PURCHASING YOUR OWN KIT

Kits may be purchased directly from:
NOTE: Kits include everything except the lactose broth tubes for testing total coliform bacteria. They must be purchased separately from Connecticut Valley Biological Supply.

LaMotte Company
P.O. Box 329
Chestertown, MD 21620
(301) 778-3100
(800) 344-3100

Name: MWRA Water Quality Testing Kit
Stock #: 5863
Cost: $295.00 excluding shipping
Discount: $280.25 for purchases of ten or more

Connecticut Valley Biological Supply
82 Valley Road
Box 326
Southampton, MA 01073
(413) 527-4030
(800) 628-7748

Name: Coliform Indicator Broth Tubes
Stock #: CS-802-T
Cost: 1 - 24 tubes $1.00/tube
25 - 100 tubes $.75/tube
101 - 499 tubes $.60/tube
500+ tubes $.50/tube
Dissolved Oxygen

Dissolved Oxygen

Oxygen is critical to the survival of aquatic plants and animals, and a shortage of dissolved oxygen is not only a sign of pollution, it is harmful to the fish. Some aquatic species are more sensitive to oxygen depletion than others, but some general guidelines to consider when analyzing test results are:

- 5-6 ppm Sufficient for most species
- <3 ppm Stressful to most aquatic species
- <2 ppm Fatal to most species

Because of its importance to the fish’s survival, aquaculturists, or “fish farmers,” and aquarists use the dissolved oxygen test as a primary indicator of their system’s ability to support healthy fish.

Where Does the Oxygen Come From?

The oxygen found in water comes from many sources, but the largest source is oxygen absorbed from the atmosphere. Wave action and splashing allows more oxygen to be absorbed into the water. A second major source of oxygen is aquatic plants, including algae; during photosynthesis plants remove carbon dioxide from the water and replace it with oxygen.

Absorption

Oxygen is continuously moving between the water and surrounding air. The direction and speed of this movement is dependent upon the amount of contact between the air and water. A tumbling mountain stream or windswep, wave covered lake, where more of the water’s surface is exposed to the air, will absorb more oxygen from the atmosphere than a calm, smooth body of water. This is the idea behind aerators; by creating bubbles and waves the surface area is increased and more oxygen can enter the water.

Photosynthesis

In the leaves of plants one of the most important chemical processes on Earth is constantly occurring-photosynthesis. During daylight, plants constantly take carbon dioxide from the air, and, in the presence of water, convert it to oxygen and carbohydrates, which are used to produce additional plant material. Since photosynthesis requires light, plants do not photosynthesize at night, so no oxygen is produced. Chemically, the photosynthesis reaction can be written as:

\[
\text{Light} + n\text{CO}_2 + n\text{H}_2\text{O} \rightarrow (\text{CH}_2\text{O})_n + n\text{O}_2
\]

\[
\text{Light} + \text{Carbon Dioxide} + \text{Water} \rightarrow \text{Carbohydrate} + \text{Oxygen}
\]

Where Does the Oxygen Go?

Once in the water, oxygen is used by the aquatic life. Like land animals, fish and other aquatic animals need oxygen to breathe or respire. Oxygen is also consumed by bacteria to decay, or decompose, dead plants and animals.

Respiration

All animals, whether on land or underwater, need oxygen to respire, and grow and survive. Plants and animals respire throughout the night and day, consuming oxygen and producing carbon dioxide, which is then used by plants during photosynthesis.

Decomposition

All plant and animal waste eventually decomposes, whether it is from living animals or dead plants and animals. In the decomposition process bacteria use oxygen to oxidize, or chemically alter, the material to break it down to its component parts. Some aquatic systems may undergo extreme amounts of oxidation, leaving no oxygen for the living organisms, which eventually leave or suffocate.

