Water (prevetion and control of pollution) Act 1974 was adopted by 16 states upto 1977. The central water control board is set up to co-ordinate the work of state board and union territories.

The power and function : The functions of central pollution control board are as follows :

1. To advice the central goverment on any matter relating to the prevention and control of water pollution.
2. To collect, compile and publish technical and statistical data relating to water pollution and the measures taken to prevent it.
3. To co-ordinate the activities of the state pollution control boards.
4. To create public awareness against water pollution.
5. To lay down the standards or purification.
6. To plan and organise the training of persons engaged or to be engaged by the board.
7. To provide technical assistance and guidance to the state pollution control boards.

DISSOLVED OXYGEN

Dissolved oxygen analysis measures the amount of gaseous oxygen (O_2) dissolved in an aqueous solution. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement), and as a waste product of photosynthesis. Fish, invertebrates, plants, and aerobic bacteria all require oxygen for respiration. Much of the dissolved oxygen in water comes from the atmosphere. After dissolving at the surface, oxygen is distributed by current and turbulence. Algae and rooted aquatic plants also deliver oxygen to water through photosynthesis.

The main factor contributing to changes in dissolved oxygen levels is the build-up of organic wastes. Decay of organic wastes consumes oxygen and is often concentrated in summer, when aquatic animals require more oxygen to support higher metabolisms. Depletions in dissolved oxygen can cause major shifts in the kinds of aquatic organisms found in water bodies. Temperature, pressure, and salinity affect the dissolved oxygen capacity of water. The ratio of the dissolved oxygen content (ppm) to the potential capacity (ppm) gives the percent saturation, which is an indicator of water quality.

Environmental Impact

Total dissolved gas concentrations in water should not exceed 110 percent. Concentrations above this level can be harmful to aquatic life. Fish in waters containing excessive dissolved gases may suffer from "gas bubble disease"; however, this is a very rare occurrence. The bubbles or emboli block the flow of blood through blood vessels causing death. External bubbles (emphysema) can also occur and be seen on fins, on skin and on other tissue. Aquatic invertebrates are also affected by gas bubble disease but at levels higher than those lethal to fish.

Adequate dissolved oxygen is necessary for good water quality. Oxygen is a necessary element to all forms of life. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 5.0 mg/l, aquatic life is put under stress. The lower the concentration, the greater the stress. Oxygen levels that remain below 1-2 mg/l for a few hours can result in large fish kills.

Measurement of DO

When performing the dissolved oxygen test, only grab samples should be used, and the analysis should be performed immediately. Therefore, this is a field test that should be performed on site. Their are two methods of measurement of D.O.

1. An iodometric method commonly known as the Winkler titration.
2. An electrometric method using a Dissolved Oxygen meter.

Here we discus Winkler titration method only.

Apparatus

1. 300 mL BOD bottle(s) with stopper(s)
2. 500 mL Erlenmeyer Flask
3. Pipette (20 mL)
4. Burette

- Magnetic Stirplates and Stirbars
- Magnetic Stirbar Retriever

Reagents

1. Manganous sulfate solution
2. Alkali-iodide-azide.
3. Concentrated Sulfuric acid.
4. Starch solution – Dissolve 2 g of soluble starch in 100 mL of hot distilled water. To preserve the solution, add 0.2 g salicylic acid.
5. Sodium thiosulfate (0.025 *M*)
6. Potassium bi-iodate $KH(IO_3)_2$ - (0.0021 *M*) –
7. Potassium iodide – free from iodate

Storage / Preservation

When used for the direct determination of DO, the samples measured must be analyzed immediately. There is no method available for preservation of DO samples. Therefore, all samples are grab samples. The DO level of the sample can be *fixed* (by performing the "Preparation of Sample" step) to allow time to transport to a laboratory setting for completion of the analysis. The sample should be kept cool and protected from sunlight until the analysis can be completed.

Procedure

I. Standardization of Sodium Thiosulfate

1. In a 500 mL wide-mouth Erlenmeyer flask place 2 g potassium iodide in 100-150 mL distilled water. Swirl to dissolve.
2. Add 2 drops of concentrated sulfuric acid and 20.0 mL of standard potassium bi-iodate solution.
3. Record the initial volume of sodium thiosulfate in the burette.
4. Titrate the potassium iodide solution with sodium thiosulfate to a straw yellow color.
5. Add several drops of starch, a blue / purple color will develop. Titrate dropwise until the blue / purple color disappears (solution will become clear).
6. Record the final volume of sodium thiosulfate in the burette.
7. Calculate the volume of sodium thiosulfate used.

Note: The amount of sodium thiosulfate used should be equal to the amount of potassium bi-iodate solution titrated (20 mL). This verifies that the sodium thiosulfate is 0.025 *M* (± 0.001).

