A COMPARATIVE STUDY OF PRECIPITATE FORMATION OF INORGANIC SUBSTANCE

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ABSTRACT

The present study aims for the kinetic measurements of precipitation reactions of Strontium Chloride, sulphuric acid; the technique used for the study is, nephelometeric and conductometeric analysis for observing precipitation reactions. study shows changes in precipitate formation with time. The effect of concentration on the rate of reaction were investigated, it is observed that reaction follows first order kinetics. This Precipitate formation of Strontium Chloride, sulphuric acid and is carried out at different temperatures, experiment were also performed to study effect of salt and effect of radiation. By this study different thermodynamic parameters $\Delta H, \Delta S \, \Delta G$ were calculated using Arrhenius equation.

KEYWORDS: Strontium Chloride, Sulphuric Acid, Precipitation reaction, Nephelometer, conductometer, Kinetics.

INTRODUCTION

In a chemical reaction influence of different reaction condition on reaction rate gives information about reaction mechanism. the development of chemical kinetics was formulated by using law of mass action which states that speed of chemical reaction is proportional to quantity of reacting substance.[1,5]

The reaction kinetics is dependent on solubility of an ionic salt in pure water depends on the solubility product constant alone, provided that only cations and anions of salts are in solution.[6] One of the oldest methods of chemical separation is fractional precipitation.[7] This involves the addition of a reagent which precipitates most of metal ion and leaves another mostly in solution. Many ions which form insoluble salts can be determined by titration, if a

suitable method of estimating the equivalence point is available.[8] the most convenient method is potentiometric, but chemical indicators are available for a number of cases.

We have given the combined application of various methods of investigation[9] (e.g. nephelometry, conductivity measurements, electron microscopy, isotope exchange, paper chromatography, co-precipitation etc) lead to refined insight into the course of precipitation reaction.

The precipitation reaction for strontium chloride, was previously carried using Nephelometry.[10] The precipitation reaction becomes complicated if an additional reaction such as hydrolysis, condensation takes place simultaneously.

EXPERIMENTAL

The chemicals used for the present investigations were of S.D.Fine Chemicals Ltd and used without further purification. Double distilled water was used as solvent. (CL 52D) Elico made nephelometer was calibrated using farmazine solution and Equiptronic made conductometer is used to study the Effect of variation of concentration, effect of radiation and effect of temperature, effect of salt was studied. A known amount of strontium chloride was mixed was mixed with known concentration of sulphuric acid the appearance of turbidity was observed by using nephelomete rand same type of study was carried out by using conductometer.
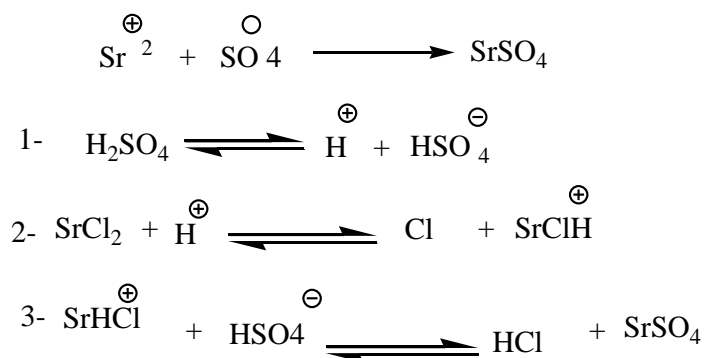
RESULTS AND DISCUSSION

Part-I Reaction between Strontium chloride and H_2SO_4

For the present study, we have taken a definite amount of solid Strontium chloride, which is treated with Sulphuric acid solution. The solution becomes turbid, due to the formation of Strontium Sulphate. The reaction takes sufficient times; therefore it can be successfully studied by using Nephelometry.

