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Biological Oxygen Demand

BOD is defined as the number of milligrams of Dissolved Oxygen required for the oxidation of biologically oxidizable impurities present in 1000 ml of waste water under aerobic conditions at 20 °C over a period of 5 days.

BOD Determination by Winkler's method

Aim: To estimate the amount of Biological Oxygen Demand present in the supplied sewage sample by Winkler's method.

Apparatus: 300 ml BOD bottle, Burette, 10 ml pipettes, 100 ml measuring cylinder, 250 ml volumetric flask, beakers, conical flasks and funnel.

Chemicals: Manganese sulphate, alkaline potassium iodide, sodium thiosulphate, sulphuric acid and starch indicator.

Theory:

Dissolved oxygen is used as an indicator for the health of a water body. Aquatic animals need dissolved oxygen (DO) to live.

Winkler's Method is a technique used to measure D**issolved Oxygen (DO)** in freshwater systems. The amount of dissolved oxygen available in waste water is determined before and after 5 days of incubation by Iodometric titration.

$$\text{Biodegradable load (CHONS)} + O_2 \longrightarrow CO_2 + H_2O + NO_3^- + SO_4^{2-}$$

The **principle** involved in this method is the **DO in water oxidizes KI solution to liberate equivalent quantity of iodine**, which is then **titrated against std. $Na_2S_2O_3$** solution using **starch as an indicator**.

Procedure:

A definite known volume ('**A**' ml) of sewage sample is diluted to a known volume ('**B**' ml) with fresh water. Equal quantities of diluted sewage samples are taken in two BOD Bottles.

Blank Titration:

Dissolved Oxygen (D1) in BOD **Bottle-1** is determined immediately as given below. To the Bottle-1 sample, add with the help of pipette 5ml of $MnSO_4$ and 5ml of alkaline KI reagents. Stopper the bottle immediately and shake well by inverting the bottle 3 to 4 times and allow it stand for 5 minutes. The brown precipitate of basic manganic oxide, $MnO(OH)_2$ gets settles down.

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Now, add one test tube of dil. H_2SO_4, insert the stopper and shake well till the precipitate is completely dissolved. The **reaction mixture** acquires **brownish yellow colour** due to the **liberation of iodine**.

Take **100 ml of the above reaction mixture** into a conical flask and **titrate against $Na_2S_2O_3$** solution until the reaction mixture becomes **pale yellow colour**, then add 1ml of freshly prepared **starch** solution. The reaction mixture turns into **deep blue colour** due to the formation of less stable **starch-iodide complex**. Continue the titration till the **blue colour disappears**. Note down the burette reading and perform another 2 sets of titrations for accuracy.

B.R. → / **B.L. ↓**	**I ml.**	**II ml.**	**III ml.**	**Mean BR**
Final level				**…' V_1 ' ml**
Initial level				
Difference				

Sample Titration:

The BOD **Bottle-2** is incubated for 5 days under aerobic conditions at 20 ^oC. After 5 days of incubation, the unconsumed **Dissolved Oxygen (D2)** in BOD **Bottle-2** is determined as described above in blank titration.

B.R. → / **B.L. ↓**	**I ml.**	**II ml.**	**III ml.**	**Mean BR**
Final level				**…' V_2 ' ml**
Initial level				
Difference				

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Calculation:

Volume of sewage sample before dilution = **A** ml

Volume of sewage sample after dilution = **B** ml.

Volume of reaction mixture (sewage sample) used for both blank and sample titration = '**Vs**' ml

Normality of reaction mixture (sewage sample) in **Bottle-1** = $\mathbf{N_{DO1}}$

Normality of reaction mixture (sewage sample) in **Bottle-2** = $\mathbf{N_{DO2}}$

Volume of $Na_2S_2O_3$ consumed for blank titration in **Bottle-1** = $\mathbf{V_1}$ ml

Volume of $Na_2S_2O_3$ consumed for sample titration in **Bottle-2** = $\mathbf{V_2}$ ml

Normality of $Na_2S_2O_3$ solution = N_1

Dissolved Oxygen – D1 in Bottle-1:

Vs $N_{DO1} = V_1 N_1$

$$\mathbf{N_{DO1} = V_1 N_1 / Vs}$$

Dissolved Oxygen in Bottle-1 = **D1** = Normality of reaction mixture (sewage sample) in Bottle-1 x Equivalent weight of Oxygen x 1000 ppm

$$\mathbf{D1 = N_{DO1} \times 8 \times 1000\ ppm.}$$

Dissolved Oxygen – D2 in Bottle-2:

Vs $N_{DO2} = V_2 N_1$

$$\mathbf{N_{DO2} = V_2 N_1 / Vs}$$

Dissolved Oxygen in Bottle-2 = **D2** = Normality of reaction mixture (sewage sample) in Bottle-2 x Equivalent weight of Oxygen x 1000 ppm

$$\mathbf{D2 = N_{DO2} \times 8 \times 1000\ ppm.}$$

Biological Oxygen Demand (BOD):

$$\mathbf{BOD = \frac{(D1 - D2) \times B}{A}\ ppm.}$$