

Kinetic Measurements of Precipitation Reaction of Inorganic Compounds

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Research Article

Abstract: The present paper aims to study kinetics of precipitation reactions of cerium chloride and silver nitrate. nephelometer is used for studying precipitation of cerium chloride and silver nitrate. The reactions shows variation in precipitate with time and it follows first order kinetics. Turbidometric study of precipitate formation of Cerium Oxalate, and Silver Chloride. Though the mechanism is studied previously by conventional methods, we used turbidometric method for determination of formation of precipitations.

Key Words: Cerium Chloride, Oxalic Acid, Silver Nitrate Hydrochloric Acid, Turbidometer and Precipitation reaction.

Introduction

The equilibrium between a solid ion, salt and its solutions in water was generated by the solubility product expression. Many ion which form insoluble salts can be determined by titration¹, if a suitable method and/or indicator is available. There is Nephelometry, Conductometry, Potentiometry³, Chromatographic technique⁴ are used to monitor precipitation reaction. The precipitation reaction for sodium thiosulphate and strontium chloride was previously carried using nephelometry⁵. The precipitation reaction becomes complicated if an additional reaction such as hydrolysis, condensation takes place simultaneously.

Experimental

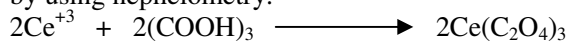
The chemicals used for the present investigations were of S.D. Fine Chemicals Ltd and used without further purification. Double distilled water was used as solvent. A (CL 52D) Elico make nephelometer was calibrated using farmazine solution. Effect of variation of concentration, effect of radiation and effect of temperature was studied. A known amount of $CeCl_3$ was mixed with known concentration of OXALIC ACID and

the appearance of turbidity was followed using nephelometer. Similarly known quantity of Silver Nitrate was equilibrated with Oxalic acid solution and the reaction was followed nephelometrically.

Results and Discussion

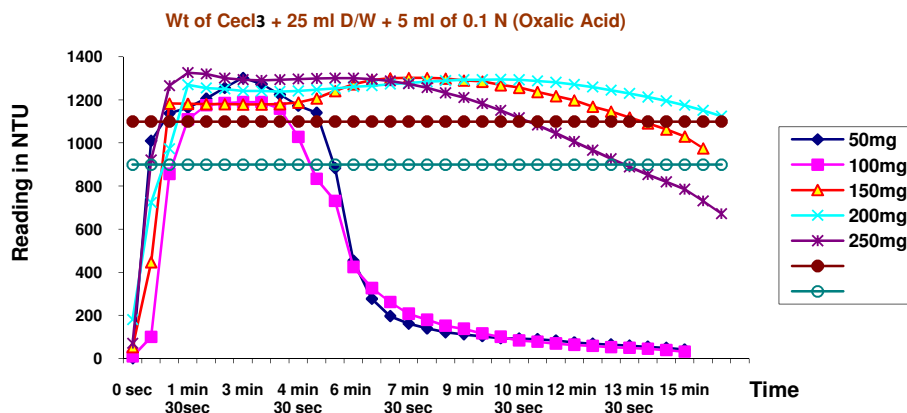
Part-I Reaction between Cerium chloride and $C_2H_2O_4$

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



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 cerium chloride. The curve shows sudden increase in NTU reading for 2 to 3min then smooth decrease in reading is shown for higher concentration of cerium chloride. When 250 mg of cerium chloride was dissolved in Oxalic Acid. A smooth curve was observed keeping the higher concentration of Oxalic Acid, the pseudo first order.



Rate constants were determined (Table 1). It is observed that the increasing the concentration of Cerium Chloride the rate constant increases but decreasing the concentration Oxalic acid increases the rate constant. The data suggests that when the concentration of oxalic acid and Cerium Chloride are in the same range 10^{-2} M. rate constant is Maximum.

Table 1: Variation of rate constant (k Sec-1) with [CeCl₃]

[(COOH) ₂] (M)	[CeCl ₃] 1.352x 10 ⁻² M k Sec ⁻¹	[CeCl ₃] 2.704 x 10 ⁻² M kSec ⁻¹	[CeCl ₃] 4.056 x 10 ⁻² M k Sec ⁻¹
0.1	8.9 x 10 ⁻³	9.6 x 10 ⁻³	3.8 x 10 ⁻²
0.05	2.04 x 10 ⁻²	5.041 x 10 ⁻²	3.06 x 10 ⁻¹
0.025	9.2 x 10 ⁻³	1.036 x 10 ⁻²	2.03 x 10 ⁻²

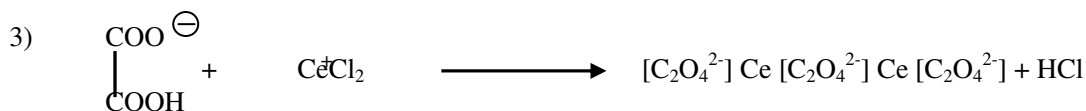
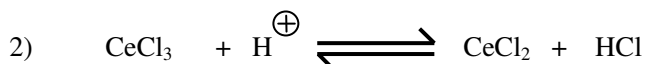
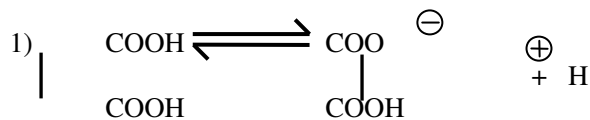
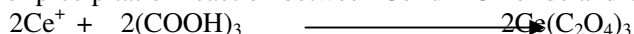
To check the effect of added salt on precipitation, we added KCl, The result reveals that at [C₂H₂O₄] = 0.1 M and [CeCl₃] = 1.352 x 10⁻² M increase in rate constant with increasing KCl is observed.