It is possible that SrCl2 get dissociate in solution $\quad SrCl2 \rightleftharpoons Sr^{+2} + 2Cl$

.

$$Sr^{2\oplus} + SO_4^{\ominus} \longrightarrow SrSO_4$$

$$1\text{-} \quad H_2SO_4 \rightleftharpoons H^{\oplus} + HSO_4^{\ominus}$$

$$2\text{-} \quad SrCl_2 + H^{\oplus} \rightleftharpoons Cl + SrClH^{\oplus}$$

$$3\text{-} \quad SrHCl^{\oplus} + HSO4^{\ominus} \rightleftharpoons HCl + SrSO_4$$

In the present investigation, we monitored the turbidity obtained due to product formation. Although reaction order is different, we maintained pseudo first order conditions. So the different order reactions exhibit different functional forms for the time dependence of reactant concentrations. It was observed that NTU reading increases very fast up to 2 to 3 min and then slightly decreases for two to three readings and suddenly decreases for lower concentration of Strontium chloride. The curve shows sudden increase in NTU reading for 2 to 3min then smooth decrease in reading is shown for higher concentration of Strontium chloride. When 250 mg of Strontium chloride was dissolved in Sulphuric Acid. A smooth curve was observed keeping the higher concentration of Sulphuric Acid, the first order kinetics.

Variation of turbity by Nephelometric measurements
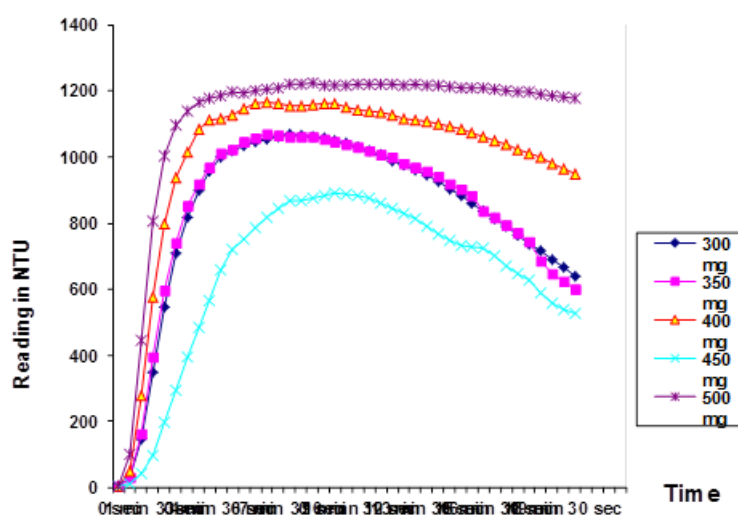
This precipitation reaction has been studied for observing effect of different factors.

Table No. 1: Effect of concentration.

| Concentration of Srcl2	NTU reading in 1min
21.028×10^{-3} M	81
42.056×10^{-3} M	293
63.084×10^{-3} M	988

From the above table it is clear that as the concentration of the salt is increased precipitation is increasing. The rate of precipitation of the reaction was calculated then these rates are determined from the initial concentration value and here initial concentration 'a' is determined by taking the difference of reading as,

$$\text{'a'} \longrightarrow (NTU)_\infty - (NTU)_0$$

And the remaining concentration $(a - x)$ is taken as

$$\text{'}a - x\text{'} \longrightarrow (NTU)_\infty - (NTU)_t$$

By using these values graph was plotted log a / a − x vs Time and value of rate constant is calculated from the graph. The values of rate constant for the different concentration of the salt were calculated.
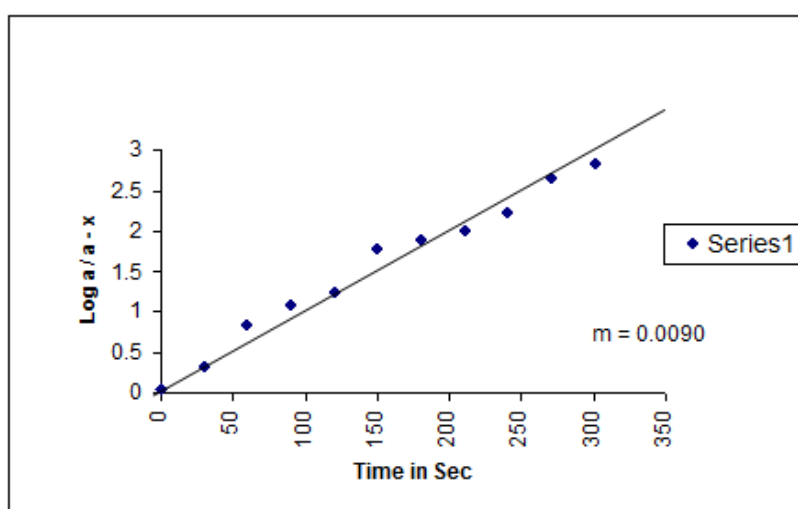
Concentration of SrCl$_2$	Rate Constant Sec^{-1}
21.028×10^{-3} M	0.17×10^{-3}
42.056×10^{-3} M	0.23×10^{-3}
63.084×10^{-3} M	0.46×10^{-3}

