Excel Journal of Engineering Technology and Management Science
(An International Multidisciplinary Journal)
Vol. I No. 8 June - July 2015 (Online) ISSN 2277-3339

"A KINETIC STUDY OF PRECIPITATION OF CADMIUM SULPHATE IN AQUEOUS SOLUTION"

** Momin Nishat Parveen, Sir Sayyad College of Arts, Commerce and Science, Aurangabad.*
*** Ayesha Durrani, Dr Rafic Zakaria Campus for Women, Aurangabad.*
**** Shalini Dengle, Vivekanand College Aurangabad.*

Introduction:

K H Liesr(1) have given the combined application of various methods of investigation (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 formation of a new solid.

Different studies show that the 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. One of the oldest methods of chemical separation is fractional precipitation.[2] This involves the addition of a reagent which gives precipitates of most of the 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.[3] 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[4] (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 Cadmium sulphate, was previously carried out using nephelometry[5].It measures the scattering of light radiation by dispersed phase.

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.,which was prepared by using Hydrazine Sulphate and Hexamethylentetraamine. Equal volume of these solution were mixed and kept for 48 hours, this solution was used for calibration of Nephelometre . Effect of variation of concentration of concentration of cadmium sulphate, effect of radiation and effect of temperature and effect of salt was studied. A known amount of cadmium sulphate was mixed with known concentration of Oxalic acid and the appearance of turbidity was measured by using using Nephelometer.

Results and Discussion:

Part-I: Reaction between Cadmium Sulphate and $C_2 H_2 O_4$

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

It is possible that $CdSO_4$ get dissociate in solution

$$CdSO_4 \longrightarrow Cd^{+2} + SO_4^{-2}$$

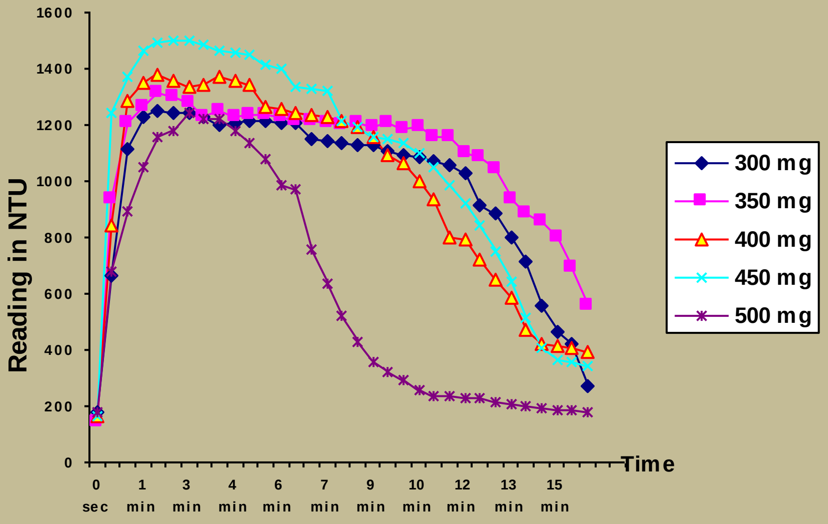
$$C_2H_2O_4 \longrightarrow C_2O_4^{-2} + H^{+2}$$

$$Cd^{+2} + C_2O_4^{-2} \longrightarrow CdC_2O_4$$

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 is slow initially for few seconds than increases up to 2 to 3 min and then slightly decreases for two to three readings and smoothly decreases. For lower concentration of Cadmium Sulphate. The curve shows sudden increase in NTU reading for 1 to 2min then slightly towards constant than smooth decrease in reading is shown for higher concentration of Nickel Sulphate . When 500 mg of Cadmium Sulphate was dissolved in Oxalic Acid. A smooth curve was observed

$CdSO_4$ Vs $C_2H_2O_4$



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

Table No.1 Variation of rate constant (k Sec-1) with [$CdSO_4$]

[$H_2C_2O_4$] (M)	[$CdSO_4$] 14.39×10^{-2}M k Sec^{-1}	[$CdSO_4$] 28.78×10^{-2}M k Sec^{-1}	[$CdSO_4$] 43.17×10^{-2}M k Sec^{-1}
0.1	8.5×10^{-3}	11.3×10^{-3}	20.4×10^{-3}
0.05	6.3×10^{-3}	10.8×10^{-3}	11.0×10^{-3}
0.025	4.8×10^{-3}	7.9×10^{-3}	9.1×10^{-3}

