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Stability studies of cadmium (ii) in presence of 2-(3, 4-Dimethoxy benzylidene Amino)-2-methyl propane-1-ol by using dc polarography in 40% v/v methanol-water system

K Ramanjaneyulu, P Malleswara Reddy, V Krishna Murthy Naik and K Sudhakar Babu

Abstract

Nowadays consciousness on metal pollution increases, heavy metal pollution reduction strategies became major field of interest. In literature many organic reagents were used to determine heavy metals and their stability studies were done. Apart from potentiometry, polarography is one of the best electro analytical technique to study the stability of metal complexes, In this present investigation author studied stability of Cd(II) in presence of 2-(3,4-dimethoxy Benzylideneamino)-2-methyl propane-1-ol by dc polarography. Colourless 2-(3, 4-dimethoxy Benzylideneamino)-2-methyl propane-1-ol (B.P.103°C) is prepared by condensation of 2-amino-2-methyl-1-propanol and 3, 4 dimethoxy benzaldehyde and purified. Characterized by IR, UV and Elemental analyzer. Current-voltage curves of 2-(3, 4-Dimethoxy Benzylidene Amino)-2-methyl propane-1-ol and Cadmium (II) recorded separately by using An ELICO DC recording polarograph model CL-357 (Digital). Saturated calomel electrode (SCE) was used as reference electrode. An ELICO glass capillary having the following characteristics $m = 1.7434 \text{ mg sec}^{-1}$, $t = 4.00 \text{ sec}$ at constant height of mercury head 67.0 cm (in 0.1M KNO_3 in open circuit) was used. Effect of hydrogen ion concentration, Effect of Ligand concentration, Effect of height of mercury column on polarograms of azomethine was studied. Millicoulometric method is employed in order to calculate electron donating probability of new azo methine. After this polarographic behavior of Cd (II) in presence of new azomethine studied in 40% v/v methanol-water system. Deford-Hume method employed to evaluate consecutive stability constants $[F_0]$ $[F_1]$ $[F_2]$ $[F_3]$ $[F_4]$ and metal to ligand ratio of metal with organic reagent. From this studies it was observed that Cd(II) complex showed irreversible two electron reduction and 1:4 metal to ligand ratio with consecutive stability constants as $\beta_1 = 0.90 \times 10^2$, $\beta_2 = 5.0 \times 10^3$, $\beta_3 = 2.30 \times 10^5$, $\beta_4 = 4.0 \times 10^6$.

Keywords: cadmium, azomethine, deford - humemethod, DC polarography

Introduction

Cadmium usually undergoes reversible electrode reaction at D.M.E with two electron reduction in presence of supporting electrolytes as well as Complexing agents. Perusal of literature revealed that number of references was cited in the literature employing various techniques about the behavior of Cadmium towards Schiff bases derived from Alkanolamine and carbonyl compounds. Vyas *et al* ^[2] were the first to report complexes of cadmium with Schiff bases namely salicylaldehyde Tris (ST) and benzaldehyde Tris (BT) in 60% (V/v) Methanol - Water medium using potentiometry. They also presented the Polarographic evidence for Cadmium Schiff base complexes with ST, BT and also with Vanillin Tris (VT) ^[3]. The same authors while studying the complexation of cadmium ion with ST established a new method for the determination of ligand-proton stability constant by Polarographic method ^[1]. The stability constants and molar absorptivities of complexes of copper (II) with 2-Amino-2-Mehtyl-Propanol (AMP) in aqueous medium were determined employing spectrophotometric method ^[8] even the available few references on metal complexes of AMP not emphasized the applications of those complexes in biological fields. Synthesis, Structural, Magnetic and Spectral properties of alkanolamine complexes of Pt, W, Ni, Ag, Au and Zn have been reported ^[4-10]. In addition to Tris, AMP is one of the important compounds of unique series of alkanolamines. Literature survey reveals that significant Alkanolamine such as Tris has also been employed extensively as a complexing agent in polarographic analysis. Millicoulometric method developed by Devris and Kroon ^[19] used a mercury poolcathode

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was one of the best method to determine the electrons(n) donated by ligands. The value of 'n' determined by using formula

$$n_2 = n_1 (\Delta i_d \text{ cad} / i_d \text{ cad}) (i_d \text{ sub} / \Delta i_d \text{ sub}) C_1 V_1 / C_2 V_2 \quad \dots\dots(1)$$

Where

i_d = diffusion current (μA)

Δi_d = change in the diffusion current (μA) of polarograms obtained, when the experimental solution is subjected to the electro-reduction.

n_1 = number of electrons involved in the reduction of cadmium ions.

n_2 = number of electrons involved in the reduction of substrate, (4a).

