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Research Article

ELECTROCHEMICAL BEHAVIOR OF COMPLEXES OF CD^{2+} WITH BUPROPION HYDROCHLORIDE IN AQUEOUS, NON-AQUEOUS BINARY MIXTURES

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ABSTRACT

The complexation of Cd^{2+} with Bupropion hydrochloride was studied in aqueous and some binary mixtures of methanol and ethanol using DC polarographic technique at pH 7.30±0.01 and ionic strength μ = 1.0 M KCI at two temperatures 25^{0}C and 35^{0}C. The stiochiometry and stability constants of the complexes were determined by Deford and Hume method. Complexes formed were in 1:1, 1:2 ratios and the nature of electrode processes were reversible and diffusion controlled. The results show that the stability of the complexes depends on the nature and composition of the mixed solvents. The thermodynamic parameters (ΔH, ΔG, ΔS) have also been reported. The formation of the metal complexes was found to be spontaneous and exothermic in nature.

Keywords: Metal complexes, Stability constant, Cd^{2+}, Bupropion hydrochloride.

INTRODUCTION

The study of Cd^{2+} complexes with L-amino acids and vitamin-c has been carried out by voltammetric technique[1]. Interactions between pyridine -2, 6- dicarboxylic acid with Cu(Π), Pb(Π) and Cd(Π) ions were characterized in aqueous solutions by means of d.c. polarography[2]. The complexes of Tl^{+1}, Pb^{2+} and Cd^{2+} cations with macrocyclic ligands have been studied in mixed solvents using differential pulse polarography (DPP), square wave polarography and conductometry[3]. Pandey et al have studied the complexes of Cd(Π) with antibiotic drug at DME in 20% Methanol-Water and Ethanol-water mixture[4]. The present study is related with the formation of complexes of Cd(Π) with Bupropion hydrochloride by Direct current Polarography with the view that this drug and their metal complexes could be used against several severe diseases like depression, cancer, AIDS and also metal toxicity.

MATERIALS AND METHODS

The following chemicals were used for all polarographic experiments: Bupropion hydrochloride (3×10^{-2}M), KCl(1M), $CdCl_2$(2.5×10^{-2}M). A model CL 357 a polarographic analyzer (from elico) was coupled with the cell for direct current polarographic experiments. The current response and the applied potential were recorded at scan rate 150mV/min. The current voltage measurements were performed with three electrodes assembly, a dropping mercury electrode as working electrode, calomel as reference and platinum as counter electrode. The dropping mercury electrode had the capillary characteristics, m = 2.768 mg/s, t = 3.0 sec, h = 60 cm. pH was adjusted to suitable range by Elico digital pH meter.

RESULT AND DISCUSSION

A well-defined two-electron[5] reversible reduction and diffusion-controlled wave of Cd^{2+} was observed in 1.0 M KCl at pH 7.30±0.01.

The polarographic reduction of $2.5\text{x}10^{-3}$M Cd^{2+} in the presence of different Bupropion hydrochloride concentrations was investigated. The cathodic shift in $E_{1/2}$ values of metal ion, coupled with decrease in diffusion current (i_d) on

increasing ligand concentration from $0.3x10^{-3}$M to $7.5x10^{-3}$M, indicates the complex formation[5]. Fig 1-2 shows the resulting polarograms for Cd-Bupropion system in aqueous medium at 25^0C (Fig 1) and in 20% methanol at 35^0C (Fig 2)

The decrease in diffusion current with increasing ligand concentration is to be expected due to increased size of complexed ions relative to that of the solvent ions.

The logarithmic analysis of the produced polarographic waves indicate that the electrode reaction is reversible at the dropping mercury electrode, since the slope of the straight line plots of log i/id-i vs $E_{d.e}$ were 30±2 mV. The linear dependence of the limiting current on the square root of the height of the mercury column indicates that the reduction of the metal ion is diffusion controlled.

The stiochiometry and stability constants of the complexes were determined by monitoring the shifts in half wave potentials of the polarographic waves of metal ions against the ligand concentration. The Deford and Hume method confirmed the formation of 1:1 and 1:2 complexes of Cd^{2+} with Bupropion.

Comparison and trend of stability of complexes

As shown in table 1, stability constant values decrease with increase the temperature in all the mediums which suggests that Cd-Bupropion complexes are more stable at lower temperature[6-7].

Further, stability constants of 1:1 complexes, at both the temperatures, in aqueous, 20% methanol, 20% ethanol, decrease as follows:

aqueous > 20% methanol > 20% ethanol

This can be explained, suggested by Van uitert et al[8]., that with the increase of dielectric constant of solvent, the ion-ion interaction between metal ion and ligand increases to a greater extent than the ion-dipole interaction between metal ion and solvent molecules. But in case of 1:2 complexes which is formed in 20% methanol and 20% ethanol medium at 25^0C, the order is as follows:

20% methanol < 20% ethanol

This is probably due to the high gutmann doner number of the methanol than ethanol.

