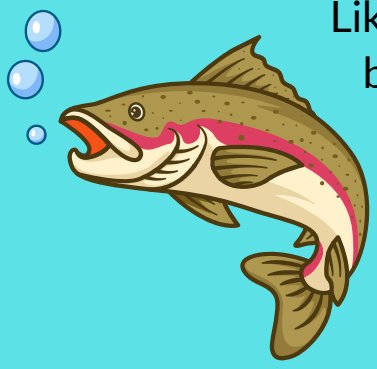
DISSOLVED OXYGEN

Community Science Institute
Partnering with Communities to Protect Water

WHAT IS DISSOLVED OXYGEN?

Water (H_2O) has one atom of oxygen for every 2 atoms of hydrogen, but that oxygen is not available to aquatic life. Dissolved oxygen refers to the amount of oxygen that is present in the water as O_2. This oxygen can come from the atmosphere or from aquatic plants or algae, which give off oxygen just like land plants do.

WHY DO WE MEASURE DISSOLVED OXYGEN?

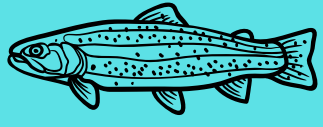


Like humans, most aquatic organisms need oxygen to breathe. In bodies of water, this oxygen occurs in a dissolved form. We measure dissolved oxygen because it is a good indicator of how suitable an aquatic ecosystem is for organisms like fish, amphibians, and invertebrates.

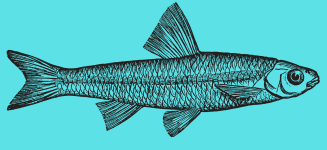
Levels of dissolved oxygen may be higher in what we call “riffles,” or fast-moving parts of a stream that run over rocks. That is why CSI’s biological monitoring volunteers always look for benthic macroinvertebrates, or “stream bugs,” near a riffle.

If dissolved oxygen levels are too low, little to no aquatic life is able to survive. Low-oxygen conditions, or “hypoxic conditions,” can be referred to as “dead zones” because they are unable to sustain most life. The following organisms develop optimally with dissolved oxygen at or above the following levels:

Daphnia sp. (water fleas)
6 mg/L dissolved oxygen



Rainbow trout
7 mg/L dissolved oxygen



Fathead minnows
5 mg/L dissolved oxygen

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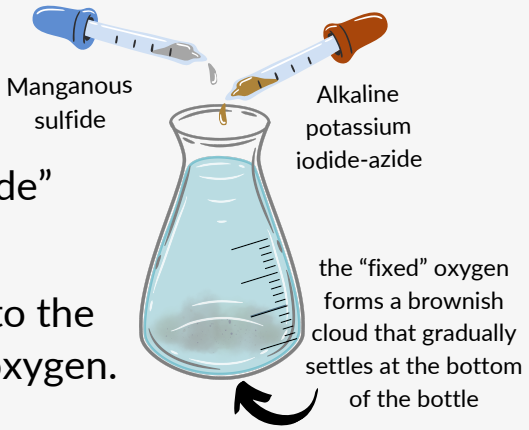
HOW DO WE MEASURE DISSOLVED OXYGEN?

Dissolved oxygen is measured using the Winkler method. First, chemicals are added that "fix" the oxygen, or cause the oxygen to bind to the manganese in one of the reagents to prevent its concentration from changing. Then, the solution is titrated to determine dissolved oxygen concentration in the sample.

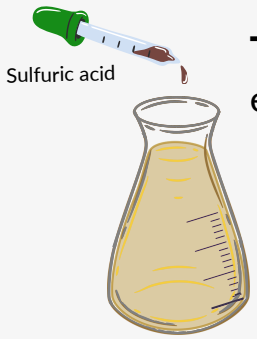
"Fixing" the oxygen



First, a chemical called "manganous sulfate" and a chemical mixture called "alkaline potassium iodide-azide" are added to the water sample.

The dissolved oxygen present in the sample binds to the manganese in the manganous sulfate, "fixing" the oxygen.

The alkaline potassium iodide-azide serves multiple purposes in the dissolved oxygen test. First, this chemical mixture raises the pH of the water (making it more basic). Dissolved oxygen and manganese can only bind in high-pH conditions.



Then, sulfuric acid is added. Visually, this dissolves the brownish cloud evenly into the water, turning the mixture brownish yellow.

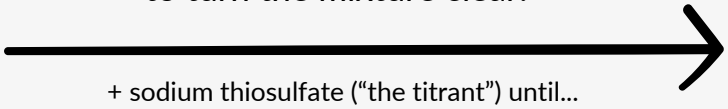
On a chemical level, the chemical reagents are separating and recombining with each other, releasing free iodine (from the "alkaline potassium iodide-azide") into the water. This free iodine is what causes the yellow-brown color in the solution.

The amount of iodine in the solution at this stage is proportional to the amount of dissolved oxygen that was present in the original water sample.

Titration

Before titrating, an "indicator" is added to turn the mixture dark purple through a reaction with the iodine. The final step is adding "sodium thiosulfate" (the "titrant") drop by drop until the solution becomes colorless.

The sodium thiosulfate reacts with the free iodine. Because the amount of iodine is proportional to the original amount of dissolved oxygen, the concentration of dissolved oxygen can be calculated based on how much sodium thiosulfate is needed to turn the mixture clear!



colorless liquid!