De Ford and Hume [3] developed a method for determining consecutive formation constants of complex ions from polarographic data. It is a method of mathematical analysis of the shift of half-wave potentials with Ligand concentration which makes possible the identification of successive complex ions formed and the evaluation of formation constants. De-Ford and Hume method is best suited for the study of series of complexes of moderate and comparable stability. Include synthesis. Keeping all the above mentioned facts in view the author in the present research investigation Synthesized 2-(3, 4-dimethoxy Benzylideneamino)-2-methyl propane-1-ol. Polarographic behaviour of this compound was tested and then polarographic behaviour of cadmium in presence of newly synthesized azo methane.

Experimental

(I) Synthesis of new azomethine (2-(3, 4-Dimethoxy Benzylidene Amino)-2-Methyl Propane-1-ol)

0.05 moles of 3,4-dimethoxybenzaldehyde or Veratraldehyde (brought from SL scientific) was added to a mixture of 50ml of methanol and 5ml 0.05M 2-Amino-2-methyl-1-propanol (AMP) and 50ml of double distilled water. The reaction mixture was taken in a clean 250ml round bottom flask and stirred well with a magnetic stirrer. Then it was refluxed for 8 hours. A colourless product was formed. It was separated by filtration and washed several times with hot water and methanol and dried in vacuum. This compound was recrystallized from methanol. The percentage of yield was 70% and melting point of the compound was 103°C.

(II) Electrochemical Studies

All chemicals used were of Analar Grade. A stock solution (0.1 M) of Cadmium (II) in a 250 ml volumetric flask was prepared using AR Cadmium acetate (Merk) and standardized gravimetrically. Recrystallized Compound (i) were used as complexing agents. As the ligand was not freely soluble in water, 40% V/V methanol-water medium was maintained uniformly throughout the experiment to establish the Complexation towards Cadmium. The $E_{1/2}$ of Cd has been determined in similar conditions in order to avoid discrepancy due to liquid-junction potential. The ionic strength was kept constant at 0.1M by using potassium nitrate. 0.002% Triton-X-100 was used as maximum suppressor. Double distilled mercury was employed for dropping mercury electrode. Purified mercury was employed for deoxygenation of all test solutions prior to recording. All the solutions were prepared in double distilled water. DC recording polarograph model CL-357 (Digital) was used for recording the polarograms.

Saturated calomel electrode (SCE) was used as reference electrode. An ELICO glass capillary having the following characteristics $m = 1.7434 \text{ mg sec}^{-1}$, $t = 4.00 \text{ sec}$ at constant height of mercury head 67.0 cm (in 0.1M KNO_3 in open circuit) was An ELICO used. The pH measurements of the solutions were recorded with an ELICO digital pH meter model (LI 120) and pH adjustments were made using 0.1 M HNO_3 and 0.1 M NaOH . Solutions were taken in the H-type cell of Lingane and Latimer for recording polarograms. Toshniwal Thermostat type GL-15 was used to keep the temperature at 30 ± 0.1 °C. Polarographic studies of azomethine carried out in Britton-Robinson buffer solutions of pH 2.1 – 10.1. Effect of Mercury column height was carried out at pH 4.10. Kinetic parameters and Redox behavior were carried out at pH 2.10-10.10

Results and Discussion

Characterization of azomethine

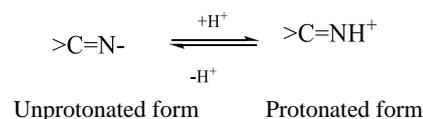
Compound (i) show OH- $3446(\text{cm}^{-1})$ Ar-H $-3003(\text{cm}^{-1})$ Aliphatic C-H $-2926(\text{cm}^{-1})$ $>\text{C}=\text{N}569(\text{cm}^{-1})$, compound (i) showed two UV bands near 328 nm due to $\pi-\pi^*$ another one at 332 nm due to $n-\pi^*$. Elemental analysis shows carbon% (65.77%), Hydrogen (7.98%), Nitrogen (5.05%) all the above data confirms that molecule having following molecular formula $\text{C}_{13}\text{H}_{19}\text{NO}_3$,

(ii) Polarographic behaviour of azomethine

Azomethine in Britton-Robinson buffer solution exhibit one wave in the pH range 2.1-10.1. An inspection of the structure of reveals that the sites susceptible for reduction at the dropping mercury electrode were the exocyclic $>\text{C}=\text{N}$. The Polarographic reduction wave observed with compound was attributed the reduction of Azomethine group ($>\text{C}=\text{N}$). A polarographic wave generally exhibits one or other of the following characteristics. The results presented in the Tables that in the present investigation both the half-wave potential and limiting current were pH dependent.

