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Spectrophotometric Determination of Arsenazo-III Using Transition Metals.

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ABSTRACT

Arsenazo –III, an azo dye, has structure which enables it to act as a chelating agent. The formation of transition metal complexes of arsenazo-III has been studied spectrophotometrically. Arsenazo-III forms stable complexes with three of the transition metal Mn^{2+}, Fe^{2+}, and Co^{2+} having absorption maximum at 620nm, 560nm, and 622nm respectively. By using Job's method of continuous variance and mole ration method the metal: ligand ratio in all the three complexes was found to be 1:1. The values of log of complex formation constant for the arsenazo-III: Mn^{2+} complex is 5.43, for arsenazo-III: Fe^{2+} complex is 5.43 and for arsenazo-III: Co^{2+} complex is 5.43.The formed complexes show stability with respect to time.
Keywords: Transition metals, Chelate, Arsenazo-III, Formation constant.

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INTRODUCTION

Arsenazo III is an azo dye derivative of chromotropic acid used extensively for spectrophotometric analysis. Its high sensitivity, low selectivity and ability to form stable complexes over a wide pH range and in concentrated acid, has resulted in numerous uses.

Transition metals differ from main group metals in several by properties. One of the most interesting is their ability to form coordination compounds. Among the important metal ions in biological system elements like Mn, Fe, Co have been found essential for the plant and animal growth. A survey of chemical literature, reveals few references of arsenazo III complexs with transition metals [1-10]. The nature and composition of the complex have been determined spectrophotometrically. In this communication the composition and stability of the chelate formed by arsenazo-III with Mn^{+2}, Fe^{+2} and Co^{+2} have been reported.

EXPERIMENTAL

An ECIL made PC based double beam UV-Visible spectrophotometer UV 5704 SS was used for absorbance measurement using matched quartz cells. Arsenazo-III and $MnCl_2$, $FeSO_4$, $CoCl_2$ were obtained from BDH. All the reagents were of analytical grade. The solutions were prepared in double distilled water. pH was measured on EC made L 1612 microprocessor based pH- meter. All the experiments were performed at $25+0.1°C$. The total volume of the mixture prepared for the measurement was kept 25 ml. The requisite amounts of buffer solutions were added to maintain the desired pH.

The method applied for determination of stability constant are Job's method of continues variation[11] and Dey and Coworkers' [12] method and mole ratio method [13]. The method of Vosburgh and Cooper[12] was employed to determine the nature of the complexes formed in the solution.

RESULT AND DISCUSSION

In view of the observation of Dey and Coworkers [12], the organic chelating agents behave as colloidal electrolytes; dilute solutions of 10^{-4} M and 10^{-5} M of arsenazo-III were employed to avoid complications in absoptiometric measurements. With variation in hydrogen ion concentration arsenazo-III changes its colour and its region of maximum absorption is found to shift. From table-1 it is concluded that arsenazo III exists in two different forms depending upon the pH of the solutions.

The method of Vosburgh and Cooper [13] was employed to determine the nature of the complexes formed in solution. The reagent alone showed a maximum absorption at 530 nm at pH range 2 to 9, but mixtures containing varying proportions of metals (Mn^{+2}, Fe^{+2} and Co^{+2}) and ligand (Arsenazo-III) i.e. 0:1.0, 1:0.5, 1:1, 1:2, 1:3, 1:4 had λmax at 620 nm for Mn^{+2} & Co^{+2}, 560 nm for Fe^{+2} indicated under the condition of study.

The color formation is instantaneous and the absorbance values remain constant for 72 h. No significant change occurs when the order of addition of the reaction of the reactants is altered.

For determining the empirical formula of the chelate formed under the experimental conditions, mole ratio method (figure 1), and method of continues variation (figure 2) were used. It was found that the combining ratio of these metals with Arsenazo- III was 1: 1 at 7.2 pH and λmax 620nm for Mn^{+2} & Co^{+2} and 5.5 pH and λmax 560nm for Fe^{+2} suggesting the formation of M (arsenazo-III).

