Experiment No. : 3

Determination of free chlorine in a given water sample

Apparatus required:

(1) Pipette, (2) Burette, (3) Stopper conical flask, (iv) Beaker, (5) Funnel, (6) Filter paper, (7) Stand.

Chemicals required:

1. Standard N/20 $K_2 Cr_2 O_7$ solution
2. Potassium iodide solution (10%)
3. Conc. HCl
4. $NaHCO_3$
5. N/20 hypo solution
6. Starch solution

Theory:

Various kinds of undesirable microorganism like algae, bacteria and fungi may present in surface water. The presence of these microorganism in water may lead to serious health hazards. Thus drinking water should sterilized and disinfected before domestic use. Since, chlorine is powerful oxidizing agent and is cheaply available. It is widely used for disinfection of potable and municipal water supplies.

Chlorination is done with the help of bleaching powder or chlorine gas or chlorine dissolved in water in the form of concentrated solution or with chloramines. The sterilizing action of chlorine is supposed to be due to its reaction with water producing hypochlorous acid and nascent oxygen, both of which have powerful germicidal properties.

$$CaOCl_2 + H_2O \longrightarrow Ca(OH)_2 + Cl_2$$

$$Cl_2 + H_2O \longrightarrow HOCl + HCl$$

$$\underset{\text{(Hypochlorous acid)}}{HOCl} \longrightarrow HCl + \underset{\text{(nascent oxygen)}}{(O)}$$

However, excess of free chlorine in drinking water is undesirable as it is not only unpleasant for drinking but is also injurious for human metabolism. Hence, the amount of free chlorine in municipal water is estimated prior to the domestic supply so as to make necessary adjustments in dose.

The principle involved in the estimation of free chlorine in water is that when a measured quantity of water is treated with excess of potassium iodide, the free chlorine present in the water oxidizes the corresponding amount of potassium iodide to iodine. The liberated iodine is estimated by titrating against standard hypo solution using starch as indicator.

$$Cl_2 + 2KI \rightarrow 2KCl + I_2$$

$$I_2 + \underset{\text{(Sodium thiosulfate)}}{2Na_2S_2O_3} \rightarrow \underset{\text{(Sodium tetrathionate)}}{Na_2S_4O_6} + 2NaI$$

Procedure:

(a) Standardization of hypo solution:

Transfer 100 ml of distilled water into 250 ml flask, and add about 2 g of KI and 2 g of $NaHCO_3$ and shake until the salts are dissolved. Add 6 of conc. HCl slowly while gently rotating the flask. Add 25 of N/20 $K_2Cr_2O_7$ solution and mix the solution well. Wash the inner sides of the flask with a little distilled water and stopper of the flask. Allow it to standby for 5 minutes in dark for the completion of the reaction:

$$Cr_2O_7^{2-} + 6I^- + 14H^+ \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$$

Rinse the stopper with distilled water and titrate the liberated iodine with the hypo solution from the burette. When most of the iodine has reacted, the solution acquires a greenish-yellow colour. At this stage, add 1 ml of starch solution when the solution turns violet due to the formation of starch iodine complex. Continue the titration until the violet color changes to light green by the addition of a single drop of hypo at the end-point.

(b) Determination of free chlorine in the water sample:

Transfer 10% of 10 ml KI solution into a 250 ml conical flask (or stoppered conical flask) and add 100 ml of water into it. Replace the stopper to the flask and shake is vigorously. Remove the stopper, wash the solution adhering in the flask with 5-10 ml of distilled water. Titrate the solution with N/20 hypo solution taken in the burette until the solution is pale yellow. Then add 1 ml of starch and continue the titration until the solution becomes just colorless. Note the titre values.

Observation:

A) Standardization of hypo solution

S. N.	Vol. of N/20 $K_2Cr_2O_7$ (V_1) (ml)	Volume of hyposolution run down (V_2) (ml)
1.	25	
2.	25	
3.	25	

B) Determination of free chlorine in the water sample :

S. N.	Volume of water sample (ml)	Volume of hyposolution run down (ml
1.		
2.		
3.		

Calculation :

A) Standardization of hypo solution

Vol. of $K_2Cr_2O_7$ (V_1) = 25 ml

Normality of $K_2Cr_2O_7$ (N_1) = N/20

Vol. of hypo solution (V_2) = 30 ml

Normality of hypo solution (N_2) = ?

Applying formula

$$N_1V_1 = N_2V_2$$

We have, $N_2 = \frac{N_1V_1}{V_2} = \frac{\frac{N}{20} \times 25}{30}$

B) Calculation with the water sample:

Volume of water sample take (V_1) = 100 ml

Normality of water sample taken (N_1) = ?

Volume of hypo solution (V_2) =

Normality of hypo solution (N_2) =

Applying, formula

$$N_1V_1 = N_2V_2$$

Normality of the water sample is N_1 = ... with respect to free chlorine present.

Now strength of free chlorine in the sample

= Normality X Eq. wt. of Cl.

= N_1 X 35.45 g/l.

∴

= .....mg/l = ...ppm

Results:

Free chlorine present in the water sample .....ppm.