# Using an Oxygenating and Degassing Column to Improve Water Quality in Salmonid Hatcheries

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**Abstract**

Oxygenating and degassing columns, simple effective devices for economically adding oxygen to water, have been used successfully in aquaculture. Increasing the oxygen content of water enables fish culturists to increase fish loads and improve the rearing environment. Tests conducted in the present study were to evaluate the effectiveness of the column, injected pure oxygen or air into, at a rainbow trout hatchery. For this purpose, concentration of dissolved oxygen and carbon dioxide in the column outflow were monitored. Although injecting pure oxygen increased the oxygen concentration and reduced the carbon dioxide, injecting air had a little effect on the carbon dioxide level. Notwithstanding, the oxygen and carbon dioxide concentrations were not high enough to affect fish production, we recommended that users of the air injected column closely monitor the concentration of the gases to avoid from negative effects.

**Keywords:** Oxygenating and degassing column, dissolved oxygen, dissolved carbon dioxide, salmonid hatchery.

## INTRODUCTION

A hatchery is that part of a farm or a specialized type of farm where the early incubation and hatching of eggs takes place. A characteristic feature of a good hatchery is the quality of its water supply. Although dissolved oxygen (DO) is generally adequate in flow-through systems where the water supply is abundant and vegetation is limited, low DO can occur in facilities pump water from wells [1].

The maintenance of adequate (DO) is particularly desirable for fish health; DO should exceed 5 ppm for warm-water fish and 6 ppm for coldwater fish [2]. Water for salmonid hatcheries usually has 100 per cent oxygen saturation [3]. Davis [4] reviewed the literature on the effects of low DO on salmonids and established safe criteria for the required DO (a minimum DO of 7.75 mg/L for a high level of safety).

Ground water supplies may be not only poorly oxygenated but also supersaturated with nitrogen, carbon dioxide and oxygen. Supersaturation of around 107 per cent can cause gas bubble disease and mortality of fish. So, such water has to be degassed by suitable means. In addition, the concentration of $CO_2$ has to be maintained below 10 mg/l [3]. It was reported that well water supplying a hatchery at Leavenworth, Washington showed dissolved nitrogen levels at 144% of saturation [5]. In Canada, the Federal Department of Fisheries and Oceans listed elevated levels of dissolved gas saturation in several wells which are used as hatchery water supplies in the Salmonid Enhancement Program [6].

The objective of this study was to determine the effectiveness of a new designed oxygenating and degassing column in order to increase DO. By this way, it was also aimed to present a device in order to help to design engineers and hatchery managers who would like to build oxygenating columns to meet specific needs in hatcheries.

## MATERIALS AND METHODS

The hatchery system was consisted of 6 tanks with a capacity of 700 L. City water was run trough a series of activated carbon filters for dechlorination and then into a water canal. The water was then gravity fed to each tank with a flow rate of 2 l/min per tank. The oxygenating system was designed to increase oxygen saturation by setting the rate of oxygen or air addition to the supply water [7].

The column was constructed out of a 1mm thickness of chrome sheet and 1.5m of depth. Bottom, distribution and support plates were also made out of chrome sheet. Inlet and outlet of the column were drilled and threaded to accommodate a 5cm diameter of chrome pipe. The oxygen flow from a compressed oxygen cylinder or air flow from an air pump was directed into the column trough a membrane diffuser. DO and carbon dioxide concentrations in the column outflow were hourly measured. All DO measurements were taken using an oxygen meter. Dissolved carbon dioxide in water was measured by water analysis test kit (Merck).

## RESULTS AND DISCUSSION

Potential sources of water for hatchery may be oxygen deficient (underground or spring water) or have an excess of oxygen (pond water during the day) and may be therefore need oxygenating or degassing before being fed into the rearing system. Other dissolved gases such as nitrogen ($N_2$) are toxic above 100% saturation, carbon dioxide gas ($CO_2$) at over 10 mg/l, hydrogen sulphide ($H_2S$) at over 3µg/l and hydrocyanic acid at above 10µg/L. Toxicity increase when the oxygen level in the water nears its limits for alevins and juveniles; $CO_2$ is more toxic when oxygen is deficient.

