking water supplies is neutral or above, that is 7 or higher, the overwhelming majority of chloramines in drinking water are monochloramines.**(14)**.

De-chlorination By Activated Carbon

Traditional activated carbon filters provide one solution but have limitations. The complication arises from the fact that monochloramines are highly stable in nature, making them the most difficult type of Chloramine to remove. The carbon surface (C) reacts with monochloramine to reduce it to ammonia and oxidize the carbon surface to form surface oxygen groups (CO_2). It is these groups that can mask the catalytic activity of the activated carbon.

Particle size (EBCT) of activated carbon, temperature of fluid and contact time between carbon and fluid all affect the performance of the filter in removing monochloramines. Because the destruction of monochloramines is a catalytic reaction, increasing the temperature of the fluid reducing particle size of the carbon and increasing the contact time all will increase the efficiency of the filter.

There are Four types of activated carbon available the cost of which increases proportionally with the effectiveness.
The least effective activated carbon is made from coconut shells.
The next most effective activated carbon is made from lignite.
The second best activated carbon is made from bituminous coal.
The best and most expensive is catalytic carbon made from bituminous coal.

Caution: **"All carbon is highly alkaline as it contains a large amount of ash". The ash content in carbon determines the residual alkalinity of the product fluid. Carbon with 12% to 15% ash content can have a pH of 9 toll. Carbon with 4% ash content will have a pH of less than 8. To reduce the ash content and lower the alkalinity in carbon it must be washed in acid.**
When ordering activated carbon specify "Acid Washed".

Catalytically enhanced bituminous coal-based carbon requires a fifth of the time of conventional bituminous coal-based carbons, 1/10th the time of lignite-based carbons and less 1/15th the time of wood and coconut- based carbons to absorb the same amount of material.**(14)**.

Water Filtration and De-gasification in Relation To The Ramsay Wright Labs

The Ramsay Wright Labs contains three de-chlorinating activated carbon filters, each of which have sixty-three square feet of filtering surface, thirty-six inches in depth, one hundred and ninety one cubic feet in volume, with approximately thirty-six inches of graduated anthrfilt below it. Each filter has a nominal capacity of 165 gpm. They are usually operated two filters in series, one as a pre-filter and one as a polisher. The third filter is on standby. These filters must be back-washed when the pressure differential reaches 3-5 psi or every Monday. The backwash must be accomplished using a flow of380 gpm. at 60 psi for 10 minutes. The rinse must be accomplished at 165 gpm for eighteen minutes. After backwash the filter bed must have expended in volume by 30%.**(2)**.

The filters must be inspected once for every month of operation, after they have been back-washed. The filter bed must be expanded and surface must be free of channeling and blowholes. If the filter bed surface is uneven or coated with slime the latter must be removed and the bed must be groomed.**(3)**.

The de-chlorinated water after passing through the filters is used both in a hot and cold state. When de-chlorinated water is heated dissolved gasses that occur naturally in most surface waters tend to come out of solution. This can cause problems in fish as the gasses can be absorbed and de-gas in their bloodstream.

This de-gassing can cause loss of equilibrium and a condition called Popeye. To prevent this from happening the hot water is passed through a de-gasifier, this strips dissolved gasses such as CO2 from the water.**(8)**.

CAUTION: **Wet activated charcoal has an affinity for OXYGEN, care must be taken to provide breathing air supply to the person working in the tank.(4).**

Chlorine Concentrations

Municipal water supplies are treated at the filtration plants. The concentration of free chlorine, residual chlorine and total chlorine values vary from 2 to 10 PPM in city water.**(5)**.

The de-chlorination filters must remove this chlorine. As chlorine is lethal at 80 PPB and toxic to fish at 70 PPB the residual chlorine after the filters may not exceed 50 PPB.**(6)**.

A "Rosemont Delta" titration meter measures residual chlorine. This meter on its lowest scale can measure from 0 to 100 PPB. The usual reading on the meter at this scale is 4 to 9 PPBS.

The pH of the cold water leaving the filter is usually 7.2, "Lethality of Chloramins and ammonia is presently under review".

Regeneration of Activated Charcoal

Regeneration of activated charcoal can be accomplished by heating the filter with live steam for a period of not less then 4 hours; dry heat in itself cannot drive the chlorine from the activated carbon granules.**(8)**. Care must be taken to make sure the steam does not contain either alkameen or filameen.**(9)**. Alkameen's active ingredients are Morpholine and cyclohexilamine. Human exposure criteria for Morpholine are 20 PPM, TLV: for cyclohexilamine it is 10 PPM, TLV. Human LDLO for the active ingredients is 50 mg /kg.**(10)**. Steam regeneration of the filter can be accomplished several times. Filter media should be replaced every 3 years or when breakthrough of chlorine occurs.**(11)**.

Placing Filters in Operation

After back-washing and/or steaming and/or repeated draining of filter media, it tends to retain a large amount of dissolve gases. After all backwashing the filters must be rinsed and the water must be checked for minute bubbles. If such bubbles are seen clinging to the sides of the container used in sampling, continue rinsing until they are gone.**(12)**.

After steaming, let the filter sit for 72 hours flooded before attempting to rinse and place in service.**(12)**. Whenever a filter is about to be placed in service, the administrator and the animal supervisor of the Zoology building must be informed. The water in the aquatic areas must be diverted from the tanks to drain so that no accidents occur.

References and Bibliography

(1) Fish and Invertebrate culture management in Closed Systems. By Stephen H. Spotte.
(2) Graver maintenance Manual for De-chlorinating Carbon Filters.
(3) By experience from filter operation.
(4) Disclaimer by Calgon filter media distributor
(5) City of Toronto guidelines for water treatment.
(6) As outlined by the toxicology Blue Book
(7) As (2)
(8) As determined by experience and confirmed by Dearborn test and letter of December 18, 1987.
(9) As quoted by Debra "confidential material safety data sheet" under the trade name "Alkameen".
(10) As determined by maintenance manual and experience.
(11) As determined by experience.
(12) As reported in the Water conditioning and Purification Article on catalytic carbon by "Ed Brokrnan".