From these values it is observed that the rate of reaction increases with the increasing concentration of reactants the reason can be explain on the basis of collision theory of

reaction rate which says that the number of collision increases with the increasing concentration it is so because the number of molecules per unit volume is increasing there by increasing the rate of collision among the molecules which gives the product and hence the rate of precipitation reactions increases, these reactions rates is found to be of first order kinetics.[11,13]

Effect of Temperature

The reaction has been studied at different temperature and it has been observed that the rate of precipitation increases with the increasing temperature the reason for this can also be explain on the basis of molecular theory of collision of reaction rate which says that as the temperature is increased the number of collision among the molecules is increasing and when this collision is in a proper orientation then the rate of formation of strontium sulphate increases and hence the rate is increased. This can also be explained as the temperature is increased the thermal energy of the molecule is increasing and the molecules are vibrating at the faster rate and their by increasing the collision of the molecule and hence the rate is increasing.[14,15]

Graph of log a / a − x Vs Time was plotted and rate constant were calculated at different temperature range 297 − 304. The activation Ea were calculated by using Arrhenious equation,

$K = Ae^{-Ea/RT}$ OR $\ln k_2 / k_1 = Ea / R [1/T_1 − 1/T_2]$

The free energy of rate activation ΔG is calculated by using the equation,

$\Delta G = -RT \ln k$

The free energy values with different rate constant were determine then a plot of free energy change Vs temperature were taken and from this plot value of change in entropy ΔS and change in Enthalpy and ΔH were calculated for the different concentration of strontium chloride.

21.02 x 10^{-3} M

Temperature	ΔG kj/mole	ΔS kj/mole	ΔH kj/mole	Ea kj/mole
20^{0}C	37.36			
26^{0}C	33.10	86.66	3100	126.49
30^{0}C	32.10			

42.063 x 10^{-3} M

Temperature	ΔG kj/mole	ΔS kj/mole	ΔH kj/mole	Ea kj/mole
20^{0}C	37.36			
26^{0}C	31.33	95.00	3000	99.74
30^{0}C	28.68			

63. 084 x 10^{-3} M

Temperature	ΔG kj/mole	ΔS kj/mole	ΔH kj/mole	Ea kj/mole
20^{0}C	31.20			
26^{0}C	31.46	35.00	3240	139.57
30^{0}C	36.80			

From the above values of entropy it has been observed that entropy is a positive value which indicates that precipitation reaction of strontium chloride and sulphuric acid is disordered precipitation.

Effect of Salt

The reaction has also been studied for the effect of salt has been observed i.e. the same precipitation reaction is studied in the presence of different concentration of salt and it shows that there is no effect of salt on rate of reaction and order of reaction does not change by the presence of salt. The rate of reaction has also been calculated which is found to be of first order reaction.

Effect of Radiation

The precipitation reaction of strontium chloride and sulphuric acid has also been observed for the effect of radiation and it is noted that there is no effect of radiation on the rate of precipitation reaction and it is found to be of first order.

Conductivity Measurement

The reaction of strontium chloride and sulphuric acid is a precipitation reaction and can be studied by conductivity measurements method.[10,13]

In the present work the precipitation reaction by changing the concentration of strontium chloride and by changing the temperature have studied.

