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Responsibility

Dissolved gas conditioning for mine water utilization

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By Steven Summerfelt, Ph.D. and Brian Vinci

Arctic char hatchery supplies data on dissolved gas concentrations

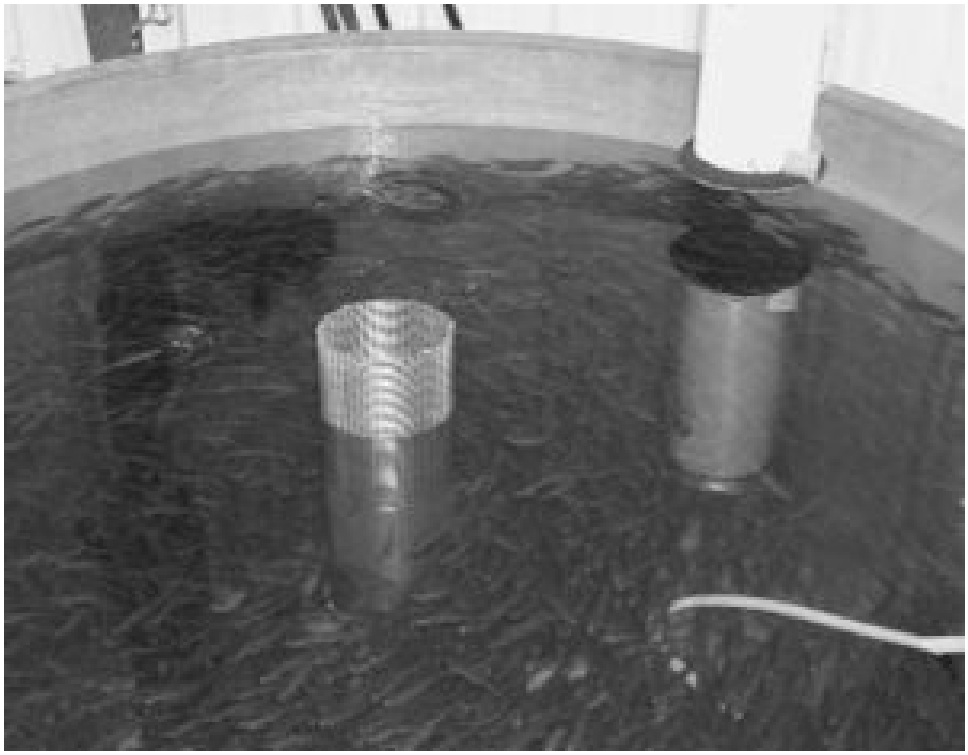
Mine water is pumped to an aeration column built into the top of a reservoir tank located above the MCRA Hatchery building where arctic

char are cultured.

Water pumped or flowing by gravity out of coal mines is now used for fish culture in West Virginia, Maryland, and Pennsylvania, USA. However, these mine water flows can contain levels of dissolved carbon dioxide and/or nitrogen gas that are too high for fish culture.

Gas bubble trauma in fish can result from high total dissolved gas super-saturations. Nitrogen saturation levels as low as 102 to 103 percent can affect juvenile fish. Nitrogen gas super-saturation problems can occur when water is heated and not allowed to come to equilibrium with dissolved gases or when air comes into contact with water at greater than atmospheric pressure, which can be the case in certain underground mines or if air is suctioned with water into a pressurized pipeline.

Ventilated cascade columns strip and decrease dissolved nitrogen gas to levels closer to atmospheric saturation. Pure oxygen transfer columns and vacuum degassing columns can be used to drive dissolved nitrogen gas concentrations down to sub-saturation levels.



This culture tank has a microbubble oxygen diffuser for emergency use.

Carbon dioxide

Safe levels of dissolved carbon dioxide depend upon the fish species, developmental stage of the fish, and other water quality variables including alkalinity, pH, and dissolved oxygen levels. Dissolved carbon dioxide begins to affect salmonids at concentrations greater than 20 milligrams per liter.

High levels of dissolved carbon dioxide can occur if mine geology includes limestone deposits, especially if mineral acidity is present to decrease the water's pH. Dissolved carbon dioxide can be stripped into the surrounding atmosphere if there is enough air water contact.

Ventilated cascade columns are often used to strip dissolved carbon dioxide because they can be easily designed to contact the 5 to 10 volumes of air required per unit volume of water flow.

Water is broken into droplets as it flows
through a counter-current forced-air
cascade stripping column installed in the top portion of a water reservoir tank at the MCRA Hatchery.

Case study

In a case study, the Mingo County Redevelopment Authority Hatchery near Delbarton, West Virginia, is supplied with up to 3 square meters per minute of water pumped from an abandoned portion of an active coal mine. The hatchery is raising arctic char for West Virginia Aqua LLC. Tina Rimmer, general manager at West Virginia Aqua LLC, supplied data on dissolved gas concentrations at the facility.

The mine water contains 40 to 80 milligrams per liter of dissolved carbon dioxide, a result of the water's high alkalinity – approximately 400 milligrams per liter as calcium carbonate. In addition, a severe dissolved nitrogen super-saturation problem could occur if the mine dewatering pump suctioned air into its pump intake, which is a real possibility during droughts. The mine water contains almost no iron, aluminum, or manganese and is nearly ideal for salmonid culture if not for its elevated levels of dissolved gases.

Before water enters the fry tanks, a nonpressurized packed oxygen column (behind culture tanks in this picture) adds pure oxygen to the water while driving out dissolved nitrogen.

To prevent dangerous levels of dissolved gases from entering the hatchery, a counter-current cascade-stripping column was built in the top portion of a water reservoir tank installed directly above the grade of the hatchery building. This stripping column at the top of the reservoir tank has successfully maintained the dissolved carbon dioxide at levels below 20 milligrams per liter while also stripping some excess dissolved nitrogen saturation from the water supplied to the hatchery. From the inlet of 150 to 160 percent nitrogen saturation flows an outlet of less than 110 percent saturation.

A non-pressurized oxygen column and low-head oxygenator were installed within the hatchery building to treat the water before it enters the fry and fingerling tanks, respectively. These columns were designed to drive dissolved nitrogen to below saturation levels, while adding dissolved oxygen to levels of 120 to 200 percent saturation.

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Authors

STEVEN SUMMERFELT, PH.D.

Conservation Fund Freshwater Institute
1098 Turner Road
Shepherdstown, West Virginia 25443 USA

s.summerfelt@freshwaterinstitute.org (mailto:s.summerfelt@freshwaterinstitute.org)

BRIAN VINCI

Conservation Fund Freshwater Institute
1098 Turner Road
Shepherdstown, West Virginia 25443 USA