Effect of pH on the half-wave potential

The results showed that the half-wave potential increases with increase in pH in the acid range but it remains unaltered in the alkaline pH range. The plot of the half-wave potential and the pH was a straight line up to pH 8.1 and the slope lies between 80-110 mV. The p (number of protons) values were low and non-integers. This suggests that the proton transfer in the reduction process was a heterogeneous process. The shift in the half-wave potentials with pH of the solution can therefore be ascribed to the following reasons. (i) Both protonated form and unprotonated form of the depolariser were electro active. There exist an equilibrium between protonated form and unprotonated form [13]. The unprotonated form is reduced at more negative potentials than protonated form of the azomethine group.



- The pH dependence of the half-wave potential was caused not only by the antecedent chemical acid-base reaction but also by the consumption of protons in the reduction process.
- The pH of the solution in bulk was different from pH values at the electrode surface. In the presence of electric

field the inequality was observed $\Delta(pH_s) < \Delta(pH_o)$ as the equilibrium shifted towards the unprotonated form, the $E_{1/2}$ remains constant. It is seen from that above pH 8.1, the shift in half-wave potential with pH was not so marked as in the acidic pH range.

$E_{1/2}$ – pH of Polarographic wave was $\sqrt{}$ shaped in the pH range of study. The $E_{1/2}$ becomes practically constant in the alkaline pH range and this constancy in $E_{1/2}$ may be due to the fact that both acidic and basic forms of the depolariser were electroactive. But in the pH range where the protonation rate decreases, the half-wave potentials of both the protonated form (acidic) and the unprotonated form (basic) were so close to each other that the waves merge ^[14] and a single wave was observed. $E_{1/2}$ vs pH graph consists of two linear segments intercepting each other and the point of interception of the two linear plots was approximately equal to pK_1 .

Effect of the height of the mercury column head (h) on the limiting current (i)

The effect of mercury column height on the limiting current indicates the diffusion controlled nature of the polarographic wave. The i_l versus $h^{1/2}$ plots are linear and passing through the origin. The values of $i_l/h^{1/2}$ were constant as shown in the Table-1. The three Polarographic reduction waves were found to be diffusion controlled wave.

Table 1: Effect of Mercury Column height (h) on the limiting current (i) of VER-AMP (1×10^{-3} M) Medium: aqueous dimethyl form amide (40% v/v)

Mercury column height (h) (cm)	pH=4.1		pH=8.1	
	First wave		First wave	
	i_l (μ A)	i_l/\sqrt{h}	i_l (μ A)	i_l/\sqrt{h}
80	3.5	0.38	3.1	0.34
70	3.2	0.38	2.81	0.34
60	2.90	0.36	2.50	0.32
50	2.61	0.36	2.30	0.32

Effect of concentration of the depolariser on the diffusion current

The effect of concentration of the depolarizer on the diffusion current of Schiff bases on the diffusion current in concentration range of 0.20 – 2.0 M has been studied at typical pH values 4.10. The i_l versus concentration graphs were linear, and are passing through the origin. The constancy of i_l/C values serves not only as a test for the diffusion controlled nature of the wave but also indicates the applicability of the polarographic method for the quantitative determination of azomethine. From the results it was concluded that the two Polarographic reduction waves noticed in the acidic pH 4.1 were diffusion controlled waves.

The experimental results observed from the effect of concentration and mercury column height on the limiting current confirmed the diffusion-controlled nature of the limiting current. The electrode processes was found to be irreversible at low acidic pH values unlike the reversible electrode process observed for simple azo and azomethine compounds ^[15] under comparable conditions. The irreversible nature of the process observed in the present investigations was also further confirmed by

- (a) The slopes of (0.08-0.15) of the semi-logarithmic plots (E_{de} Vs $\log \frac{i}{i_d - i}$) do not confirm to the values expected for two or four electrons reversible reduction process respectively.

- (b) $E_{1/2}$ shifts towards more negative potentials with increase in the depolariser concentration ^[16]
- (c) The heterogeneous rate constant ($k_{f,h}^o$) calculated from the Meites–Israel equation ^[17], the $K_{f,h}^o$ values in the present investigations were less than 10^{-4} .

$$E_{1/2} = 0.2412 + 0.05915/\alpha n_a \log 1.349 k_{f,h}^o - 0.05915/\alpha n_a \log D_o^{1/2} \dots\dots(2)$$

- (d) The ΔG^* values computed from the relation $k_{f,h}^o = KT/h \gamma_o \exp(\Delta G^*/RT)$..(4) Increases in pH range 1.1 – 7.1 and remains unaltered in alkaline pH range 8.1 – 10.1.

