Dissolved Oxygen and Alberta Lakes

Highlights

- Dissolved oxygen (DO) is very important to the health of aquatic ecosystems.
- Cold water can hold more dissolved oxygen than warm water.
- Dissolved oxygen can fluctuate greatly in short periods of time.
- There are many factors that influence dissolved oxygen.

What is dissolved oxygen?

Dissolved oxygen refers to oxygen existing in a "free" or unbound (not part of other compounds) form or state in water or other liquid. The solubility of oxygen is the degree or ease to which oxygen can dissolve in water, wastewater, or other liquid.

Temperature directly affects the solubility of oxygen in water. When the temperature of water increases, a portion of oxygen converts from liquid state to a gas. Thus the ability of water to maintain oxygen in dissolved state decreases with increasing temperature. As a result, colder water can potentially contain more dissolved oxygen than warm water.

Oxygen usually enters a lake or stream at its surface (atmospheric oxygen) and by photosynthesizing aquatic plants, including algae and cyanobacteria.

What is a dissolved oxygen test?

A dissolved oxygen test provides an indication of the amount oxygen freely available to the aquatic environment.

For the dissolved oxygen test in the Alberta Water Quality Monitoring Day kit, tablets are added to a sample of water. After about 5 minutes the water will change color. The color of the water provides an indication of the amount of dissolved oxygen.

This test is a screening test and will only give ballpark indications of poor, fair, and good water quality. If you want more accurate measurements or need a higher range, you could use a Winkler Titration kit that would be more expensive and require more careful handling.

What is the normal range of dissolved oxygen in Alberta lakes?

Due to temperature changes or large amounts of plants, algae and cyanobacteria, dissolved oxygen levels can fluctuate throughout the day. Dissolved oxygen can also change significantly from day to night.

Most lakes should be well oxygenated during the AWQA day sampling as the recent disappearance of ice cover, mixing of the whole lake from top to

Temp and DO

Cold water can hold more dissolved oxygen than warm water. For example, water at 20 degrees Celsius will be 100% saturated (can not hold any more) with 8 parts per million dissolved oxygen. Water at 8 degrees Celsius can hold up to 12 parts per million of oxygen before it is 100% saturated.

bottom, and lack of decomposing aquatic plants, algae and cyanobacteria, occur at this time of the year.

What decreases dissolved oxygen in lakes?

- Increasing water temperature. Warm water can hold less dissolved oxygen.
- High levels of bacteria from sewage pollution.
- Large amounts of rotting plants, algae and cyanobacteria.
- High salinity
- Winter ice cover

What increases dissolved oxygen in lakes?

- Decreasing water temperature. Cold water can hold more dissolved oxygen.
- High altitude
- Wind turbulence

Why is dissolved oxygen important?

Dissolved oxygen is important to the health of aquatic ecosystems and is considered to be the most important measurement of water quality. All aquatic animals need oxygen to survive. Natural waters with consistently high dissolved oxygen levels are most likely healthy, stable environments, able to support a wide variety of plants and animals. In addition, high levels of dissolved oxygen prevent the production of offensive odors.

Adequate concentrations of dissolved oxygen are necessary to support fish and other aquatic organisms. Oxygen is also necessary for "aerobic" metabolism by bacteria responsible for microbial decomposition of dead plant and animal matter within a lake, river stream or reservoir. In the absence of oxygen, "anaerobic" bacteria (bacteria capable of living without oxygen) will take over decomposing dead matter. Unfortunately, anaerobic bacteria generate odorous compounds including methane and hydrogen sulfide gases as byproducts.

Low oxygen concentrations can be damaging to a variety of critical life stages of aquatic animals, including larval invertebrates, and fish eggs and fry. Like temperature, organisms differ in their tolerance to low dissolved oxygen levels. The ideal dissolved oxygen level for fish is between 7 and 9 milligrams per liter (mg/L); most fish cannot survive at levels below 3 mg/L of dissolved oxygen. Alberta Surface Water Quality Guidelines suggest dissolved oxygen concentrations must not decline below 5 mg/L and should not average less than 6.5 mg/L over a seven-day period. However, the guidelines also require that dissolved oxygen concentrations remain above 9.5 mg/L in areas where early life stages of aquatic biota, particularly fish, are present. Anoxic (depleted oxygen) conditions can result in fishkills, which is particularly common during harsh winters with extended ice-cover.

What influences dissolved oxygen in surface waters?

As mentioned above, the amount of oxygen dissolved in a given volume of water is dependent on the **water's temperature**, as temperature affects oxygen solubility. Aside

from temperature, other factors can also affect the amount of oxygen dissolved in water. **Altitude** directly influences air pressure and thus, indirectly impacts the solubility of oxygen in water. With all other conditions being equal, high altitude lakes potentially contain more dissolved oxygen than similar lakes at lower elevations. **Salinity** also reduces the solubility of oxygen in water, hence saline lakes can contain less oxygen than freshwater lakes (all other factors being equal of course).

Atmospheric oxygen enters at the waters' surface. The amount of oxygen mixing with water is dependent on **wind turbulence** in lakes. Large wind-swept lakes are usually well oxygenated compared to smaller lakes and ponds that are sheltered from winds. . **Winter ice cover** blocks atmospheric oxygen from mixing with surface waters. Lakes and large, slow-flowing rivers with an **abundance of plants and algae** can have extremely low oxygen concentrations under ice cover due to decomposition, which consumes oxygen. When a lake is frozen, the entire water column can become anoxic because the surface is sealed off from the atmosphere.

Aquatic plants produce significant amounts of oxygen during daylight hours. With an increasing abundance of plants, algae and cyanobacteria the greater potential there is for oxygen production. However, there is another side to this story as plants, algae and cyanobacteria respire at night, which consumes oxygen. Because of this, aquatic ecosystems with an abundance of plant production can have extremely low oxygen concentrations just before dawn. As well, the microbial decomposition of dead plant matter consumes oxygen.

Some industrial and municipal discharges and effluents contain organic compounds that can be degraded by bacteria, which as we know, consumes oxygen. Biological oxygen demand (BOD) measures the amount of biologically degradable material present in organic wastes by determining the amount of oxygen consumed over a period of time through normal biological decomposition. Other discharges and effluents contain non-biodegradable compounds that can chemically bind up or otherwise remove the oxygen from a free state. Chemical oxygen demand (COD) is a measure of the amount of organic substances in water or wastewater with the potential to bind oxygen. Hence, industrial and municipal discharges and effluents can impact the oxygen content of receiving waters with time. Secondary and advanced wastewater treatment techniques are generally designed to ensure adequate dissolved oxygen in waste-receiving waters.