Variation in rate constant with KCl is shown in (Table No. 2)

Table 2: Effect of Salt [KCl] On Rate Constant (k sec-1)

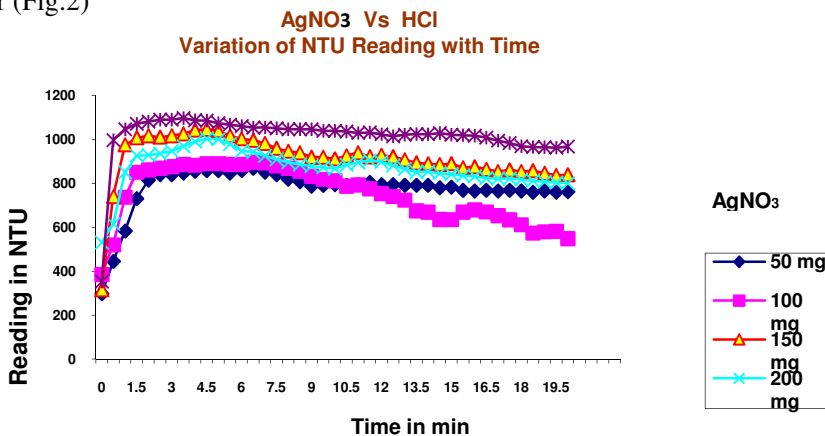
[KCl] (M)	[(COOH) ₂] = .1M [CeCl ₃] 1.352 x 10 ⁻² M	[(COOH) ₂] = 0.1M [CeCl ₃] 2.704 x 10 ⁻² M	[(COOH) ₂] = 0.1M [CeCl ₃] 4.056 x 10 ⁻² M
0.0	3.84 x 10 ⁻²	8.9 x 10 ⁻³	9.6 x 10 ⁻³
0.1	1.28x 10 ⁻²	9.67 x 10 ⁻³	1.26 x 10 ⁻²
0.2	1.31 x 10 ⁻²	1.70 x 10 ⁻²	1.28 x 10 ⁻²
0.3	2.99 x 10 ⁻²	4.49 x 10 ⁻²	1.47 x 10 ⁻²

The Mechanism of precipitation reaction between Cerium Chloride and Oxalic Acid is given as



Part-II Reaction between Silver Nitrate and Hydrochloric Acid.

In the second set of experiments Silver nitrate was allowed to mix with hydrochloric acid and the turbidity is measured using Nephelometer (Fig.2)



The first order rate constants were calculated and are represented in table 3.

Table 3: Variation of Rate Constant (k Sec-1) With [AgNO₃]

[HCL] (M)	[AgNO ₃] 1.9623 x 10 ⁻² M	[AgNO ₃] 3.9246 x 10 ⁻² M	[AgNO ₃] 5.8869 x 10 ⁻² M
0.1	0.5 x 10 ⁻²	1.4 x 10 ⁻²	2.51 x 10 ⁻²
0.05	2.2 x 10 ⁻²	4.07 x 10 ⁻²	9.0 x 10 ⁻²
0.025	2.9 x 10 ⁻³	6.8 x 10 ⁻³	8.1 x 10 ⁻³

The rate constant value increases with the increase in concentration of HCl and AgNO₃ When KCl is added to the solution, regular variation is not observed. (Table-4)

Table 4: Effect of salt [KCl] on rate constant (k Sec-1)

[KCl] (M)	[HCL] = 0.1M [AgNO ₃] 1.9623 x 10 ⁻² M	[HCL] = 0.1M [AgNO ₃] 3.9246 x 10 ⁻² M	[HCL] = 0.1M [AgNO ₃] 5.8869 x 10 ⁻² M
0.0	0.5 x 10 ⁻²	1.4 x 10 ⁻²	2.51 x 10 ⁻²
0.1	1.2 x 10 ⁻³	2.5 x 10 ⁻³	2.4 x 10 ⁻³
0.2	0.92 x 10 ⁻³	6.9 x 10 ⁻³	4.8 x 10 ⁻³
0.3	3.2 x 10 ⁻³	2.3 x 10 ⁻³	2.5 x 10 ⁻³

But the rate constant values in presence of KCl were suppressed, indicating the adverse effect of KCl on the precipitate formation of AgNO₃

The stoichiometry of reaction is



The probable mechanism of the precipitation reaction can be given as follows

- 1) $HCl \rightleftharpoons H^+ + Cl^-$
- 2) $AgNO_3 + H^+ \longrightarrow HNO_3 + Ag^+$
- 3) $Ag^+ + Cl^- \longrightarrow AgCl$

The rate constant increases with increase in concentration of HCl. The rate varies concentration of HCl as well as with concentration of AgNO₃.

Acknowledgment

We are thankful to Prof Tilawat Ali, President Sir Sayyad College, Aurangabad and Management of Maulana Azad College for providing laboratory facilities.

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