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Research Article

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Spectral investigation of complex ion formation in $CrCl_3$-$CdCl_2$-water and $CrCl_3$-$CdCl_2$-$KClO_4$-water system

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Abstract

Spectral absorbance of $CrCl_3$-$CdCl_2$-water and $CrCl_3$-$CdCl_2$-$KClO_4$-Water system was studied by dye indicator method using eosin as a dye. In this method, keeping the concentration of dye and concentration of $CdCl_2$ and $KClO_4$ type of salt is constant with increasing concentration of $CrCl_3$ solution absorbance was measured, showing corresponding complex ion formation between salts

Key words: complex, absorbance, dye indicator, spectrophotometer, λ_{max}

INTRODUCTION

Considerable research work has been done in the past, on the study of complexes [1, 2]. The studies in metal-ligand complexes in solution of a number of metal ions with carboxylic acids, oximes, phenols etc. would be interesting which throw light on the mode of storage and transport of metal ions in biological kingdom. With the view to understand the bi-inorganic chemistry of metal ions, Banerjee et al[3] have synthesized a number of mixed-ligand alkaline earth metal complexes. Bjerrum's [4] dissertation has taken the initiative to develop the field. Metal complexation not only bring the reacting molecules together to give activated complex[5] but also polarised electrons from the ligands towards the metal.

By using a number of physico-chemical properties, Nayer and coworkers [6] shown that the nature of complex ions is unstable; showing breaks or peaks in curves obtained by plotting several physical property changes against concentration of the variant in mixed salt by mono variation method. The complex compound formed in water between lead and alkali nitrates are in the ratio of 1:1, 1:2 and 1:4, lithium nitrate is not complexing. They have also studied mercuric and alkali halide system using same physico - chemical properties and indicated formation of six complexes [7]

It was observed by means of interfacial tension measurement against butyl or amyl acetate, using mono variation method that zinc chloride formed with alkali halide three to six to seven complexes in aqueous solution as the salt concentration decreased. The dilution of alkali salt solution has to be progressively increased in order of Li > Na > K for formation of maximum number of possible complexes [8], as in the case of mercuric chloride or bromide system [9]. The degree of dilution is a measure of the magnitude of binding force between the anions and metal cations which is in the order $Li^+ > Na^+ > K^+$ in view of greater polarising effect of the smaller cations.

The formation of complex ions between any two salts such as copper, cobalt, nickel, cadmium, mercury was also investigated forming three or four complexes. This novel spectral method has been applied to study complex ions formation in lead-alkali nitrate and mercuric-alkali nitrate system confirming earlier findings [10]. Thus this type of specific optical property of absorbance at λ_{max} of the dye is very significant in the study of complex formation. However there should not be interaction of the dye with metal compounds. In the previous paper we have adduced

evidence for the existence of five complex ions in $CrCl_3$ – MCl_2 – water system using novel dye indicator method [11].

In the present work, the absorbance of pure dye solution taken as the standard was measured and absorbance at λ_{max} of the dye was taken as standard in case of dye – metal salt system While measuring absorbance with increasing metal salt concentration as variant and keeping the concentration of the other metal salt constant. Mono variation method used and dye concentration was kept constant.

