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RESEARCH ARTICLE

QUANTITATIVE ESTIMATION OF DISSOLVED OXYGEN IN WATER: A NEW APPROACH TO THE CALCULATION METHODOLOGY OF WINKLAR'S METHOD

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ABSTRACT

Till date most acceptable method of estimation of dissolved oxygen in water sample is Winklar's method (APHA-2005). The method of calculation of data is followed by the formula V_1x N x E x 1000/ V_4 (V_2- V_3/V_2).
Where, V_1= Quantity of the sample water.
V_1 = Quantity of sodium thiosulphate used in titration.
N = Normality of sodium thiosulphate (N/80).
V_4 = Quantity of sample taken for titration.
V_3 = Quantity of alkaline iodite and manganese sulphate.
E = Equivalent weight of O_2.
This formula can not explain a clear picture related to the chemical reaction takes place within the reagents used in this methodology. Therefore, an attempt has been made towards chemical deduction of data, available during estimation.

Principles

Oxygen dissolved in water oxidises Manganus sulphate ($MnSo_2$) to Manganic hydroxide [$Mn(OH)_3$]. $Mn(OH)_3$ liberates Iodine (I_2) from Potassium iodide (KI), alkalined with Potassium hydroxide (KOH), in presence of concentrated sulphuric acid (H_2So_4). The liberated iodine is quantitavely estimated by titration against N/80 sodium thiosulphate ($Na_2S_2O_3$) solution from which amount of oxygen is determined by the following equations:-

1 mole of O_2≡2 moles of I_2 ≡ 4 moles of $Na_2S\ _2O_3$

Reactions

$2H_2O + O_2 + 4MnSo_4 + 8KOH = 4Mn(OH)_3 + 4K_2So_4$.
$2\ Mn(OH)_3 + 2KI + 3\ H\ _2So\ _4 = 2\ MnSo_4 + K_2So_4 + I_2 + 6H_2O$.
$2\ Na\ _2S\ _2O_3 + I_2 = Na_2S_4O_6 + 2NaI$.

Apparatus

- 250 ml conical flask containing 250ml of sample water.
- Beaker.
- Burette.
- Stand.

Reagents

- 48% Manganous sulphate.
- Alkaline Potassium Iodide.
- Concentrated Sulphuric Acid.
- N/80 Sodium theosulphate solution.
- Freshly prepared starch solution.

Procedure (Winkler's Method, 1888)

- Water sample was collected (250 ml) with great care so that the air bubbles did not enter into the flask.
- 4 ml of $MnSo_4$ and 4 ml of alkaline potassium iodide were added by using separate pipette for each reagent.
- The bottle was stopped & then the flask was shaken for several times and also allowed to precipitate.
- After 15 minutes the flask was gently shaken and then 4 ml of con. H_2So_4 was added to it.
- Then 50 ml of sample water is taken in a titration flask & placed against white back ground.
- It was then titrated by N/80 $Na_2S_2O_3$ solution till the colour turns pale yellow (straw).
- Then a few drops of freshly prepared starch solution was added to it and then the solution turns blue.
- Then it was again titrate with N/80 $Na_2S_2O_3$ till the blue colour disappeared. The end point is noted.
- This process is done for thrice for proper determination of dissolved oxygen.

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RESULTS

No. of Observation	Sample volume (ml)	Burette reading			
		Initial (ml)	Final (ml)	Difference (ml)	Mean (ml)
1.	50	8	11.5	3.5	
2.	50	11.5	15.1	3.6	3.5
3.	50	15.1	18.5	3.4	

Calculation

The amount of $Na_2S_2O_3$ used is 3.5 ml.
From the reactions we may write that –
1 mol of $O_2 \equiv$ 2 mol of I2 $\equiv$ 4 mol of $Na_2S_2O_3$
4 mol of $Na_2S_2O_3 \equiv$ 1mol of O_2
4X158 gm of $Na_2S_2O_3 \equiv$ 32 gm of O_2

We know that,

1000 ml 1(N) $Na_2S_2O_3$ contains 158 gm of this compound.
1000 ml 4 (N) $Na_2S_2O_3$ contains 4X158 gm of this compound.
So, 1000 ml 4 (N) $Na_2S_2O_3$ =32 gm of O_2.
1000 ml 1 (N) $Na_2S_2O_3 \equiv$ 32/4 gm of O_2 = 8 gm of O_2.
1000 ml N/80 $Na_2S_2O_3 \equiv$ 8/80 gm of O_2.
1 ml N/80 $Na_2S_2O_3$ $\equiv$ 8/80X1000 gm of O_2
$\equiv$ 8X1000/80X1000 mg of $O_2 \equiv$1/10 mg of $O_2 \equiv$ 0.1 mg of O_2.

So, 1 ml N/80 $Na_2S_2O_3$ neutralises 0.1 mg of O_2.
3.5 ml N/80 $Na_2S_2O_3$ neutralises = 0.1X3.5 mg of O_2 = 0.35 mg of O_2.
50 ml sample water contain 0.35 mg of O_2
1 ml sample water contain = 0.35/50 mg of O_2
1000 ml sample water contain = 0.35X1000/50 mg of O_2 =7 mg of O_2.

So, the dissolved oxygen in pond water is 7 mg/ litre.

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