II. Preparation of Sample

1. Fill a 300 mL BOD bottle with the sample to be analyzed.
2. With a pipette, add 1 mL of manganous sulfate.
3. With a pipette, add 1 mL of alkali-iodide-azide.
4. Stopper and invert the bottle several times to mix.
5. Allow the floc in the solution to settle to about half the volume of the bottle.
6. Invert the bottle several times to mix the floc back into the solution.
7. Allow the floc in the solution to settle to about half the volume of the bottle.

8. After settling, add 1 mL concentrated sulfuric acid, stopper and gently invert several times. Continue until the precipitate has dissolved back into solution.
9. If a brown color develops, there is dissolved oxygen in the sample. If no color develops or it is very faint, it may be appropriate to obtain another sample at this time to ensure that there has not been an error in the sample preparation.

Titration

1. Pour 200 mL of the sample to be titrated in a 500 mL wide-mouth flask.
2. Record the initial volume of sodium thiosulfate in the burette.
3. Titrate with standardized sodium thiosulfate solution to a pale yellow endpoint (swirl the flask gently while titrating or use a magnetic stirrer).
4. Add several drops of starch solution and continue titrating dropwise until the disappearance of the blue / purple coloration.
5. Record the final volume of sodium thiosulfate in the burette.
6. Calculate the volume of sodium thiosulfate used.

Calculations

When a 200 mL sample is used, 1 mL of sodium thiosulfate solution (0.025 *M*) is equivalent to 1 mg/L Dissolved Oxygen in the sample. (If 8.7 mL of sodium thiosulfate was used, then the DO of the sample is 8.7 mg/L).

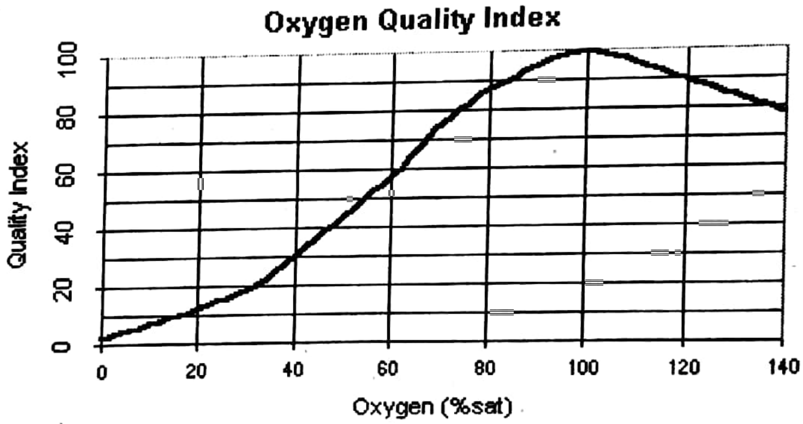

Fig 4.3. Water quality index (Note- If dissolved oxygen is greater than 140%, the quality index equals 50)

BIOCHEMICAL OXYGEN DEMAND (BOD)

(The Measure of Water Pollution)

To measure the purity of water BOD (Biochemical oxygen demand) unit is used. **BOD is the quantity of oxygen which is required by micro-organisms to decompose harmful substances present in one liter water.** BOD value of pure drinking water must be 1 ppm. When oxygen is not available according to BOD micro-organisms fail to decompose harm ful substances, then these substances are decomposed by anaerobic method and again some other harmful substances are formed, as a result of this water gives bad smell..

The BOD test is the most important measure of the polluting capacity of organic effluents. BOD is measured by keeping a sample of water containing known amount of oxygen for five days at 20° C in the dark. At the end of this period the oxygen content is again measured. A high BOD indicates intense level of microbial pollution.

BOD measures the potential of the organic matter in a sample to deplete the available dissolved oxygen. The degradation of organic matter by the microorganisms present in a water body requires oxygen. This can quickly deplete the available (Dissolve) oxygen in the water. When the dissolved oxygen levels drop too low, many aquatic species perish. In fact, if the oxygen level drops to zero, the water will become septic. When organic compounds decompose without oxygen, it gives rise to the undesirable odours usually associated with septic or putrid conditions.

Biological Oxygen Demand (BOD) is one of the most common measures of pollutant organic material in water. BOD indicates the amount of putrescible organic matter present in water. Therefore, a **low BOD is an indicator of good quality water**, while a **high BOD indicates polluted water.**

DO is the actual amount of oxygen available in dissolved form in the water. When the DO drops below a certain level, the life forms in that water are unable to continue at a normal rate. The decrease in the oxygen supply in the water has a negative effect on the fish and other aquatic life. Fish kills and an invasion and growth of certain types of weeds can cause dramatic changes in a stream or other body of water. Energy is derived from the oxidation process.

Table 4.4: BOD level of different types of water.

