Determination of Dissolved Oxygen (DO) in Waste Water

What is dissolved oxygen and why is it important?

- A water stream, both produces and consumes oxygen
- Gains oxygen from the atmosphere and from plants as a result of photosynthesis
- Respiration by aquatic animals, decomposition, and various chemical reactions consume oxygen
- Waste water from sewage treatment plants often contains organic materials that are decomposed by microorganisms, which use oxygen in the process
- The amount of oxygen consumed by these organisms in breaking down the waste is known as the <u>*biochemical oxygen demand or BOD*</u>
- Oxygen is measured in its dissolved form as dissolved oxygen (DO)
- DO is used as an indicator of the health of a water body, where higher dissolved oxygen concentrations are correlated with little pollution

The Winkler or Iodometric Method

- Technique used to measure dissolved oxygen (DO)
- Uses titration to determine DO in the water sample

Theory:

In the Iodometric method, divalent manganese solution is added to the water sample, followed by addition of strong alkali. DO rapidly oxidize an equivalent amount of divalent manganese to higher valence states

In the presence of iodide ions in an acidic solution, the oxidized manganese reverts to the divalent state, with the liberation of iodine equivalent of the original DO content

The iodine is then titrated with a stranded solution of thiosulfate. The titration end point can be detected visually with a starch indicator and interpreted in terms of DO in mg/L unit

Reactions

- If no oxygen is present, a pure white precipitate is formed when $MnSO_4$ and alkali-iodide reagent (NaOH+KI) are added to the sample

$$Mn^{2+} + 2OH^{-} \rightarrow Mn\,(OH)_2 \text{ (white precipitate)}$$

- If sample has some oxygen, Mn^{2+} is oxidized to Mn^{4+} and precipitates brown hydrated oxide

$$Mn^{2+} + 2OH^{-} + 0.5O_2 \rightarrow MnO_2 \text{ (brown hydrated precipitate)} + H_2O$$

- MnO_2 oxidizes iodide to iodine in the presence of acid

$$MnO_2 + 2KI + H_2SO_4 \rightarrow Mn^{2+} + I_2 + K_2SO_4 + 2H_2O$$

- Iodine formed is titrated with thiosulfate solution

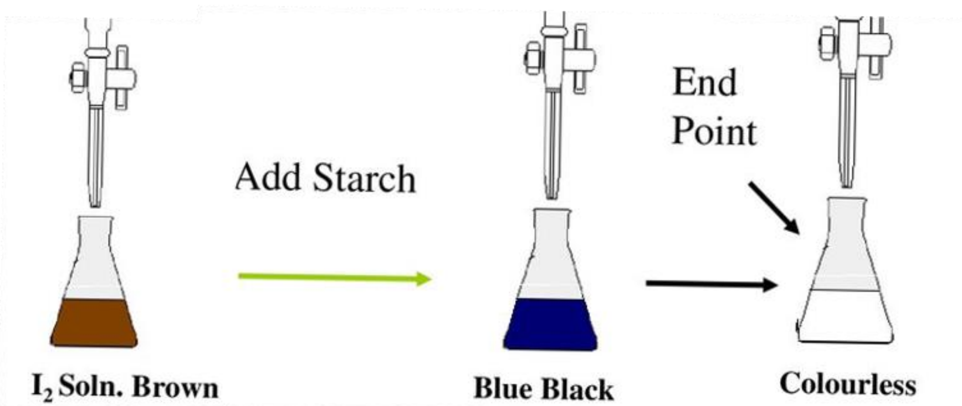
$$I_2 + 2Na_2S_2O_3 \rightarrow Na_2S_4O_6 + 2NaI$$

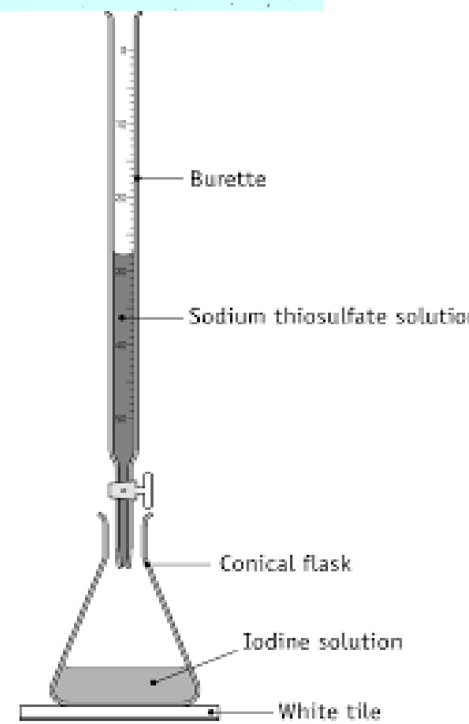
REQUIREMENT: 0.005N $Na_2S_2O_3$ solution, alkaline KI solution, $MnSO_4$ solution, starch solution as indicator

PROCEDURE:

Take 50 mL of given water sample in a conical flask. Add 2 mL each of alkaline KI solution and $MnSO_4$ solution. Shake the flask vigorously. Brown precipitates will be produced. Now add carefully 2 mL of conc. H_2SO_4 solution and shake. Brownish solution with liberated Iodine (I_2) will be produced. Quickly add 2 mL of freshly prepared starch solution (indicator), which gives blue color. Titrate slowly against standard 0.005N $Na_2S_2O_3$ solutions till the blue color just disappears. Repeat the titration 4 times.

Burette	: 0.005 N $Na_2S_2O_3.5H_2O$ solution.
Flask	: 50 mL of water sample + 2 mL alkaline KI solution + 2 mL of $MnSO_4$ solution + 2 mL of conc. H_2SO_4
Indicator	: 2 mL of starch solution
Color Change	: Blue to colorless





OBSERVATION TABLE:

Sr. No.	Initial Burette Reading (mL)	Final Burette Reading (mL)	Differences (mL)	Concurrent Reading (mL)
1	0.0	12.0	12.0	12.0
2	0.0	12.1	12.1	
3	0.0	12.0	12.0	
4				

CALCULATION:

1000 mL 1N $Na_2S_2O_3$ = 8 g of dissolved oxygen

1 mL 1 N $Na_2S_2O_3$ = 8 mg of dissolved oxygen

1 mL 0.005N $Na_2S_2O_3$ = 0.04 mg of dissolved oxygen

x mL 0.005N $Na_2S_2O_3$ = $x \times$ 0.04 mg of dissolved oxygen

SAMPLE TAKEN:

$$(\text{mg/L}) = \frac{1000 \times \text{B.R} \times 0.04}{50}$$

(Because B.R. of $Na_2S_2O_3$ = I_2 liberated)

RESULTS:

(1) Volume of 0.005N $Na_2S_2O_3$ solution required for 50 mL of given water sample = 12.0 mL

(2) Dissolved oxygen in the given water sample = 9.6 mg/L