To check the effect of added salt on precipitation, KCl was added. The result reveals that at [$C_2H_2 O_4$] = 0.1 M and [$CdSO_4$] =28.78×10^{-2} M, 43.17×10^{-2} M . It has been observed that there is increase in rate constant with increasing concentration of KCl is observed variation in rate constant with KCl is shown in (Table No. 2)

Table No. 2 Effect of Salt [KCl] On Rate Constant (k sec-1)

[KCl] (M)	[$C_2H_2 O_4$] = 0.1 M [$CdSO_4$] 28.78×10^{-2}M	[$C_2H_2 O_4$] = 0.1 M [$CdSO_4$] 43.17×10^{-2}M	[$C_2H_2 O_4$] = 0.1 M [$CdSO_4$] 57.56×10^{-2}M
0.0	11.3×10^{-2}	22.2×10^{-2}	20.5×10^{-2}
0.1	2.2×10^{-2}	9.5×10^{-3}	13.2×10^{-3}
0.2	8.2×10^{-3}	11.2×10^{-3}	10.1×10^{-3}
0.3	8.3×10^{-3}	12.4×10^{-3}	11.9×10^{-2}

Table No. 2 Effect of Temperature on Rate Constant (k sec-1)

Temp	[$C_2H_2 O_4$] = 0.1 M [$CdSO_4$] 14.39×10^{-2}M	[$C_2H_2 O_4$] = 0.1 M [$CdSO_4$] 28.78×10^{-2}M	[$C_2H_2 O_4$] = 0.1 M [$CdSO_4$] 43.17×10^{-2}M
293^0 k	2.5×10^{-3}	3.2×10^{-3}	8.2×10^{-3}
299^0 k	3.1×10^{-3}	3.9×10^{-3}	13.5×10^{-3}
303^0 k	9.5×10^{-3}	11.5×10^{-3}	18.3×10^{-3}

From the values it has been observed that there is increase in rate constant with the increase in temperature.

From the values of rate constant activation energy of reaction were calculated by using Arrhenius equation i.e: $k = Ae^{-E/RT}$

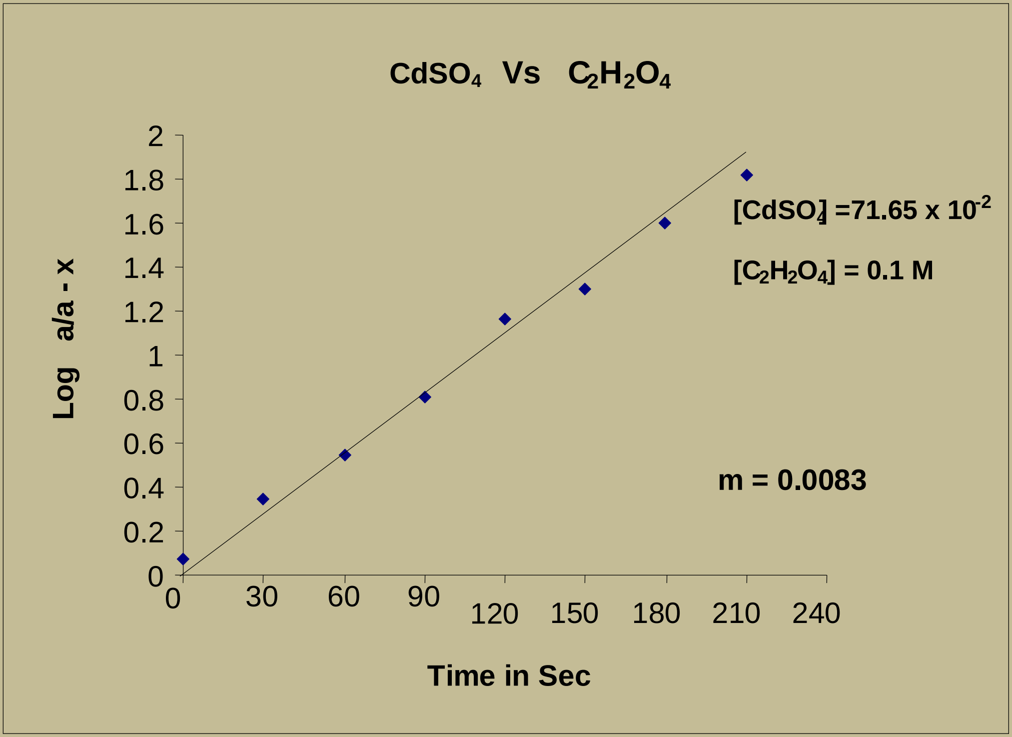
Free energy, ΔG^* is calculated by using equation