BOD Level *(in ppm)*	**Water Quality**
1 - 2	**Very Good** There will not be much organic waste present in the water supply.
3 - 5	**Fair - Moderately Clean**
6 - 9	**Poor - Somewhat Polluted** Usually indicates organic matter is present and bacteria are decomposing this waste.
100 or greater	**Very Poor - Very Polluted** Contains organic waste.

{**Note**: Generally, when BOD levels are high, there is a decline in DO levels. This is because the demand for oxygen by the bacteria is high and they are taking that oxygen from the oxygen dissolved in the water. If there is no organic waste present in the water, there won't be as many bacteria present to decompose it and thus the BOD will tend to be lower and the DO level will tend to be higher. At high BOD levels, organisms such as macroinvertebrates that are more tolerant of lower dissolved oxygen (i.e. leeches and sludge worms) may appear and become numerous. Organisms that need higher oxygen levels (i.e. caddisfly larvae and mayfly nymphs) will NOT survive}.

BOD specifies the strength of sewage. In sewage treatment, to say that the BOD hrocedure that measures the amount of oxygen consumed by living organisms while they are utilizing the organic matter present in waste, under conditions similar in nature.

Measurement of B.O.D.

The BOD test takes **5 days to complete** and is performed using a dissolved oxygen test kit. The BOD level is determined by comparing the DO level of a water sample taken immediately with the DO level of a water sample that has been incubated in a dark xygen required for the decomposition of any organic material in the sample and is a good approximation of the BOD level.

1. Take 2 samples of water
2. Record the DO level (ppm) of one immediately using the method described in the dis-

solved oxygen test.

3. Place the second water sample in an incubator in complete darkness at 20 °C for **5 days.** If you don't have an incubator, wrap the water sample bottle in aluminum foil or black electrical tape and store in a dark place at room temperature (20 °C or 68 °F).
6. After 5 days, take another dissolved oxygen reading (ppm) using the dissolved oxygen test kit.
7. Subtract the Day 5 reading from the Day 1 reading to determine the BOD level. Record your final BOD result in ppm.

CHEMICAL OXYGEN DEMAND (COD)

In environmental chemistry, the **chemical oxygen demand (COD) test is commonly used to indirectly measure the amount of organic compounds in water.** Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers), making COD a useful measure of water quality. It is expressed in milligrams per liter (mg/L), which indicates the mass of oxygen consumed per liter of solution.

The basis for the COD test is that nearly all organic compounds can be fully oxidized to carbon dioxide with a strong oxidizing agent under acidic conditions. The amount of oxygen required to oxidize an organic compound to carbon dioxide, ammonia, and water is given by-

$$CnHaObNc + (n + a - b - 3)\ O_2 \longrightarrow nCO_2 + (a - 3c)\ H_2O + NH_3$$

This expression does not include the oxygen demand caused by the oxidation of ammonia into nitrate. The process of ammonia being converted into nitrate is referred to as *nitrification.* The following is the correct equation for the oxidation of ammonia into nitrate.

$$NH_3 + 2O_2 \longrightarrow NO_3^- + H_3O^+$$

The second equation should be applied after the first one to include oxidation due to nitrification if the oxygen demand from nitrification must be known. Dichromate does not oxidize ammonia into nitrate, so this nitrification can be safely ignored in the standard chemical oxygen demand test.

Measurement of COD

The test of COD is carried out to measure the the contents of organic matter of sewage and natural water. Most types of organic matter are oxidized by a boiling mixture of chromic and sulfuric acids. A sample is refluxed (Boiled) for two hoursin strongly acid solution with a known excess of potassium dichromate ($K_2Cr_2O_7$) in presence of a catalyst $AgSO_4$ and $HgSO_4$. It is then cooled and the remaining unreduced $K_2Cr_2O_7$ is titrated with ferrous ammonium sulphate to determine the amount of $K_2Cr_2O_7$ consumed and the oxidizable matter is calculated in terms of oxygen equivalent.

$$\text{Sample} + K_2CrO_7 \xrightarrow{AgS\,O_4 \text{ and } HgSO_4} CO_2 + H_2O + \text{Ammonia}$$

$$K_2Cr_2O_7 + \text{ferrous ammonium sulphate} \longrightarrow \text{Salt}$$

Calculations

The COD is calculated with the help of following formula

$$\text{COD mg/l} = \frac{(V_1 - V_2) \times 8 \times 1000}{X}$$

Where : V_1 = Initial volume of ferrous ammonium sulphate
V_2 = Final volume of ferrous ammonium sulphate

X = Volume of sample taken.

Advantage of COD over BOD

COD is usually carried out to determine the pollutional strength of sewage because of its several advantages over BOD test. These advantages are-

1. It takes relatively less time (Only 2 hours).
2. Industrial waste do not responds to BOD test, so COD test is a must.
3. If toxic materials are present in sewage, they are likely to interfere with BOD, in such cases COD is found to be very useful.