Deep Science Publishing
https://doi.org/10.70593/978-93-49307-52-0_21

Chapter 21

Quantitative estimation of dissolved oxygen (DO) in water samples: Principles, methods, and environmental significance

Keshawanand Tripathi[1], Yashdeep Srivastava[1*], Narendra Kumar[2]
[1]*Department of Biotechnology, Invertis University, Bareilly, Uttar Pradesh, India.*
[2]*School of Biotechnology and Bioengineering, Institute of Advanced Research, Gandhinagar, Gujarat, India.*
[*]Email: yashbubiotech@gmail.com

1. Introduction:

Dissolved oxygen (DO) content in water is crucial for assessing aquatic ecosystem health and quality. It is influenced by factors like temperature, pressure, salinity, and the presence of photosynthetic organisms (Sawyer et al., 2003). Colder water holds more dissolved oxygen than warmer water, while higher pressures allow more oxygen to dissolve. Oxygen is primarily sourced from atmospheric exchange and photosynthesis, while human activities like pollution and fertilizer use can also affect dissolved oxygen levels. Low levels can cause stress, reduced growth rates, and mortality in aquatic animals, disrupting nutrient cycling and ecosystem balance. Monitoring dissolved oxygen levels is essential for understanding and managing aquatic environments, identifying pollution sources, and implementing strategies to protect and restore aquatic habitats (Metcalf and Eddy, 2013).

2. Iodometric method:

The oxidising characteristics of DO and titration are the foundations of the iodometric technique. To the water sample, a divalent manganese solution is added, then, in a sealed glass container, strong alkali. Higher valence state hydroxides are formed when DO quickly oxidises the scattered divalent manganese hydroxide precipitates. The oxidized manganese recovers to its divalent state in an acidic solution containing iodide ions, releasing iodine in a proportion to the initial DO concentration. Then, with a standardized thiosulfate solution, this freed iodine is titrated. A starch indicator makes it easy to see when the titration has reached its end (Manahan, 2017).

3. The Membrane electrode procedure:

The method of membrane electrodes gauges DO concentration by measuring the rate of diffusion of molecular oxygen across a membrane. These methods are crucial for

understanding water quality and ensuring effective management of environmental resources (Weiner, 2012).

$MnSO_4 + 2KOH$ ----------.> $Mn(OH)_2 + O$ $MnO(OH)_2 + 2H_2SO_4 + 2KI$

$Mn(OH)_2 + K_2SO_4$ ----------> $MnO(OH)_2$ $MnSO_4 + K_2SO_4 + 3H2O + I_2$

4. Materials required:

1. Measuring cylinder
2. Burette
3. Conical flask
4. Pipette

5. Preparation of Solutions:

1. Prepare manganese sulfate solution by dissolving either 480 g of $MnSO_4.4H_2O$, 400 g of $MnSO_4.2H_2O$, or 364 g of $MnSO_4.H_2O$ in distilled water. Filter and dilute the solution to 1L. Ensure no color reaction occurs with starch when added to an acidified potassium iodide (KI) solution.
2. Prepare the alkali-iodide-azide reagent.
3. Prepare sulfuric acid so that 1 mL is approximately equivalent to 3 mL of the alkali-iodide-azide reagent.
4. Make a starch solution by dissolving 2 g of laboratory-grade soluble starch and 0.2 g of salicylic acid in 100 mL of hot distilled water.
5. Prepare standard sodium thiosulfate titrant by dissolving 6.205 g of $Na_2S_2O_3.5H2O$ in distilled water. Add 1.5 mL of 6N NaOH or 0.4 g of solid NaOH and dilute to 1000 mL.
6. Prepare standard potassium bi-iodate solution (0.0021M) by dissolving 812.4 mg of $KH(IO_3)$ in distilled water and diluting to 1000 mL.

6. Standardization Procedure:

1. Dissolve approximately 2 g of KI in an Erlenmeyer flask with 100 to 150 mL of distilled water.
2. Add 1 mL of 6N H_2SO_4 or a few drops of concentrated H2SO4 and 20 mL of the standard bi-iodate solution.
3. Titrate the liberated iodine with thiosulfate titrant, adding starch when a pale straw color is achieved. Adjust the $Na_2S_2O_3$ solution concentration to 0.025M if necessary.

7. Analysis Procedure:

1. Collect the water sample in a 200ml glass bottle without introducing bubbles.
2. Using a pipette, add 2 ml of manganese sulfate ($MnSO_4.H_2O$) solution to the sample.

3. Add 2 ml of the alkali-iodide-azide reagent to the sample.
4. Allow the solutions to react with the oxygen in the sample.
5. After settling, add 2 ml of concentrated sulfuric acid to the sample.
6. Mix the sample to dissolve any precipitates.
7. Transfer 50 ml of the sample into a flask.
8. Begin titration with sodium thiosulfate solution, using starch as an indicator. Titrate until the blue color disappears, recording the burette reading.
9. Perform the same titration process for the blank sample to determine the burette reading.

8. Calculations:

$$D.O.\ (\text{in mg/lit}) = (8 \times 100 \times N / V \times v)$$

Where:
V = Volume of sample taken (ml)
v = Volume of used titrant (ml)
N = Normality of titrant
8 is the constant since 1ml of 0.025N Sodium thiosulphate solution is equivalent to 0.2mg oxy

9. Precautions:

1. Calibrate the dissolved oxygen meter according to manufacturer instructions before use.
2. Ensure the probe is clean and free from any debris or residue.
3. Handle water samples gently to avoid introducing air bubbles that could affect DO readings.
4. Allow sufficient time for the probe to equilibrate in the water sample before recording readings.
5. Perform measurements at the same depth and location within the water body to ensure consistency.
6. Use appropriate units and standards (e.g., mg/L or % saturation) for reporting DO content.
7. Verify the accuracy of readings by performing replicate measurements.
8. Keep the sample and equipment away from direct sunlight or heat sources during measurements.
9. Rinse and clean the probe thoroughly with distilled water after each use to prevent contamination.
10. Record measurements promptly to minimize potential changes in DO levels over time.

10. References:

1. Metcalf & Eddy. (2013). *Wastewater engineering: Treatment and resource recovery* (5th ed.). McGraw-Hill.
2. Manahan, S. E. (2017). *Environmental chemistry* (10th ed.). CRC Press.
3. Weiner, E. R. (2012). *Applications of environmental aquatic chemistry* (3rd ed.). CRC Press.