Fish hatcheries require water of the highest quality. Of all the dissolved gases, oxygen usually attracts most attention

from fish farmers: the concentration in the water decreases as temperature, salinity and altitude increase. It is generally advised that oxygen concentration should be close to saturation (>70 to 80%). To improve DO in aquaculture, researchers have developed and tested several mechanisms that either air or pure oxygen [7]. The addition of atmospheric air to water can increase DO but can also cause gas supersaturation, which can be detrimental to fish [8]. The injection of oxygen not only increases DO, but also reduces nitrogen and carbon dioxide concentrations [9].

In the present study, the oxygenating and degassing column was designed and after installed at the rainbow trout hatchery (Fig. 1).

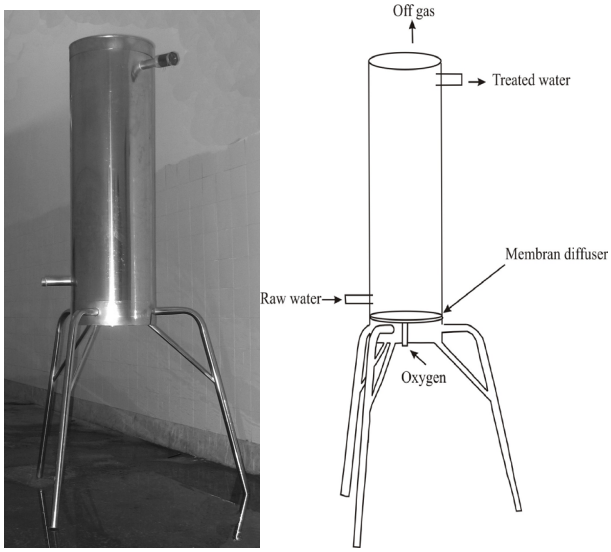


**Figure 1.** Diagram of the oxygenation and degassing column installed at the rainbow trout hatchery.

Performance of the column, injected pure oxygen or air into, at a rainbow trout hatchery was showed in Fig. 2 and 3. The treatment of no injected any gas or air was accepted as a control group. Dissolved oxygen and carbon dioxide concentrations in the column outflow were monitored. Although injecting pure oxygen increased the oxygen by around 29% and reduced the carbon dioxide concentration by around 18%, injecting air increased the oxygen by around 23% and reduced the carbon dioxide concentration by around 0.2%.

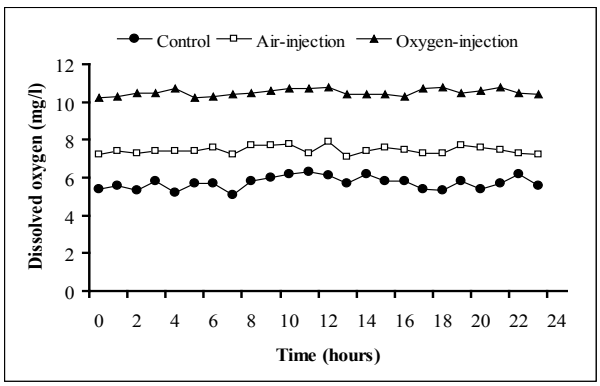


**Figure 2.** Dissolved oxygen concentrations in column effluent.

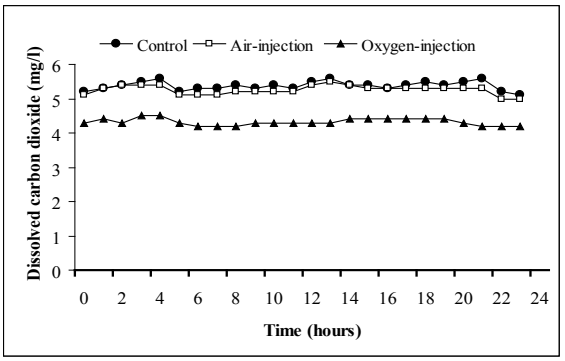


**Figure 3.** Dissolved carbon dioxide concentrations in column effluent

In conclusion, it was showed that a simple degassing and oxygenation column can be successfully used in oxygenation of the water and the elimination of carbon dioxide from water in rainbow trout hatcheries.

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