The apparent stability constants were calculated by these different methods. Values of log K are reported in table -2.
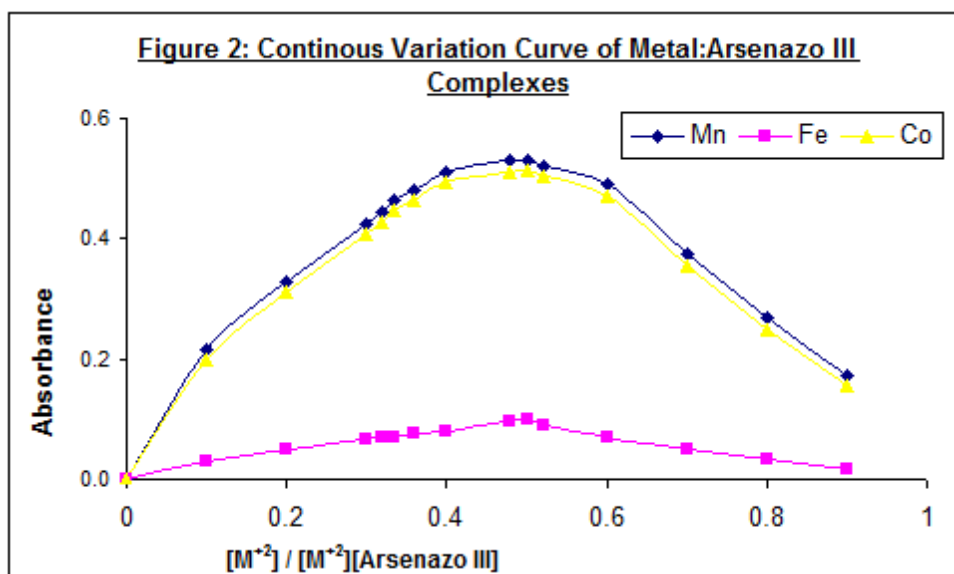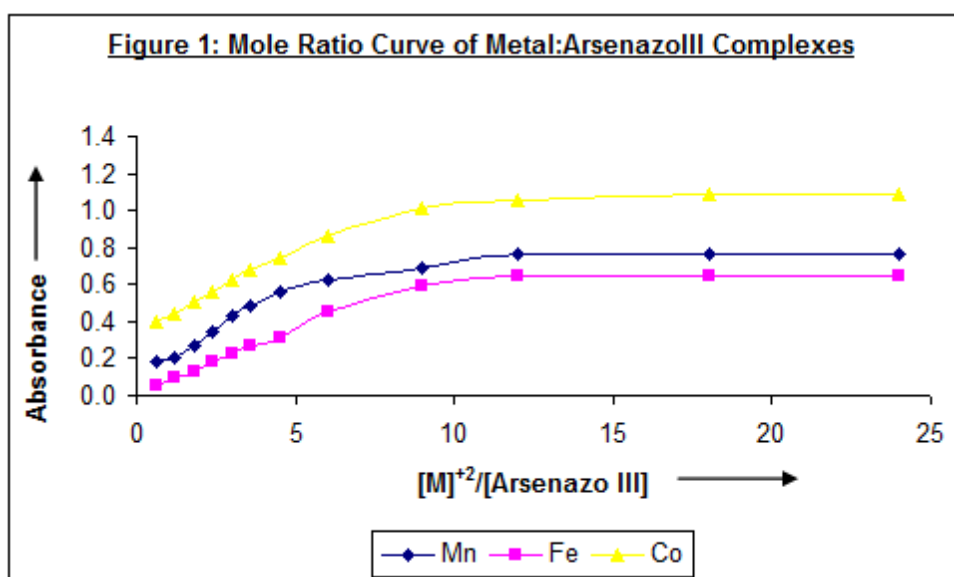
The maximum colour formation is only attained when the mixture contains five & six fold concentration of the reagent with the metal ion. The effective pH range for the determination of using Mn^{+2}, Fe^{+2} and Co^{+2} arsenazo III as a spectrophotometric reagent.

TABLE-1: Shift of λ_{max} of Arsenazo-III With pH

pH	Region of maximum Absorption (nm)
2-9	530
Above 9	550

TABLE -2: Values of log K and free energy of complexes

Method	Mn^{+2}- Arsenazo III	Fe $^{+2}$-Arsenazo III	Co^{+2} -Arsenazo III
The Mole Ratio Method	5.49	4.75	5.65
Continuous Variations	5.38	4.73	5.58
Average value of log K	**5.43**	**4.74**	**5.61**

Figure 1: Mole Ratio Curve of Metal:ArsenazoIII Complexes

Figure 2: Continous Variation Curve of Metal:Arsenazo III Complexes

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