**Determination of Dissolved Oxygen DO in water**

The term Dissolved Oxygen is used to describe the amount of oxygen dissolved in a unit volume of water. Dissolved oxygen (DO) is essential for the maintenance of healthy lakes and rivers. It is a measure of the ability of water to sustain aquatic life. The dissolved oxygen content of water is influenced by the source, water temperature, treatment and chemical or biological processes taking place in the distribution system. The presence of oxygen in water is a good sign. Depletion of dissolved oxygen in water supplies can encourage the microbial reduction of nitrate to nitrite and sulfate to sulfide. Dissolved oxygen concentration depends on physical, chemical and biological activities in the water body and its measurement provides a good indication of water quality. Oxygen is generally reduced in the water due to respiration of biota and decomposition of organic matter. Inorganic reducing agents such as hydrogen sulfide, ammonia, nitrite, ferrous iron and certain oxidation substances also tend to decrease dissolved oxygen in the water.

Drinking water should be rich in dissolved oxygen for good quality. DO test is used to evaluate the pollution strength of domestic and industrial waste. Higher values of DO may cause corrosion of Iron and Steel. Algae growth in water may release oxygen during its photosynthesis. DO test is necessary to know DO levels to assess quality of raw water and to keep a check on stream pollution. It is the basis for BOD test which is an important parameter to evaluate organic pollution potential of a waste.

Dissolved Oxygen can be measured either by titrimetric or electrometric method.

**Titrimetric Method**

Titrimetric method is based on the oxidizing property of DO while the electrometric method (using membrane electrodes) is based on the rate of diffusion of molecular oxygen across a membrane.

There are different titrimetric methods based on the nature of sample to be tested: Winkler Method With Azide Modification.

Winkler method is considered the "gold standard" for measuring the concentration of dissolved oxygen in a sample of water. Through a series of chemical reactions, the O2 combines with iodine to form a golden yellow chemical.

Therefore, each oxygen molecule is associated with an iodine molecule, and we can measure oxygen by measuring the iodine. When the iodine is neutralized by the addition of sodium thiosulfate, the golden color disappears, and we can determine how much iodine (hence oxygen) was in the sample.

Once the water sample is collected, it is important to "fix" the sample immediately. Phytoplankton, bacteria, and other organisms in the sample can quickly change the oxygen content of the sample through photosynthesis and respiration. The first step of the Winkler method is the addition of manganous sulfate (a source of manganese ions) to the sample, quickly followed by the addition of potassium iodide (a source of iodine). In the presence of the strong base, each oxygen atom binds with a manganese ion to form a manganous hydroxide complex. This reaction creates a pale precipitate that will eventually sink to the bottom of the sample container. Sulfuric acid is added to the solution to reduce the pH and dissolve the precipitate. When this occurs, free iodine is produced at a rate of one iodine molecule per manganese ion. This produces one iodine molecule for each oxygen molecule in the sample.

The final step of the dissolved oxygen measurement is a titration. In the titration step, sodium thiosulfate is slowly added to the solution until all the iodine is neutralized (color disappears). We can determine how much iodine was in the solution from the amount of thiosulfate added. Furthermore, because each iodine molecule was produced by the reaction of a single oxygen atom, the amount of thiosulfate added also tells us how much oxygen was in the sample.

**Reagents:**

Manganese sulfate, Alkali-iodide-azide, Concentrated sulfuric acid

Starch solution, Sodium thiosulfate.

**Procedure:**

1.Carefully fill a 300-mL glass Winkler stoppered bottle with sample water.

2.Immediately add 1mL of manganese sulfate to the collection bottle by inserting the calibrated pipette just below the surface of the liquid.

3.Add 1 mL of alkali-iodide-azide reagent in the same manner.

4.Stopper the bottle with care to be sure no air is introduced. Mix the sample by inverting several times. Let the sample stand for 10 minutes.

5.Add 1 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.

6.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.

7.Add 1 mL of starch solution so a blue color forms.

8.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.

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.

**Steps in the Winkler method of oxygen determination.**

1. Manganese(II) ions liberated from the manganese sulfate are loosely bound with excess hydroxide.  
http://www.lumcon.edu/education/K-12/StudentDatabase/Images/equation1.jpg  
2. Manganese(II) is oxidized to Manganese(III) in the presence of a strong base and binds the dissolved oxygen.  
http://www.lumcon.edu/education/K-12/StudentDatabase/Images/equation2.jpg  
3. Free iodine is produced upon acidification of the sample at a rate of one I2 molecule for each atom of oxygen.  
http://www.lumcon.edu/education/K-12/StudentDatabase/Images/equation3.jpg  
4. Free iodine complexes with excess iodide ions.  
http://www.lumcon.edu/education/K-12/StudentDatabase/Images/equation4.jpg  
5. The iodine/iodide complex is reduced to iodide with thiosulfate.  
http://www.lumcon.edu/education/K-12/StudentDatabase/Images/equation5.jpg