These observations suggest that the Polarographic reduction of azomethine (>C=N-) was found to be irreversible in nature. This may be due to the presence of bulky groups at the end of the >C=N- groups.

Effect of pH on the limiting current

It is observed from the Table-2, the height of the wave decreases with increase of pH and this suggests that both the protonated form (acidic) and the unprotonated form (basic) were transported to the electrode surface, and both of them may be electroactive. The limiting current depends on the nature of electro active species.

Table 2: Polarographic results of azomethine in Briton Robinson buffer solutions (1×10^{-3} M) Medium: Aqueous DMF (40% v/v)

pH	$E_{1/2}$ vs SCE	Limiting Current i_l (μ A)
2.1	0.51	3.6
3.1	0.60	3.6
4.1	0.69	3.6
5.1	0.78	3.5
6.1	0.87	3.4
7.1	0.96	3.3
8.1	1.05	3.0
9.1	1.05	3.0
10.1	1.05	3.0

Electrode reaction

The plots of $-E_{dme}$ versus $\log i/i_d - i$ shown in the Figs. at typical pH 4.1 were linear but the slopes are not in agreement with the theoretical values (0.030 V and 0.015 V for 2-electron and 4-electron reduction, respectively) expected for the reversible waves. This indicates that the electrode reaction is irreversible. The slopes further indicate that the tendency of the irreversibility increases with increase in the pH. Tome’s criteria ^[18] was also employed to determine the irreversible nature of the polarographic wave. It gives the relationship between $E_{1/4}$ and $E_{3/4}$ as follows.

$$E_{1/4} - E_{3/4} = 0.0564/\alpha n_a V \text{ for reversible} \dots(3)$$

$$E_{1/4} - E_{3/4} = 0.05172/\alpha n_a V \text{ for irreversible} \dots(4)$$

It follows from the equation (13) that the difference between potentials $E_{1/4}$ and $E_{3/4}$ depends only on the number of electrons (n_a) exchanged in the elementary process. The αn_a values obtained from the above equation are almost equal to the values obtained from conventional logarithmic plots. The αn_a values obtained from conventional log plots are shown in the Tables 10-15.

The half-wave potential increases with pH and this suggests that the protons are involved in the reduction process. The number of protons involved in the reduction process is calculated from the equation (14). The half-wave potential remain constant in alkaline pH range 8.1 – 10.1

$$\Delta E_{1/2}/\Delta pH = 0.05915/\alpha n_a p \dots\dots\dots(5)$$

Millicoulometric Method

There is much interest in knowing the number of electrons (n), involved per molecule during the reaction at the dropping mercury electrode. The use of Ilkovic equation $i_d = 607 n D^{1/2} m^{2/3} t^{1/6} C$ to determine 'n' from the average diffusion current (i_d) and other quantities, requires a knowledge of the diffusion coefficient of the depolariser undergoing electrochemical reduction. This obviously has a limitation. Another method was based on a fundamental equation for the polarographic wave is even more restricted because it applies only to electrochemically reversible reaction and to the rate limiting steps. It is possible to determine the value of 'n' (number of Faradays per mole of electrode reaction) by the method developed by De-Vris and Kroon [19] and this method was shown to give results within $\pm 2\%$ for several organic compounds.

$$E_{dme} = \frac{E_{1/2} - 0.05912 / \log i/(i_d - i)}{\alpha n} \dots\dots(6)$$

A mercury pool cathode was used for determining the number of electrons (n) in the millicoulometer described by De-Vris and Kroon [19]. The value of 'n' was determined using the formula.

The Millicoulometric experiment was performed on I in Britton-Robinson buffer solution of pH 4.1 containing 40% (V/V) aqueous dimethyl formamide. The Millicoulometric data was shown in the Table-3. The I in the experimental conditions exhibit one Polarographic reduction wave. The Polarographic reduction wave was ascribed to the electron reduction (I) of azomethine >C=N- group to amine stage. The Milli Coulometric experiment was performed by with CdSO₄ as reference standard.