In a solvent with high solvating ability (high donor number), the solvent can compete strongly with the ligand for the cation, therefore, the interaction between the ligand donor atoms and the metal ions will be decreased[9].

Thermodynamic parameters

The kind of complex species that reduces on a mercury electrode depends on thermodynamic aspects[10]. Examination of the values of ΔG, ΔH and Δ**S** in table 1 shows that

a) The negative value of ΔG for the complexation process suggests the spontaneous nature of such process. These values are less negative at higher temperature, confirming that complexes are not stable at higher temperature[11-12].
b) The ΔH values are negative, meaning that these processes are exothermic and favorable at lower temperature[13-14].
c) A negative value of Δ**S** corresponds to a highly ordered activated complex and this implies a small value of the steric factor[15-16.]

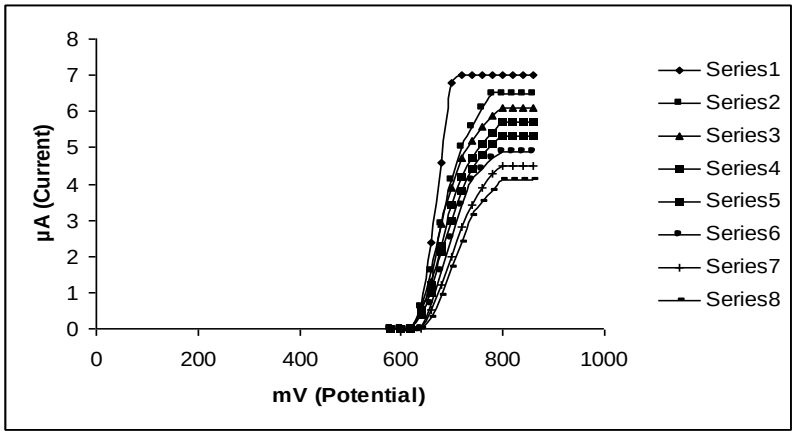

Fig. 1: Polarograms of $2.5x10^{-3}$ M Cd^{2+} ions in the presence of different ligand concentrations Series (1) 0.0 (2) 0.0015 (3) 0.00195 (4) 0.0024 (5) 0.003 (6) 0.0039 (7) 0.00498 (8) 0.0057 M

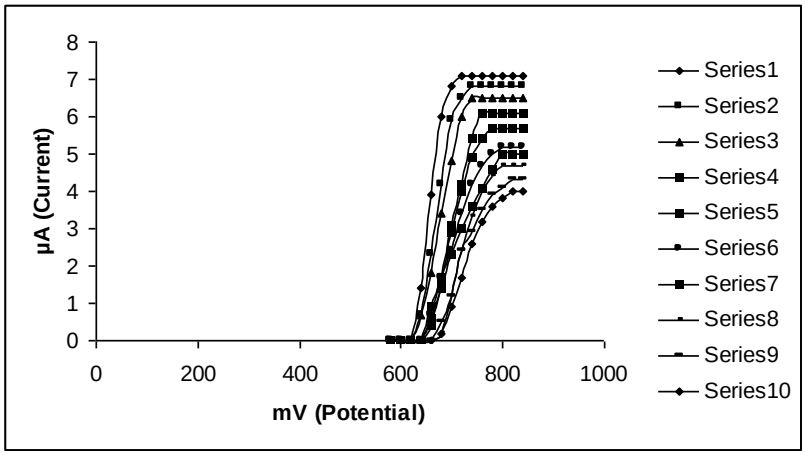

Fig. 2: Polarograms of 2.5x10^{-3} M Cd^{2+} ions in the presence of different ligand concentrations Series (1) 0.0 (2) 0.0003 (3) 0.0009 (4) 0.0015 (5) 0.0021 (6) 0.003 (7) 0.0039 (8) 0.00498 (9) 0.0057 (10) 0.0075M

Table 1: Stability constants and thermodynamic parameters for Cadmium-Bupropion system in aqueous-Non-aqueous medium

Medium	Composition of complex	Stability constant		ΔG Kcal/mol		ΔH Kcal/mol	ΔS cal/ degree/mol
		25^{0}C	35^{0}C	25^{0}C	35^{0}C		
Aqueous	1:1	3.515141	3.194086	-4.776592	-4.485971	-13.4371	-29.0621
20% Methanol	1:1	3.263636	2.776704	-4.434831	-3.777867	-20.3795	-58.4643
	1:2	5.265762	-	-7.155445	-		
20% Ethanol	1:1	3.114354	2.596963	-4.231978	-3.647335	-21.6543	-58.4643
	1:2	5.47695	-	-7.44242	-		

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