EXPERIMENTAL SECTION

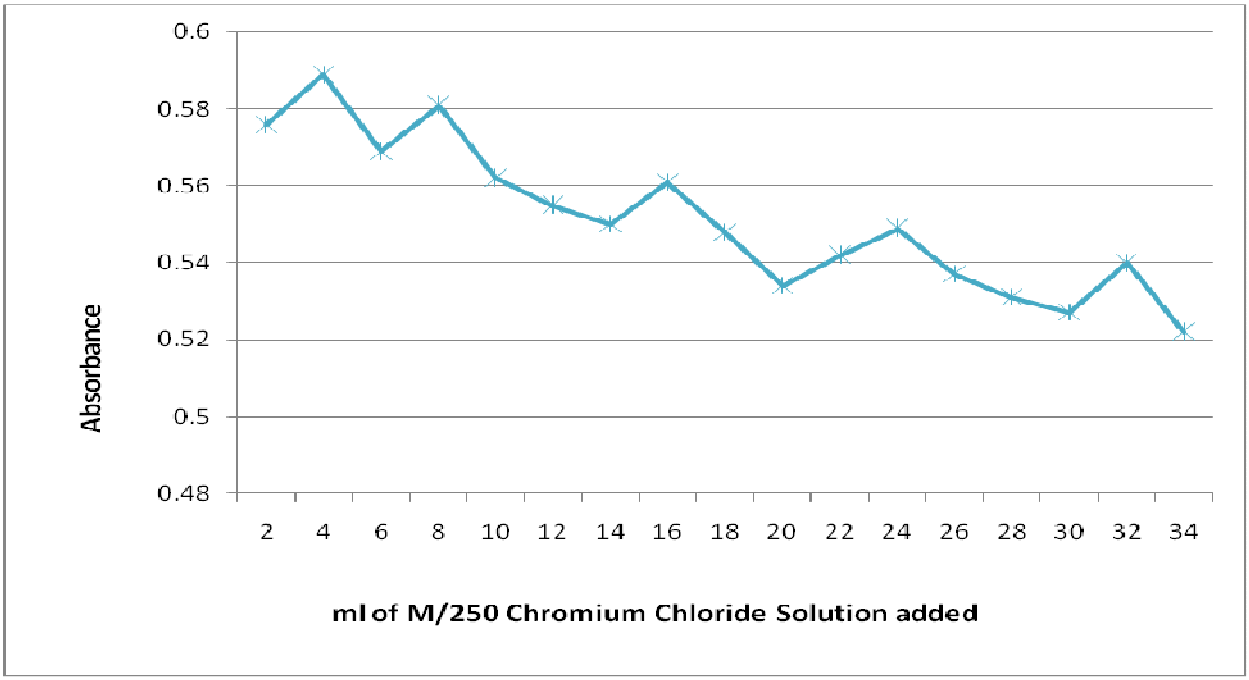
A shimadzu double beam spectrophotometer UV-150-02 was used for spectral measurements. Salts used were of AR grade and purified dye eosin was used as indicator. Here two systems were studied.

(1) In first system $CrCl_3$-$CdCl_2$-water system by keeping concentration of $CdCl_2$ and dye constant with increasing concentration of $CrCl_3$.
(2) In second system $CrCl_3$-$CdCl_2$-$KClO_4$-Water System by keeping concentration of $CdCl_2$, $KClO_4$ and dye constant with increasing concentration of $CrCl_3$.

RESULTS AND DISCUSSION

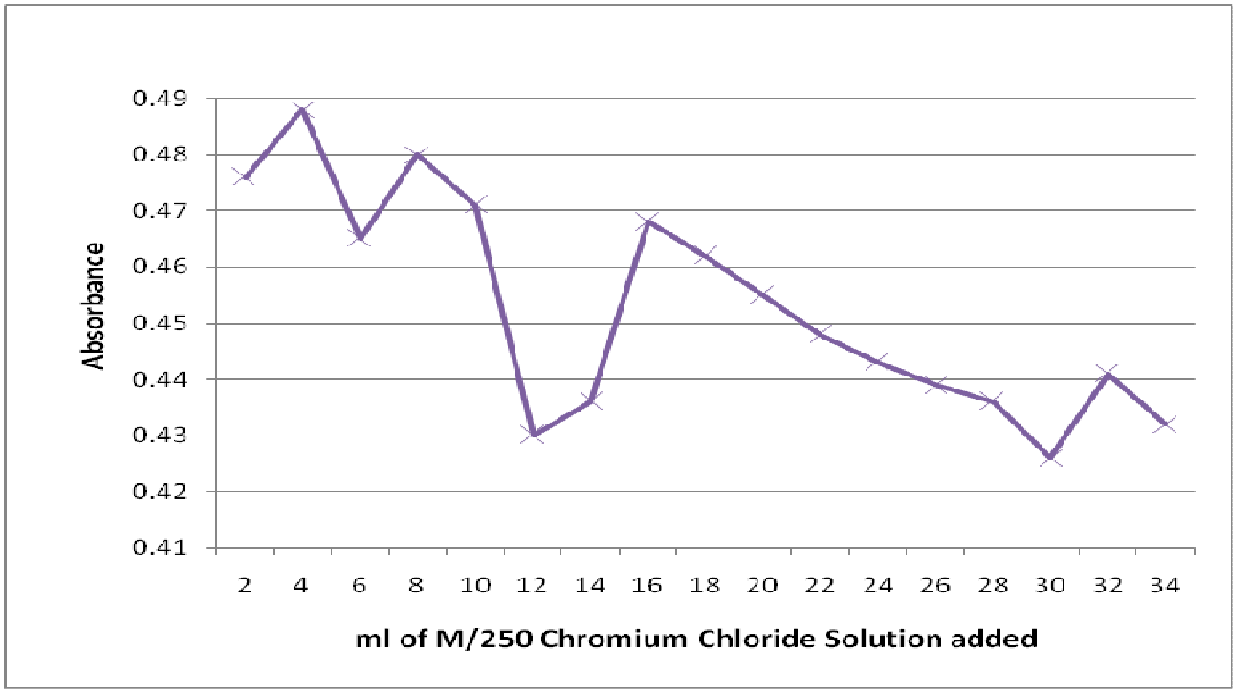
In first system, when such absorbance is plotted against increasing $CrCl_3$ concentration as variant the graph indicate five peaks corresponding to the ratio 1:4, 1:2, 1:1, 3:2, 2:1 observed in graph I. While in second system the mixture of $CdCl_2$ and $KClO_4$ being constant and $CrCl_3$ salt being variable, the graphs II, III, IV indicate 4, 3 and 2 peaks corresponding to the complex ion formation in the ratio of 1:4, 1:2, 1:1, 2:1 and 1:4, 1:1, 2:1 and 1:4, 2:1 respectively.