Table 3: Polarographic characteristics and kinetic parameters of new azomethine (1x 10⁻³mm) Medium: Aqueous dimethyl form amide (40% v/v)

pH	-E _{1/2} /pH (Mv)	α_{na}	No. of protons p	D X 10 ⁻⁶ cmsec ⁻¹	I* X 10 ³	K ⁰ fh cm sec ⁻¹	ΔG^* k cal mole ⁻¹
2.1	0.086	0.43	0.54	3.02	4.1	4.19x10 ⁻⁴	9.07
4.1	0.086	0.45	0.62	2.40	3.4	3.01x10 ⁻⁴	10.01
6.1	0.086	0.51	0.76	1.50	2.8	1.52x10 ⁻⁴	10.89
8.1	0.086	0.63	0.91	0.43	1.2	5.10x10 ⁻⁵	11.45
10.1	0.086	0.63	0.91	0.43	1.2	5.10x10 ⁻⁵	11.45

(iii) Polarographic behavior of cadmium (II) in presence of azomethine

The effect of hydrogen ion concentration on the Polarographic reduction of Cadmium (1.0 mm) in presence of constant concentration (0.06 M) of newly synthesized azomethine (i) and in 0.1 M KNO₃ as supporting electrolyte, has been studied. Well defined Polarographic waves were obtained for Cadmium over the pH range 7.0 to 11.0 in presence of new azomethine. Studies at lower pHs were not carried out because of precipitation.

From the experimental results it was observed that the hydrogen ion concentration has a considerable effect on the half-wave potentials and diffusion currents of Cadmium. The diffusion current was decreased, whereas the half-wave potentials were shifted to negative values in all the instances with increase in pH values (Table-4). Slope values obtained from E_{de} vs $\log \frac{i}{i_d - i}$ revealed that the electrode reaction at D.M.E. was reversible with two electron reduction. The stock solutions (0.1 M) of compound (i) showed a pH value in between 8.0 and 9.0. Hence for uniformity sake pH 8.0 was fixed in all the cases to carry out other Polarographic studies such as effect of ligand concentration, effect of height of

mercury column and effect of metal ion concentration.

Table 4: Effect of pH on Cadmium – new azomethine complex

pH	E _{1/2} -V vs SCE	Slope mV
7.0	0.606	30.43
8.0	0.609	30.43
9.0	0.621	30.77
10.0	0.633	28.57
11.0	0.648	29.17

The effect of ligand concentration was studied using the solution containing 1.0 mm Cd²⁺, 0.1 M KNO₃ at pH 8.0. For all the systems studied, single, well-defined waves were obtained. From polarograms, it is observed that the half-wave potentials shifted towards more cathodic values whereas diffusion current decreased with increase in concentration (0.005 to 0.1 M) of the Schiff bases indicating complex formation. Log plots drawn between E_{de} vs $\log \frac{i}{i_d - i}$ were found to be linear (Fig-1) and the slope values obtained from the graphs revealed that the electrode reaction was reversible with two electron reduction. The results are incorporated in Table-5.

Table 5: Effect of ligand VER-AMP concentration on cadmium

[Ver-Amp]	E _{1/2} -V vs SCE	i _d μ A	Slope mV
0.005	0.5520	5.20	31.58
0.008	0.5550	5.46	29.17
0.010	0.5580	5.34	31.25
0.020	0.5700	5.28	32.00
0.030	0.5820	5.22	30.77
0.040	0.5910	5.10	31.82
0.050	0.6000	5.04	30.77
-0.060	0.6090	4.92	30.43
0.080	0.6210	4.86	28.57
0.100	0.6300	4.62	27.77

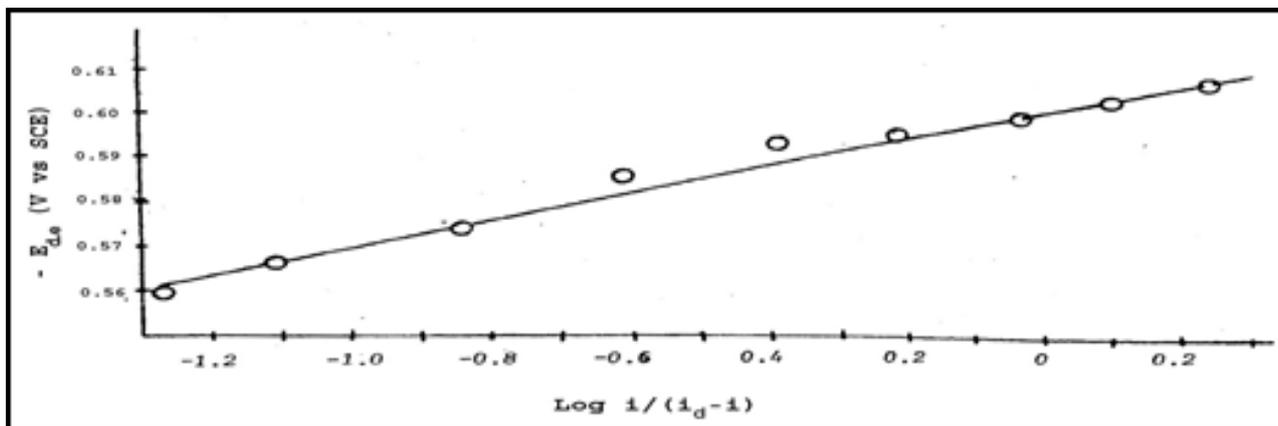


Fig 1: A typical log plot of 1.0 mm Cadmium in 0.05 M VER-AMP and 0.1 M KNO₃ at pH ~ 8.0