Other Factors

The oxygen level of a water system is not only dependent on production and consumption. Many other factors work together to determine the potential oxygen level, including:

- Salty vs. fresh water: Fresh water can hold more oxygen than salt water.
- Temperature: Cold water can hold more oxygen than warm water.
- Atmospheric pressure (Altitude): The greater the atmospheric pressure the more oxygen the water will hold.
TESTING DISSOLVED OXYGEN

Dissolved oxygen is often tested using the Ammonium modification of the Winkler method. When testing dissolved oxygen, it is critical not to introduce additional oxygen into the sample. Many people avoid this problem by filling the sample bottle all the way and allowing the water to overflow for one minute before capping. The first step in a DO titration is the addition of Manganese Sulfate Solution (4167) and Alkaline Potassium Iodide Solution (7166). These reagents react to form a precipitate, or floc, of manganese hydroxide, Mn(OH)₂. Chemically, this reaction can be written as:

\[ \text{MnSO}_4 + 2\text{KOH} \rightarrow \text{Mn(OH)}_2 + \text{K}_2\text{SO}_4 \]
\[ \text{Manganous Sulfate} + \text{Potassium Hydroxide} \rightarrow \text{Manganese Hydroxide} + \text{Potassium Sulfate} \]

Immediately upon formation of the precipitate, the oxygen in the water oxidizes an equivalent amount of the manganous hydroxide to manganic hydroxide. In other words, for every molecule of oxygen in the water, one molecule of manganous hydroxide is converted to manganic hydroxide. Chemically, this reaction can be written as:

\[ 2\text{Mn(OH)}_2 + \text{O}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{Mn(OH)}_4 \]
\[ \text{Manganous Hydroxide} + \text{Oxygen} + \text{Water} \rightarrow \text{Manganic Hydroxide} \]

After the precipitate is formed, a strong acid, such as Sulfamic Acid Powder (6286) or Sulfuric Acid, 1:1 (6141) is added to the sample. The acid converts the manganic hydroxide to manganic sulfate. At this point the sample is considered "fixed" and concern for additional oxygen being introduced into the sample is reduced. Chemically, this reaction can be written as:

\[ 2\text{Mn(OH)}_4 + 4\text{H}_2\text{SO}_4 \rightarrow 2\text{Mn(SO)}_4 + 8\text{H}_2\text{O} \]
\[ \text{Manganic Hydroxide} + \text{Sulfuric Acid} \rightarrow \text{Manganic Sulfate} + \text{Water} \]

Simultaneously, iodine from the potassium iodide in the Alkaline Potassium Iodide Solution is replaced by sulfate, releasing free iodine into the water. Since the sulfate for this reaction comes from the manganic sulfate, which was formed from the reaction between the manganic hydroxide and oxygen, the amount of iodine released is directly proportional to the amount of oxygen present in the original sample. The release of free iodine is indicated by the sample turning a yellow-brown color. Chemically, this reaction can be written as:

\[ 2\text{Mn(SO}_4)_2 + 4\text{KI} \rightarrow 2\text{MnS}_4\text{O}_6 + 2\text{K}_2\text{SO}_4 + 2\text{I}_2 \]
\[ \text{Manganic Sulfate} + \text{Potassium Iodide} \rightarrow \text{Manganic Thiosulfate} + \text{Potassium Sulfate} + \text{Iodine} \]

The final stage in the Winkler titration is the addition of sodium thiosulfate. The sodium thiosulfate reacts with the free iodine to produce sodium iodide. When all the iodine has been converted the sample changes from yellow-brown to colorless. Often a starch indicator is added to enhance the final endpoint. Chemically, this reaction can be written as:

\[ 4\text{Na}_2\text{S}_2\text{O}_3 + 2\text{I}_2 \rightarrow 2\text{Na}_2\text{S}_4\text{O}_6 + 4\text{NaI} \]
\[ \text{Sodium Thiosulfate} + \text{Iodine} \rightarrow \text{Sodium Tetrathionate} + \text{Sodium Iodide} \]