(GRAPH – I)



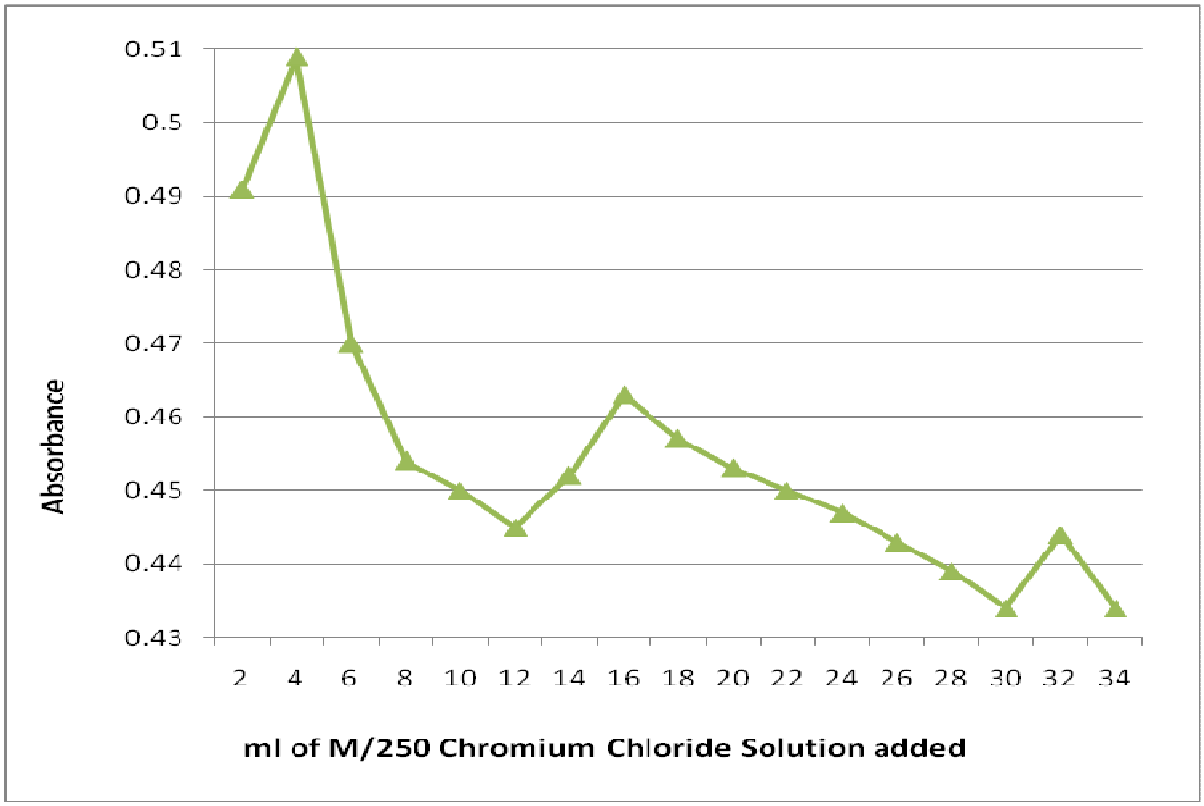
ml. of M/250 $CrCl_3$ + 16 ml. M/250 $CdCl_2$ + 10 ml. 1×10^{-4} M Eosin

