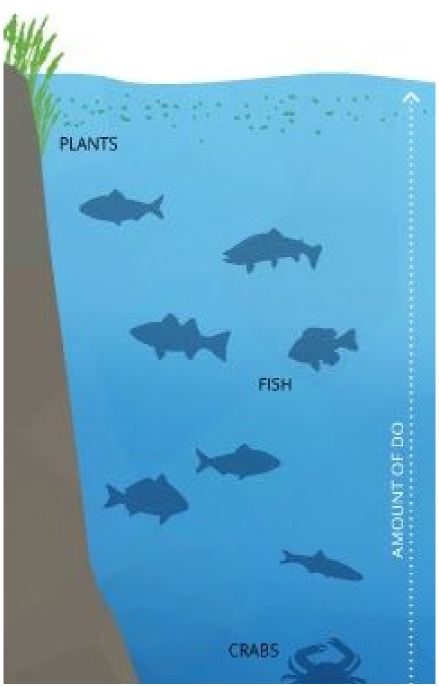
Brayden Santa Barbara

Chemistry IA

What is the most suitable dissolved oxygen content in water for freshwater fish using the winkler method?

Research Question: What is the most suitable dissolved oxygen content in water for freshwater fish using the winkler method?

Personal Engagement: Being an avid fisherman, I was interested in conducting this study on the different oxygen levels of water to see which were suitable enough for fish because I noticed a long stream connecting to a larger pond near where I live, and saw that there were no fish in it. I then decided to find the oxygen content in this water sample as well as others in the area using the Winkler Method. The Winkler test is used to determine the concentration of dissolved oxygen in water samples. Dissolved oxygen is widely used in water quality studies and routine operation of water reclamation facilities to analyze its level of oxygen saturation. The dissolved oxygen in the sample is "fixed" by adding a series of reagents that form an acid compound that is then titrated with a neutralizing compound that results in a color change. The point of color change is called the "endpoint," which coincides with the dissolved oxygen concentration in the sample. Dissolved oxygen analysis is best done in the field, as the sample will be less altered by atmospheric equilibration.



Background: The concentration of dissolved oxygen can be readily, and accurately, measured by the method originally developed by Winkler in 1888 (Ber. Deutsch Chem. Gos., 21, 2843). Dissolved oxygen can also be determined with precision using oxygen sensitive electrodes; such electrodes require frequent standardization with waters containing known concentrations of oxygen. They are particularly useful in polluted waters where oxygen concentrations may be quite high. In addition, their sensitivity can be exploited in environments with rapidly-changing oxygen concentrations. However, electrodes are less reliable when oxygen concentrations are very low. For these reasons, the Winkler titration is often employed for accurate determination of oxygen concentrations in aqueous samples.

Dissolved oxygen is necessary to many forms of life including fish, invertebrates, bacteria and plants. These organisms use oxygen in respiration, similar to organisms on land. Fish and crustaceans obtain oxygen for respiration through their gills, while plant life and phytoplankton require dissolved oxygen for respiration when there is no light for photosynthesis 4. The amount of dissolved oxygen needed varies from creature to creature. Bottom feeders, crabs, oysters and worms need minimal amounts of oxygen (1-6 mg/L), while shallow water fish need higher levels (4-15 mg/L)[5].

Microbes such as bacteria and fungi also require dissolved oxygen. These organisms are used to decompose organic material at the bottom of a body of water. Microbial decomposition is an important contributor to nutrient recycling.

1. Dissolved Oxygen by the Winkler Method

2.DETERMINATION OF DISSOLVED OXYGEN BY WINKLER TITRATION

Procedure: Carefully fill a 300-mL glass Biological Oxygen Demand (BOD) stoppered bottle brim-full with sample water.

1. Immediately add 2mL of manganese sulfate to the collection bottle by inserting the calibrated pipette just below the surface of the liquid. (If the reagent is added above the sample surface, you will introduce oxygen into the sample.) Squeeze the pipette slowly so no bubbles are introduced via the pipette.
2. Add 2 mL of alkali-iodide-azide reagent in the same manner.
3. Stopper the bottle with care to be sure no air is introduced. Mix the sample by inverting several times. Check for air bubbles; discard the sample and start over if any are seen. If oxygen is present, a brownish-orange cloud of precipitate or floc will appear. When this floc has settle to the bottom, mix the sample by turning it upside down several times and let it settle again.
4. Add 2 mL of concentrated sulfuric acid via a pipette held just above the surface of the sample. Carefully stopper and invert several times to dissolve the floc. At this point, the sample is "fixed" and can be stored for up to 8 hours if kept in a cool, dark place. As an added precaution, squirt distilled water along the stopper, and cap the bottle with aluminum foil and a rubber band during the storage period.
5. In a glass flask, titrate 201 mL of the sample with sodium thiosulfate to a pale straw color. Titrate by slowly dropping titrant solution from a calibrated pipette into the flask and continually stirring or swirling the sample water.
6. Add 2 mL of starch solution so a blue color forms.

7. Continue slowly titrating until the sample turns clear. As this experiment reaches the endpoint, it will take only one drop of the titrant to eliminate the blue color. Be
8. especially careful that each drop is fully mixed into the sample before adding the next. It is sometimes helpful to hold the flask up to a white sheet of paper to check for absence of the blue color.
9. The concentration of dissolved oxygen in the sample is equivalent to the number of milliliters of titrant used. Each mL of sodium thiosulfate added in steps 6 and 8 equals 1 mg/L dissolved oxygen.

Data:

Location of Water Sample	Oxygen Content (AVG.)	Fish Present At Location (Y/N)
Lake Quonnipaug-Guilford	9.72 mg/L	Y
Stream Behind House-Guilford	0.71 mg/L	N
Chatfield Hollow-Killingworth	12.3 mg/L	Y
Chestnut Hill-Madison	1.2 mg/L	N

1. Dissolved Oxygen by the Winkler Method
2. Dissolved Oxygen - Environmental Measurement Systems

Data Uncertainty: The main issue with this experiment is that the larger bodies of water that I studied, such as lake quonnipaug, could have had a range of O_2 contents based on the specific area the water was taken from. I did not have the means to sample the entirety of the lake so the data collected is helpful as an estimate of the oxygen count in the water, but not an exact representation of the entirety of the lake.

Conclusion: Based on the research conducted, the bodies of water with larger amounts of fish had higher levels of oxygen present. The results of the experiment were not enough to make a definite conclusion on the reason fish were not present at certain locations and present at others, but the data can give us an idea of the most suitable oxygen levels for freshwater fish to survive. The locations with large amounts of fish had about 9.72 and 12.3 mg/L of oxygen. The locations with no fish had oxygen levels of 0.71 and 1.2 mg/L. This experiment further proves the theory that the most suitable levels of oxygen for freshwater fish are between 5-15 mg/L, while levels below and above are not.

Works Cited:

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