The effect of height of mercury column on the polarographic waves of Cadmium in presence of five ligands under consideration at constant concentration of ligands (0.06 M) and in 0.1 M KNO₃ as supporting electrolytes, has been studied at pH 8.0. The $i_d \sqrt{h}$ values were found to be constant within the range of experimental error (Tables 6). A linear relationship between diffusion current and the square root of height of mercury column proves the diffusion controlled nature of the electrode reaction.

Table 6: Effect of height of mercury column on Cadmium polarogram

Height of the mercury columnh (cm)	$i_d \mu A$	i_d / \sqrt{h}
67.0	4.92	0.6011
60.0	4.62	0.5964
55.0	4.50	0.6068
50.0	4.26	0.6024
45.0	4.08	0.6082
40.0	3.78	0.5977

The influence of Cadmium ion concentration (0.4 mm– 1.2 mm) on wave height was carried out in 0.06 M ligand and 0.1 M KNO₃ at pH 8.0. In all the five systems, single well-defined waves were obtained over the concentration range studied. Calibration plots constructed between metal ion concentration and diffusion current were found to be straight lines passing through the origin. In all instances, i_d/C values were obtained within the experimental error.

(IV) Evaluation of stability parameters of cd (II) metal complex

Hence De-Ford and Hume method was employed to calculate

the metal-to-ligand ratio and stepwise formation constants for each system $F_0 [x]$ functions were plotted (Fig-3) against each concentration of the ligand studied. Steeply rising curves were obtained with a limiting slope value of β_1 as $[X]$ approached to zero. For both systems, $F_1 [x]$ functions were derived for different concentrations of ligand employing the equation i.e., A plots (Figs -4, 5) of derived $F_1[x]$ values against corresponding values of $[x]$ gave straight lines with intercept values equal to β_2 as $[X]$ tends to zero which indicated the formation of penultimate complex. $F_2 [x]$ functions were calculated and plotted against $[x]$ for the two systems. (Fig-5) From the $E_{1/2}$ data of Cadmium at different concentrations of the ligand (VER-AMP) $F_0 [x]$, $F_1 [x]$ and $F_2 [x]$ were computed. In order to determine β_1 , plots of $F_0 [x]$ (Fig-3) and $F_1 [x]$ (Fig-4) at corresponding values of $[X]$ were drawn. Steeply rising curves were obtained for each system. The graphs (Fig-5) plotted between $F_2 [x]$ values against $[x]$ were not straight lines parallel to x-axis, but smooth curves were obtained. Hence calculations are extended further to evaluate other functions such as $F_3 [x]$ and $F_4 [x]$. $F_3 [x]$ functions were calculated and the graphs (Fig-6) were drawn between $F_3 [x]$ values against $[x]$. Straight lines with intercept values equal to β_3 and limiting slope equal to β_4 were obtained indicating the formation of penultimate species.

A plots were constructed between $F_4 [x]$ against the corresponding values of $[x]$. Straight lines (Fig-7) parallel to the x-axis with intercepts equal to β_4 were obtained indicating the existence of stable complex species in solution.

The obtained data (Table-7) indicates that Cadmium formed 1:4 Complexes with VERAMP.

Table 7: Derived functions for Cadmium-VER-AMP complex

[VERAMP] M	$i_d \mu A$	Slope Mv	$E_{1/2}$ - V vs SCE	$\Delta E_{1/2}$ -V vs SCE	Log I_m / I_c	F_0 [VERAMP]	F_1 [VERAMP] X 10 ²	F_2 [VERAMP] X 10 ³	F_3 [VERAMP] X 10 ⁵	F_4 [VERAMP] X 10 ⁶
0.000	5.88	29.41	0.549	-	-	-	-	-	-	-
0.005	5.52	31.58	0.552	0.003	0.0274	1.3445	0.6889	-	-	-
0.008	5.46	29.17	0.555	0.006	0.0322	1.7159	0.8949	-	-	-
0.010	5.34	31.25	0.558	0.009	0.0418	2.2143	1.2143	3.1434	-	-
0.020	5.28	32.00	0.570	0.021	0.0467	5.6850	2.3425	7.2127	1.1063	-
0.030	5.22	30.77	0.582	0.033	0.0517	14.5992	4.5330	12.1102	2.3701	-
0.040	5.10	31.82	0.591	0.042	0.0618	30.0519	7.2629	15.9074	2.7268	1.0671
0.050	5.04	30.77	0.600	0.051	0.0669	61.1527	12.0305	22.2610	3.4522	2.3044
0.060	4.92	30.43	0.609	0.060	0.0774	125.9969	20.8328	33.2210	4.7035	4.0058
0.080	4.86	28.57	0.621	0.072	0.0827	323.7815	40.3477	49.3096	5.5387	4.0484
0.100	4.62	27.77	0.630	0.081	0.1047	685.0086	68.4008	67.5008	6.2500	3.9500