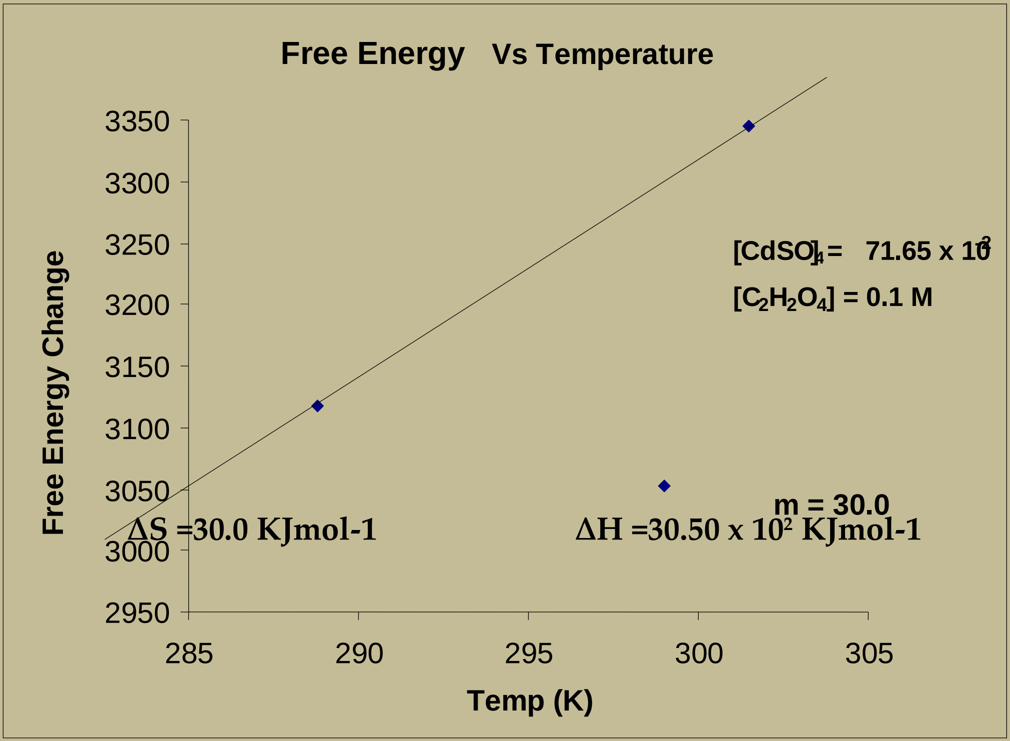
$$\Delta G^* = - RT\ln K$$

Free energy values at different temperature were calculated and graph of ΔG^* Vs Temperature was plotted which gives straight line, slope of this line is used to calculate ΔS^* values i.e. entropy change, intercept of this line gives values of ΔH^*.

$Ea^* = 34.80 \times 10^2$ KJ mol^{-1} $\Delta G^* = 30.1 \times 10^2$ KJ mol^{-1}

$\Delta H^* = 30.50 \times 10^2$ KJ mol^{-1} $\Delta S^* = -30.0$ KJ mol^{-1}





References:

(1) K H Liesr Interscience Angewandte chem international edition, 8(3), 188-202, 2004.

(2) Schneider, and G. Inden, Science Direct Acta Materiliavol, 53(2), 519-531, 2005.

(3) M.B. Bellakki, R T Mahesh, Ind. J. Chem, 43-(A), 1639, 2004.

(4) Ashish Kumar singh, Ind. J. Chem, 41-(A), 1654, 2004.

(5) Kabiruddin, Inter J. Chem, Kin (35), 543-554, 2003.

(6) Momin Nishat Parveen, Mazhar Farooqui, Mohsin Abdul Aziz Inter J of Chem Tech Research Vol. (2) pp871-875 june 2010

(7) Momin Nishat Parveen inter J of Recent Trends Science technology pp12-14 sept 2013

(8) Momin Nishat Parveen,Mazhar Farooqui, Mohsin Abdul Aziz, Proceeding inter national conference, pp4-6 jan 2012

(9) Momin Nishat Parveen ,Mazhar Farooqui, Sangeeta Sutar, Mohsin Abdul Aziz Inter J of M Chem dd, pp 189-195 Jan2015

(10) Momin Nishat Parveen World J of Pharmacy and Pharmaceutical Science PP 1426-1432 March 2015

(11) Gerald J Smith, **J. of Photo chem & Photobiology,** 169 (2), 147-152, 2005.

(12) De Lury, R.E, J Phy Chem., 11, 239, 1907.

(13) Luther and Rutter, J, Z org Chem, 54, 1, 1907.

(14) Lang and Zwerina, J. Z org Chem., 170, 389, 1928.

(15) Kessler F. Pogg; Ann 119, 218 1863.