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# Physico Chemical Significance of Dye Indicator Method in Complex Ions Variation in Aqueous Methanol System of Chromium (III) Chloride – Sodium Chloride

**Mona S. Shah, R. B. Gamit and N. B. Patel**

*Department of Chemistry, The P.G. Science College, Bardoli, Gujrat, India*

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## ABSTRACT

*The Chromium (III) Chloride – Sodium chloride system was studied in aqueous phase spectrophotometerically and it was found that eight types of complexes were formed. The aqueous phase of the system was replaced by aqueous methanol phase and it was found that as the methanol concentration was increased in the system the dielectric constant decreased and complex formation susceptibility decreased.*

**Key words:** dye indicator, complex, spectrophotometer, dielectric constant

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## 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 polarized electrons from the ligands towards the metal.

In the previous paper [6] we had adduced evidence for the existence of eight complex ions in the aqueous phase of Chromium (III) chloride – alkali halide –water system.

In the present work Chromium (III) chloride – Sodium chloride system is studied in aqueous – methanol phase using novel dye indicator method.

## MATERIALS AND METHODS

A shimadzu double beam spectrophotometer UV-150-02 was used for spectral measurements. The chemical used in the study are of AR grade. Chromium (III) chloride and sodium chloride solution of M/100 and M/100 respectively and dye crystal violet 1 x $10^{-4}$M concentration solution was prepared in aqueous methanol (50,55,60,65, 70,75,80,85,90%).

For spectral study by mono variation method different sets of solutions were prepared, increasing Chromium (III) chloride concentration and sodium chloride – dye concentration being kept constant.

## RESULTS AND DISCUSSION

When absorbance of pure dye solutions was measured and plotted against increasing Chromium (III) chloride ; the graph indicate peaks corresponding to the ratio of concentration of the two salts in stoichiometric proportion for the system. The complexation ratio and formulae of the complexes are tabulates in table 1 and 2 respectively.

**(Table – 1)**

| Sr. No. | Reference | $\lambda_{max}$ (nm) | No. of Peaks | Complexation ratio |
|---|---|---|---|---|
| 1 | Water | 585 | 8 | {6:1, 4:1, 3:1, 2:1, 3:2, 1:1, 2:3, 1:2} |
| 2 | 50% methanol | 584 | 8 | {6:1, 4:1, 3:1, 2:1, 3:2, 1:1, 2:3, 1:2} |
| 3 | 55% methanol | 584 | 8 | {6:1, 4:1, 3:1, 2:1, 3:2, 1:1, 2:3, 1:2} |
| 4 | 60% methanol | 584 | 7 | {4:1, 3:1, 2:1, 3:2, 1:1, 2:3, 1:2} |
| 5 | 65% methanol | 584 | 6 | {4:1, 3:1, 2:1, 3:2, 1:1, 1:2} |
| 6 | 70% methanol | 582 | 5 | {4:1, 3:1, 2:1, 1:1, 1:2} |
| 7 | 75% methanol | 582 | 4 | {4:1, 3:1, 2:1, 1:1} |
| 8 | 80% methanol | 582 | 3 | {3:1, 2:1, 1:1} |
| 9 | 85% methanol | 582 | 2 | {3:1, 2:1} |
| 10 | 90% methanol | 582 | 1 | {2:1} |

**(Table – 2)**

| Complexation ratio | Molecular formula of complexes |
|---|---|
| 6:1 | $6NaCl : CrCl_3 = Na_6[CrCl_9]$ |
| 4:1 | $4NaCl : CrCl_3 = Na_4[CrCl_7]$ |
| 3:1 | $3NaCl : CrCl_3 = Na_3[CrCl_6]$ |
| 2:1 | $2NaCl : CrCl_3 = Na_2[CrCl_5]$ |
| 3:2 | $3NaCl : 2CrCl_3 = Na_3[Cr_2Cl_9]$ |
| 1:1 | $NaCl : CrCl_3 = Na[CrCl_4]$ |
| 2:3 | $2NaCl : 3CrCl_3 = Na_2[CrCl_{11}]$ |
| 1:2 | $NaCl : CrCl_3 = Na[Cr_2Cl_7]$ |

## CONCLUSION

In Chromium(III) chloride – sodium chloride system eight type of complexes were formed in aqueous phase. When aqueous phase of the above system was replaced by aqueous methanol with increasing methanol concentration up to 90% , number of complexes decreased from eight to one. One explanation of this result is that a water molecule bound by H-bond to methanol molecule is less nucleophilic than water dipole H-bonded to another water molecule. Another reason is the addition of methanol decreases the dissociation of complex ion with decreasing dielectric constant which also discourages anionic ion dissociation. This behavior of water-methanol system can be visualized in the light of change of water structure in presence of alcohol. Many properties of liquid water suggested that it is a mixture of fluctuating regions of three dimensional H-bonded polymers in equilibrium with randomly arranged $H_2O$ monomer molecules. Aliphatic alcohols also have a considerable fraction of molecules joined in ring and chains, but they do not seem to participate in the formation of three dimensional clusters characteristics of water; when alcohol is added to water, highly polar structure of water is destroyed progressively as alcohol content increased. Thus hydrogen bonding between adjacent $H_2O$ molecules will be replaced by H-bonding with methanol and structure of water will be largely broken. Hence the number of complex ions decrease with increasing contentment of methanol. [7-10]

## REFERENCES

[1] A. E. Martell and M. Calvin : *Chemistry of metal chelate compounds*, Prentice Hall, Inc. England, Cliffs, N. J.**1962.**
[2] F.H.C. Rossotti and H. Rossotti : *The determination of stability constants*, McGraw Hill Book Co.
[3] A. K. Banerjee and T.V.R. Rao, *J. Indian Chem. Soc.* **1968**, 63, 480.
[4] J. Bjerrum : *Metal amine formation in aqueous solutions*, P. Hasse and Sons, Copenhagen **1941.**
[5] A. T. Florence and D. Attwood: *Physical principle's of pharmacy*, Macmillan. London **1981**.
[6] Mona S. Shah, G. C. Desai and M. B. Mahida, *Der Pharma Chemica* **2013**, 5(2), 212-215
[7] H. P. Benetto and E. F. Cadlin, *J. Chem. Soc*., **1971**, A, 2191
[8] A. A. Zaghloul, S. A. El-Shazly, K. A. Odha, M. F. Amira and F. M. Abdel-Halim, *J. Ind. Chem. Soc*., **1996**, 73, 572
[9] S. C. Dutta and S. C. Lahiri, *J. Ind. Chem. Soc*., **1995**, 72, 315
[10] V. K. Sharma, G. P. Yadav and Jaibir Singh, *J. Ind. Chem. Soc*., **1995**, 34A, 594