$\beta_1 = 0.90 \times 10^2$; $\beta_2 = 5.0 \times 10^3$; $\beta_3 = 2.30 \times 10^5$; $\beta_4 = 4.0 \times 10^6$

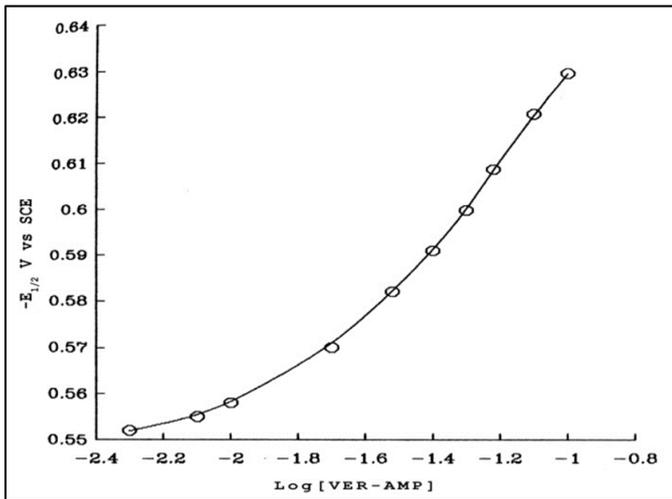


Fig 2: Plot of $E_{1/2}$ vs $\log[\text{VER-AMP}]$ in 0.1M KNO_3 at pH 8.0 for 1.0 mm Cadmium

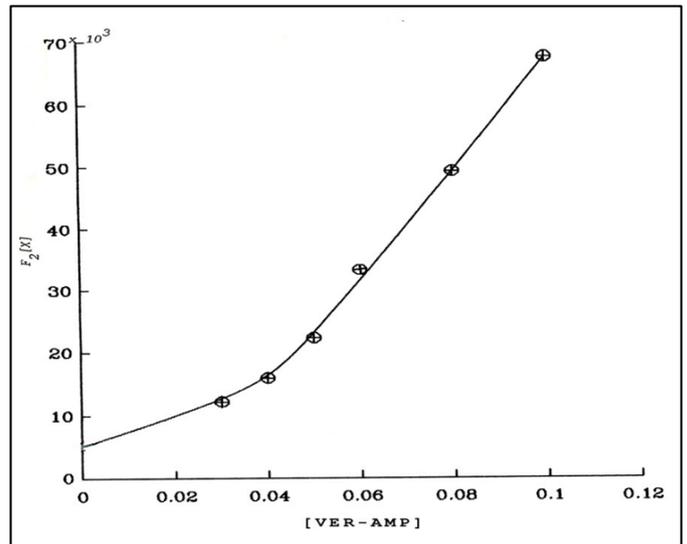


Fig 5: The function of $F_2[X]$ plotted as function of ligand concentration for the Cadmium-VER-AMP system

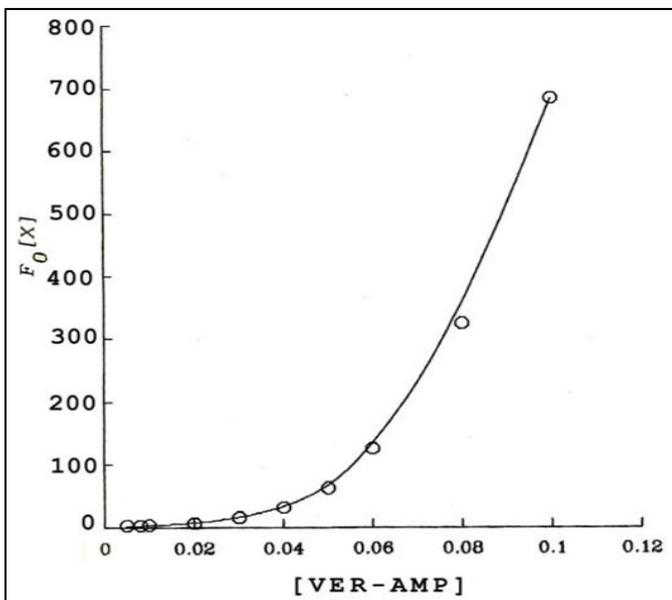


Fig 3: The function of $F_0[X]$ plotted as function of ligand concentration for the Cadmium-VER-AMP system

