EXPERIMENT 1

Aim

To study the effect of concentration on the rate of reaction between Sodium Thiosulphate and Hydrochloric Acid.

Theory

According to the law of mass action, rate of a chemical reaction is directly proportional to the product of the molar concentrations of the reactants. It means the rate of reaction increases with the increase in the concentration of the reactants.

$$Na_2S_2O_3(aq) + 2HCl(aq) \longrightarrow S(s) + 2NaCl(aq) + SO_2(aq) + H_2O(l)$$

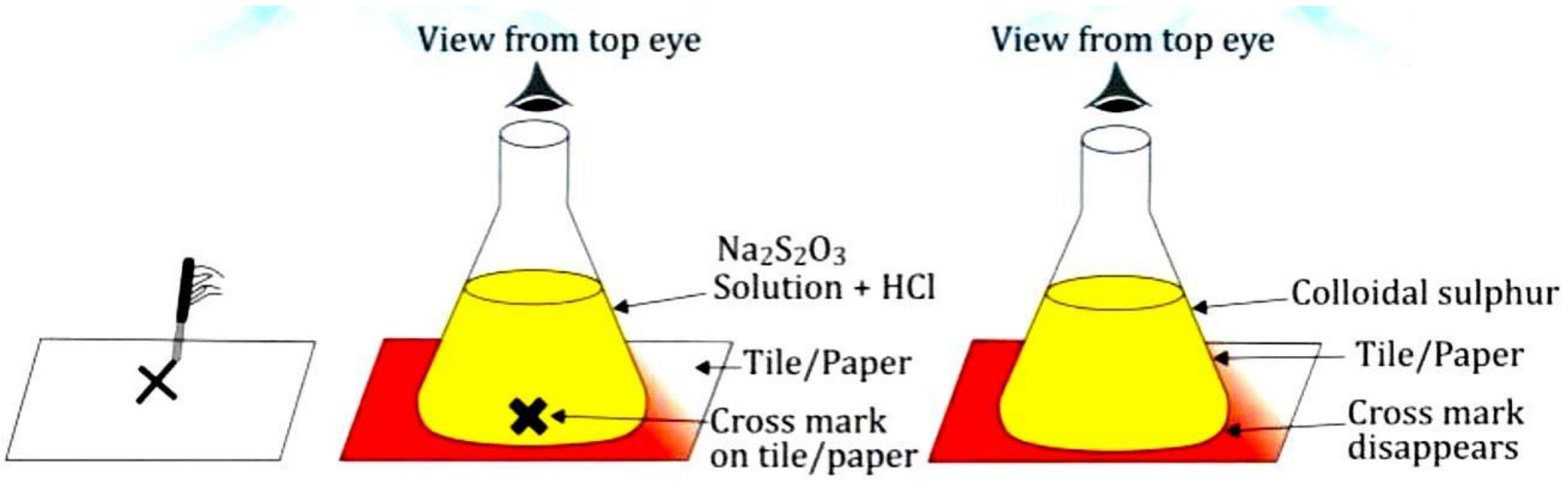
The insoluble sulphur, formed during the reaction, gives a milky appearance and makes the solution opaque. Therefore, rate of reaction can be studied by measuring the time taken to produce enough sulphur to make some mark invisible on a paper kept under the conical flask in which the reaction is carried out.

Material Required

Pipette (10 ml), stop-watch, three burettes and five conical flasks (100 ml), 0.1M $Na_2S_2O_3$ solution and 1 M HCl and distilled water.

Procedure

1. Wash the conical flasks with water and label them as 1, 2, 3, 4 and 5 respectively.
2. With the help of a burette, add 10, 20, 30, 40 and 50 ml of 0.1M $Na_2S_2O_3$ solution to the flasks 1, 2, 3, 4 and 5 respectively.
3. Now add 40, 30, 20 and 10 ml of distilled water to the flask 1, 2, 3 and 4 respectively so that the volume of solution in each flask is 50 ml.
4. Take 5 ml of 1M HCl in a test tube with the help of a burette.
5. Put a cross mark on a white tile or white paper and keep the beaker 1 on the mark.
6. Add 5 ml of hydrochloric acid taken in a test tube to the conical flask No. 1, shake the contents of the conical flask and start the stopwatch.
7. Go on observing from top to downwards in the flask and stop the stopwatch when the cross mark just becomes invisible. Note down the time.
8. Repeat the experiment by adding 10 ml of 5M HCl to flasks 2, 3, 4 and 5 and record the time taken in each case for the cross to become just invisible.



Study of rate of reaction between $Na_2S_2O_3$ and dil. HCl

Observations

Record the observations in a tabular form as given table.1.

