

Summary Report

The objective of this experiment was to determine the concentration of hypochlorite ions in liquid bleach. In order to do that, the solution of sodium thiosulfate needed to be prepared beforehand by dissolving a known mass of sodium thiosulfate pentahydrate ($\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$) and sodium carbonate to remove the hydrates. A known mass of potassium iodide solid, that had been dissolved with known volume of distilled water and hydrochloric acid prior, were prepared and potassium iodate (KIO_3) was added and dissolved. The solution was then titrated with the thiosulfate solution until the color of the solution had less-intense brown color. Starch indicator was added into the solution and the titration was continued until its end point, where the dark-blue color solution turned colorless. The initial and final buret reading were recorded and three replicates in total were needed. As tabulated in **Table 1**, the **average molarity of $\text{Na}_2\text{S}_2\text{O}_3$ solution** was **0.09472 M** with a **standard deviation of 0.00144 M**. From there, known volume of distilled water and known mass of KI were mixed and dissolved in a flask, with known volume and concentration of sulfuric acid. Exactly 2 mL of sodium hypochlorite (NaOCl) was pipetted into the flask and the $\text{Na}_2\text{S}_2\text{O}_3$ solution from the previous part was titrated into the flask until the brown color of the solution started to fade. Starch solution was added, and the titration was continued up to its end point. The initial and final buret reading were recorded. 2 more replicates were needed by conducting the same steps. By referring to Table 2, the average molarity of NaOCl was **0.09693 M** with a **standard deviation of 0.00982 M**. The **formula** used to determine the values tabulated in **Table 1** and **2** were as listed in **Table 3** and **4** respectively.

Sodium Thiosulfate standardization			
Erlenmeyer flask #	1	2	3
Mass of KI solid (g)	1.8801	2.1689	2.1266
Mass of KIO_3 solid (g)	0.1421	0.1249	0.1376
Initial buret reading (mL)	0.29	0.23	0.82
Final buret reading (mL)	42.35	36.65	42.18
Titrated volume (mL)	42.06	36.42	41.36
Molecular weight of KIO_3 (g/mol)	214.001		
Mole of IO_3^- ions (mol)	6.640E-04	5.836E-04	6.430E-04
Mole of I_3^- ions (mol)	1.992E-03	1.751E-03	1.929E-03
Mol of $\text{S}_2\text{O}_3^{2-}$ ions (mol)	3.984E-03	3.502E-03	3.858E-03
Molarity of $\text{Na}_2\text{S}_2\text{O}_3$ solution (M)	0.09472	0.09615	0.09328
Average molarity (M)	0.09472		
Standard deviation in molarity (M)	0.00144		
RSD (%)	1.5		

Table 1: The standardization of Sodium Thiosulfate solution

Determination of Hypochlorite in Bleach			
Erlenmeyer flask	1	2	3
Mass of KI solid (g)	1.5865	1.9429	1.7282
Initial buret reading (mL)	42.18	14.93	18.95
Final buret reading (mL)	45.90	18.95	23.49
Titrated volume (mL)	3.72	4.02	4.54
Average molarity Na ₂ S ₂ O ₃ solution (M)	0.09472		
Volume of NaOCl (mL)	2.00		
Mole of S ₂ O ₃ ²⁻ ions (mol)	3.523E-04	3.808E-04	4.300E-04
Mole of I ₃ ⁻ ions (mol)	1.762E-04	1.904E-04	2.150E-04
Mole of OCl ⁻ (mol)	1.762E-04	1.904E-04	2.150E-04
Molarity of NaOCl (M)	0.08809	0.09519	0.1075
Average molarity NaOCl (M)	0.09693		
Standard deviation molarity NaOCl (M)	0.00982		
RSD (%)	10.1		

Table 2: The determination of Hypochlorite Ions in Bleach Reagent

Formula	
Titrated volume (mL)	Final buret reading (mL) - Initial buret reading (mL)
Mole of IO ₃ ⁻ ions (mol)	Molecular weight of KIO ₃ (g/mol) / Mass of KIO ₃ (g)
$\text{IO}_3^- + 8\text{I}^- + 6\text{H}^+ \leftrightarrow 3\text{I}_3^- + 3\text{H}_2\text{O}$ $2\text{S}_2\text{O}_3^{2-} + \text{I}_3^- \leftrightarrow \text{S}_4\text{O}_6^{2-} + 3\text{I}^-$	
Mole of I ₃ ⁻ ions (mol)	Mole of IO ₃ ⁻ (mol) * 3 (based on stoichiometry)
Mole of S ₂ O ₃ ²⁻ ions (mol)	Mole of I ₃ ⁻ ions (mol) * 2 (based on stoichiometry)
Molarity of Na ₂ S ₂ O ₃ solution (M)	Mole of S ₂ O ₃ ²⁻ ions (mol) / Titrated volume (L)
Average molarity (M)	AVERAGE(values) function in excel
Standard deviation (M)	STDEV(values) function in excel
RSD (%)	Standard deviation/Average molarity * 100 %

Table 3: Formula used to evaluate the values in Table 1

Formula	
Titrated volume (mL)	Final buret reading (mL) - Initial buret reading (mL)
Mole of S ₂ O ₃ ²⁻ ions (mol)	Average molarity of Na ₂ S ₂ O ₃ (M) / Titrated volume (L)
$2\text{S}_2\text{O}_3^{2-} + \text{I}_3^- \leftrightarrow \text{S}_4\text{O}_6^{2-} + 3\text{I}^-$ $\text{OCl}^- + 3\text{I}^- + 2\text{H}^+ \leftrightarrow \text{Cl}^- + \text{I}_3^- + \text{H}_2\text{O}$	
Mole of I ₃ ⁻ ions (mol)	Mole of S ₂ O ₃ ²⁻ ions (mol) / 2 (based on stoichiometry)
Mole of OCl ⁻ ions (mol)	Mole of I ₃ ⁻ ions (mol) (based on stoichiometry)
Molarity of NaOCl (M)	Mole of OCl ⁻ ions (mol) / Volume of bleach (L)
Average molarity (M)	AVERAGE(values) function in excel
Standard deviation (M)	STDEV(values) function in excel
RSD (%)	Standard deviation/Average molarity * 100 %

Table 4: Formula used to evaluate the values in Table 2