(GRAPH – II)



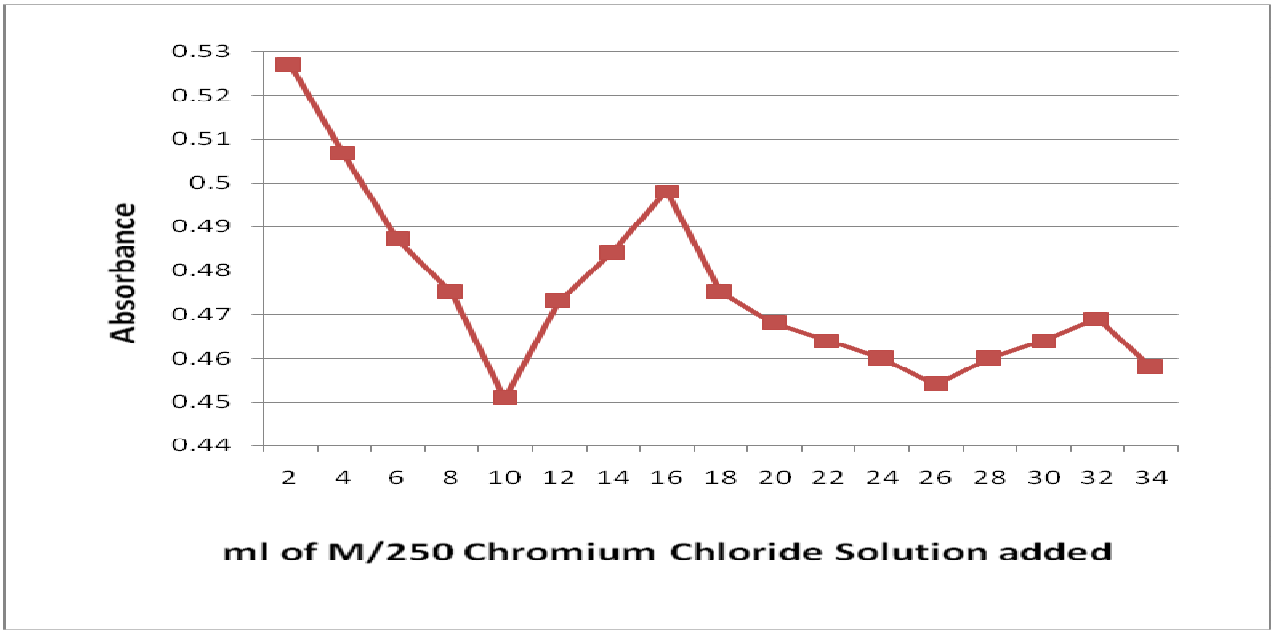
ml. of M/250 $CrCl_3$ + 16 ml. M/250 $CdCl_2$ +8 ml. 0.01M $KClO_4$ + 10 ml. 1×10^{-4} M Eosin

(GRAPH – III)



ml. of M/250 $CrCl_3$ + 16 ml. M/250 $CdCl_2$ +8 ml. 0.005M $KClO_4$ + 10 ml. 1×10^{-4} M Eosin

(GRAPH – IV)



ml. of M/250 $CrCl_3$ + 16 ml. M/250 $CdCl_2$ +8 ml. 0.0025M $KClO_4$ + 10 ml. 1×10^{-4} M Eosin

CONCLUSION

The peaks decreases from five to four to three to two as the $KClO_4$ is 0.01M, 0.005M, 0.0025M because per chlorate ion is known as least polarisable and has no tendency to form a complex with metal ions.

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