Table.1.

Flask No.	Volume of $Na_2S_2O_3$ solution in ml	Volume of water in ml	Volume of HCL (ml)	Time taken from cross to become just invisible (second)	$\frac{1}{t}(s^{-1})$
1.	10	40	5	---	---
2.	20	30	5	---	---
3.	30	20	5	---	---
4.	40	10	5	---	---
5.	50	0	5	---	---

Plotting of graph

Plot a graph between 1/t (in seconds) and the conc. of sodium thiosulphate by taking 1/t along ordinate (vertical axis) and the conc., of $Na_2S_2O_3$ along abscissa (horizontal axis). It should be a straight sloping line.

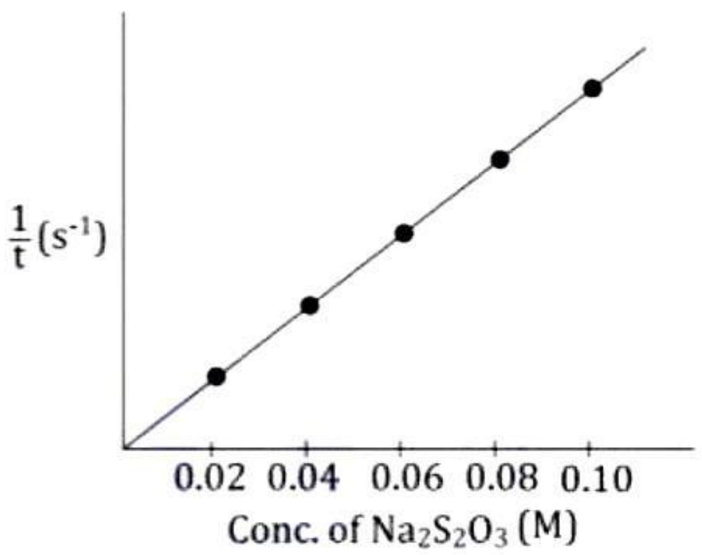


Fig.1 A graph of conc. of $Na_2S_2O_3$ and $\frac{1}{t}$

Result

From the graph, it is clear that 1/t is directly proportional to the conc., of $Na_2S_2O_3$solution. But y is a direct measure of rate of the reaction, therefore, rate of the reaction between $Na_2S_2O_3$ and HCl is directly proportional to the conc., of $Na_2S_2O_3$ solution taken. Hence, rate of reaction between sodium thiosulphate and hydrochloric acid increases with increase in concentration of thiosulphate.

Note: The reaction can be studied by keeping the volume (conc.) of thiosulphate constant and varying the volume(conc.) of HCl.

Precautions

1. The apparatus must be thoroughly clean. If the same conical flask is to be used again and again, it should be thoroughly washed with conc. HNO_3 and then with water.

2. Measure the volumes of sodium thiosulphate solution, hydrochloric acid and distilled water very accurately.
3. Complete the experiment at one time only so that there is not much temperature variation.
4. Start the stopwatch immediately when half of the hydrochloric acid solution has been added to sodium thiosulphate solution.
5. View the cross-mark through the reaction mixture from top to bottom from same height for all observations.

VIVA VOCE

Q 1. What is the influence of increasing sodium thiosulfate concentration on the reaction rate with hydrochloric acid?

Ans. Higher concentrations of sodium thiosulfate result in a faster reaction rate with hydrochloric acid, showcasing the concentration-dependent nature of the reaction.

Q 2. How does the rate of reaction change with varying concentrations of sodium thiosulfate in the sodium thiosulfate-hydrochloric acid system?

Ans. The rate of reaction exhibits a direct correlation with sodium thiosulfate concentration, demonstrating the concentration's pivotal role in determining the reaction kinetics.

Q 3. Why is it important to keep the concentration of hydrochloric acid constant when studying the effect of concentration on the reaction between sodium thiosulfate and hydrochloric acid?

Ans. Keeping the concentration of hydrochloric acid constant ensures that any observed changes in reaction rate are solely due to variations in the concentration of sodium thiosulfate.

Q 4. What is the expected trend in reaction rate as the concentration of sodium thiosulfate increases, based on collision theory?

Ans. According to collision theory, an increase in the concentration of sodium thiosulfate should lead to a higher frequency of collisions between reactant particles, resulting in a faster reaction rate.

Q 5. How can the experimental data obtained from varying the concentration of sodium thiosulfate be analysed to determine the relationship between concentration and reaction rate?

Ans. The experimental data can be analysed graphically by plotting reaction rate against concentration to observe any patterns or trends, providing insights into the relationship between concentration and reaction rate.