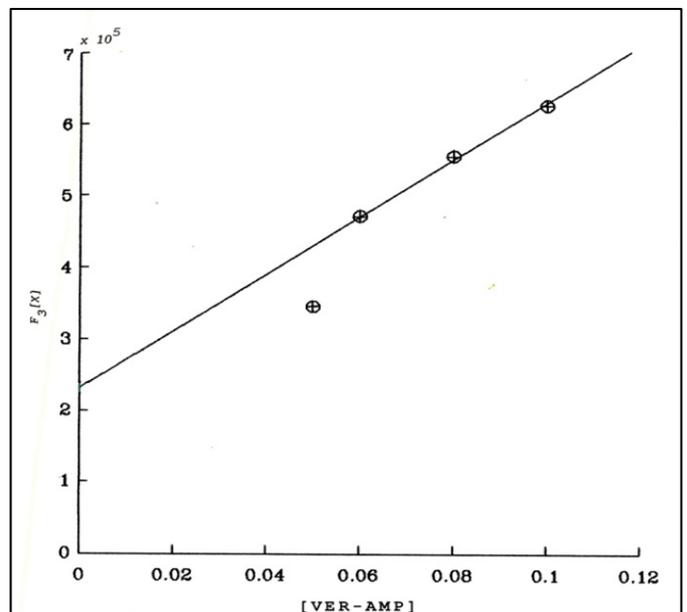


Fig 6: The function of $F_3[X]$ plotted as function of ligand concentration for the Cadmium-VER-AMP system

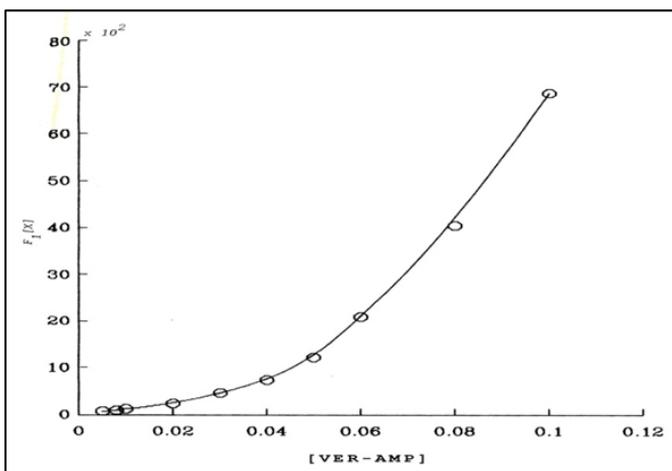


Fig 4: The function of $F_1[X]$ plotted as function of ligand concentration for the Cadmium-VER-AMP system

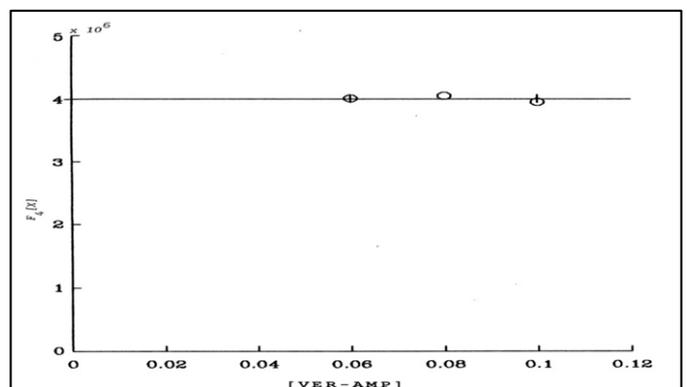


Fig 7: The function of $F_4[X]$ plotted as function of ligand concentration for the Cadmium-VER-AMP system

Conclusion

From this studies it was observed that Cadmium formed complex with of 2-(3, 4-Dimethoxy Benzylidene Amino)-2-methyl propane-1-ol under consideration over the concentration studies. The reduction of these complexes at D.M.E was diffusion controlled and reversible with two electrons participating in the electrode reaction. The presence of more than one complex species in equilibrium in all the systems was evidenced from the smooth curves obtained. This observation confirms that cadmium could forms stable metal complexes with metal- ligand ratio 1:2 and less stable metal complexes with 1:4 ratio.

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