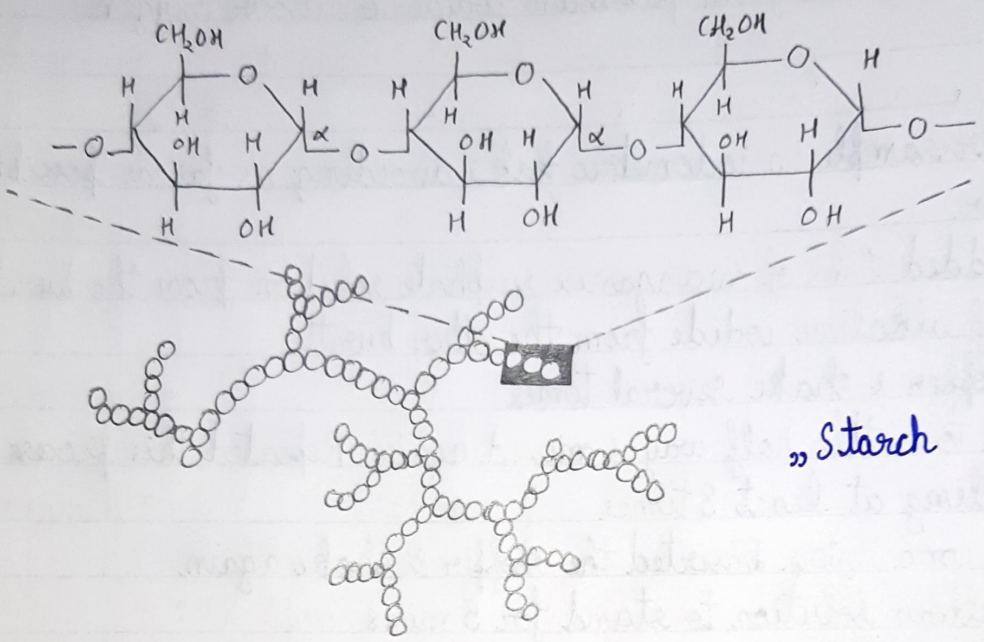
Indicator used:

Starch is used as an indicator in iodometric titration.



Reactions involved:

$$Cl_2 + H_2O \rightarrow HOCl + H^+ + Cl^-$$

$$HOCl \rightleftharpoons H^+ + OCl^-$$

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

$$2CuSO_4 + 4KI \rightarrow Cu_2I_2 + I_2 + 2K_2SO_4$$

I_2 + starch indicator → blue colour

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

Sodium thiosulphate → Sodium tetrathionate

Experiment 6.

Aim:

To determine the strength of free chlorine in given water sample iodometrically. Given standard N/40 copper sulphate ($CuSO_4$) solution to standardize sodium thiosulfate solution.

Apparatus required:

Burette, Pipette, Measuring flask, glass rod.

Chemicals required:

Potassium iodide solution (10%), Hypo solution ($Na_2S_2O_3$), starch solution (freshly prepared), (N/40) $CuSO_4$ solution.

Theory:

(a) Background:

(i) Chlorine is a powerful oxidising agent and is cheaply available. It is widely used for disinfection of potable and municipal water supplies to remove bacteria, fungus and other pathogenic micro-organisms and for deodorization.

(ii) Chlorination is done with the help of bleaching powder or chlorine gas or chlorine dissolved in water in the form of conc. solution or with chloramines

(iii) Chlorine gas hydrolyses in water almost completely to form hypochlorous acid.

(iv) The hypochlorous acid dissociates into hydrogen ions (H^+) and hypochlorite ions (OCl^-) in the reversible reaction.

(v) Hypochlorous acid is a weak acid with pK_a of approximately 7.5 at 25°C.

Teacher's Signature : ----------

Observations:

Titration of hypo solution versus given $CuSO_4$ solution

S.no.	Vol^m of $CuSO_4$ solution	Burette readings		Vol^m of hypo solution	Concordant reading
		Initial	Final		
1.	10 ml	0.0	10.5	10.5 ml	10.5 ml
2.	10 ml	10.5	21.0	10.5 ml	
3.	10 ml	21.0	31.5	10.5 ml	

Titration of hypo solution versus given water sample.

S.no.	Vol^m of water solution	Burette readings		Vol^m of hypo solution	Concordant reading
		Initial	Final		
1.	10 ml	0.0	3.4	3.4 ml	3.4 ml
2.	10 ml	3.4	6.8	3.4 ml	
3.	10 ml	6.8	10.2	3.4 ml	

Calculations:

Titration of hypo solution versus given $CuSO_4$ solution.

N_{CuSO_4} (N_1) = N/40 ,, V_{CuSO_4} (V_1) = 10ml

N_{hypo} (N_2) ,, V_{hypo} (V_2) = 10.5ml

$$N_1 V_1 = N_2 V_2$$

$$N_2 = \frac{N_1 V_1}{V_2} = \frac{N}{40} \times \frac{10}{10.5} = \frac{N}{42}$$

(vi) Hypochlorous acid, the prime disinfecting agent, is therefore dominant at a pH below 7.5 and is a more effective disinfectant than hypochlorite ion, which dominates above pH 7.5.

(vii) In dil. solutions & at pH levels above 4, very little molecular Cl exist in solution

According to EPA, allowable chlorine levels in drinking water (up to 4 parts per million) pose "no known or expected health risk [including] an adequate margin of safety" while providing for "control of pathogens under variety of conditions."

(b) Principle:

The determination of the available chlorine is done by treating the known volume of sample with an excess of a solution of KI. The free chlorine present in the water oxidises the corresponding amount of KI to iodine. Liberated iodine is estimated by titrating against standard hypo solution, using starch as indicator.

Procedure:

1. Standardization of hypo solution with given copper sulphate solution

Took 10 ml of given copper sulphate solution ($CuSO_4$) from pipette in conical flask. Added 1 ml of potassium iodide (KI) solution and titrated with the hypo solution till faint yellow colour developed. At that point, added 1-2 drops of starch as indicator. The solution then turned blue in colour. Titrated further with hypo to colourless as end point. Noted the concordant volume of hypo solution as V ml.

Titration of hypo solution versus given water sample
Normality of water sample (equivalent to dissolved chlorine)

$N_{water}\ (N_3)$ " $V_{water}\ (V_3) = 10\,ml$

$N_{hypo}\ (N_2) = \frac{N}{42}$ " $V_{hypo}\ (V_2) = 3.4\,ml$

$N_2 V_2 = N_3 V_3$

$N_3 = \frac{N_2 V_2}{V_3} = \frac{N}{42} \times \frac{3.4}{10} = \frac{3.4}{420} N$

Total chlorine residuals $= N_3 \times 35.5\ g\,l^{-1}$

$= \frac{3.4}{420} \times 35.5\ g\,l^{-1} \simeq 0.2874\ g\,l^{-1}$

≈ 287.38 ~~ppm~~

2. Titration of given water sample with hypo solution:

Took 10 ml of given water sample from pipette in a conical flask. Added 1 ml of potassium iodide (KI) solution and titrated with the hypo solution till faint yellow colour developed. At that point, added 1-2 drops of starch as indicator. The solution then turned blue in colour. Titrated further with hypo to colourless as end point. Noted the concordant volume of hypo solution as V ml.

Result:

Amount of total residual chlorine in given sample of water = 287.38 ppm

Precautions:

(i) The solution being unstable should be titrated immediately after preparation.

(ii) The solution should be well shaken before each aliquot is withdrawn for titration.

(iii) Chlorine vapours being harmful, the solution should not be sucked into pipette with the mouth.