Effect of Concentration
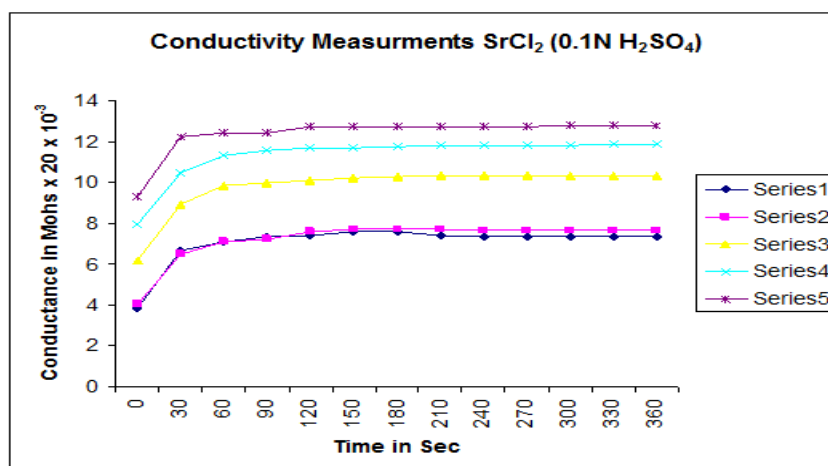
It has been observed that with the increase of concentration of solution the conductance of solution also increases and then become constant it is because of mobility of ions increases during the formation of strontium sulphate and becomes constant because the precipitate has been formed.

The plot of Log of a / a − x Vs Time is taken and from this graph the value of rate constant is calculated the rate of reaction is found to be of first order with respect to concentration.
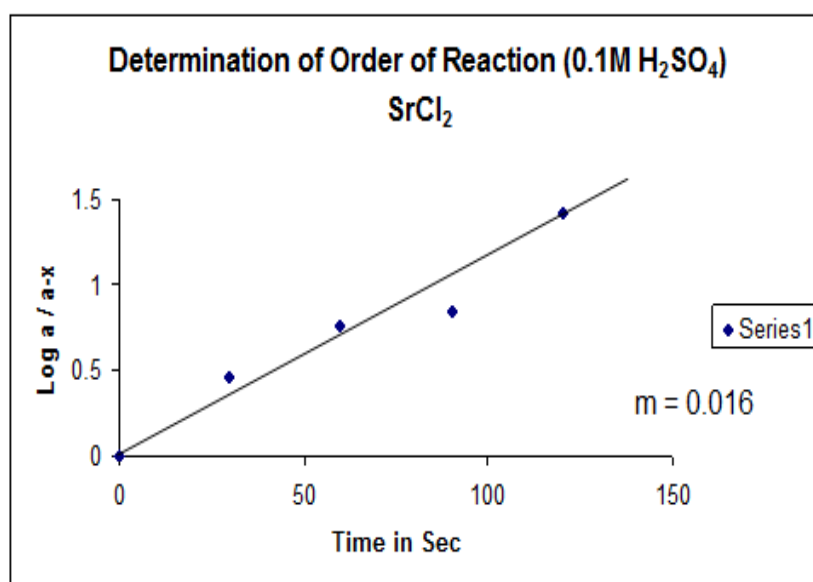
Effect of Temperature

The reaction has been studied at different temperature and it is observed that at the higher temperature the conductance increases and then becomes constants, it is because of the mobility of ions during the formation of strontium chloride.

Graph of log a / a – *x* Vs Time was plotted and rate constant were calculated at different temperature range 297 – 304. The activation Ea were calculated by using Arrhenious equation,

$$K = Ae^{-Ea/RT} \quad \text{OR} \quad \ln k_2 / k_1 = Ea / R [1/T_1 - 1/T_2]$$

The free energy of rate activation ΔG is calculated by using the equation,

$$\Delta G = -RT \ln k$$

The free energy values with different rate constant were determine then a plot of free energy change Vs temperature were taken and from this plot value of change in entropy ΔS and change in Enthalpy and ΔH were calculated for the different concentration of strontium chloride.

21.02 x 10^{-3} M

Temperature	ΔG kj/mole	ΔS kj/mole	ΔH kj/mole	Ea kj/mole
20^{0}C	21.08			
26^{0}C	15.66	11.11	5202	496.0
30^{0}C	15.60			

42.063 x 10^{-3} M

Temperature	ΔG kj/mole	ΔS kj/mole	ΔH kj/mole	Ea kj/mole
20^{0}C	13.23			
26^{0}C	13.13	9.48	1260	376.9
30^{0}C	12.33			

63. 084 x 10^{-3} M

Temperature	ΔG kj/mole	ΔS kj/mole	ΔH kj/mole	Ea kj/mole
20^{0}C	14.4			
26^{0}C	13.5	6.13	1400	694.9
30^{0}C	16.2			

CONCLUSION

The precipitation reaction can be studied by using Nephelometry and conducyometric analysis. The results from both the techniques are well comparable.

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