Short Communication

Comparison of stability constants of lead(II)-Schiff base complexes-A polarographic study

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Abstract

The complexing ability of four schiff bases derived from tris (hydroxymethyl) methylamine towards lead(II) has been studied polarographically. The stability constants of the complexes have been determined by Lingane method and discussed based on the electron density on the donor azomethine nitrogen and hydroxyl oxygen atoms.

Key words: Polarography, lead(II), schiff bases, stability constants.

It is known that schiff base compounds of lead(II) are tuberculostatically and fungicidally active and therefore with reference to our earlier work[1,2], it was considered worthwhile to study the interaction of lead(II) with orthohydroxy acetophenone tris (hydroxymethyl) methylamine (OHAPT), resacetophenone tris (hydroxymethyl) methylamine (RPT) and acetophenone tris (hydroxymethyl) methylamine (APT) at dropping mercury electrode (DME) in aqueous dimethyl formamide medium.

Instruments employed and experimental details are given in our previous papers[1,2]. A stock solution (0.1 M) of lead(II) was prepared using AR lead nitrate and standardized[3]. Mannitol (4%) solution was used to suppress the hydrolysis of lead(II).

Lead(II) gives single well defined and reversible polarographic reduction wave in the presence of all schiff bases. The plot of E_{de} vs log($i/i_d - i$) is a straight line with a slope of 30 ± 1 mV. Cathodic reduction of lead(II) in Schiff bases is therefore reversible and involves two electron transfer in all the cases. Polarographic results are presented in Table I.

The plots of $E_{1/2}$ vs log[ligand] are straight lines for all the four systems indicating a single complex formation. Lingane method[4] was therefore employed for the determination of stability constants of the complexes at 1.0 M ligand concentration and found to be 4.44×10^8, 1.30×10^8, 1.01×10^7 and 7.56×10^6 for complexes of OHAPT, RPT, ST and APT respectively. The stability constants order of the complexes therefore follows as:

$$\beta_{(Pb - OHAPT)} > \beta_{(Pb - RPT)} > \beta_{(Pb - ST)} > \beta_{(Pb - APT)} \tag{1}$$

Table I
Polarographic data of the interaction of lead(II) with Schiff bases
(OHAPT; RPT; ST and APT)

[X]	P^x	Pb - OHAPT		Pb - RPT		Pb - ST		Pb - APT	
(M)	$-\log$ [X]	$E_{1/2}$ (−V)	i_d (μA)	$E_{1/2}$ (−V)	i_d (μA)	$E_{1/2}$ (−V)	i_d (μA)	$E_{1/2}$ (−V)	i_d (μA)
0.00	—	0.400	6.220	0.400	6.220	0.400	6.220	0.400	6.220
0.04	1.397	0.603	5.442	0.603	5.923	0.584	5.451	0.583	6.025
0.06	1.221	0.610	5.312	0.608	5.614	0.585	5.321	0.586	6.008
0.08	1.096	0.615	5.295	0.612	5.306	0.587	5.284	0.588	5.684
0.10	1.000	0.619	5.183	0.614	5.208	0.589	5.192	0.589	5.321
0.20	0.699	0.631	4.815	0.623	4.918	0.594	4.775	0.594	5.156
0.40	0.393	0.644	4.381	0.632	4.415	0.600	4.370	0.600	4.928
0.60	0.222	0.650	3.962	0.637	4.025	0.603	3.851	0.602	4.481
0.80	0.097	0.656	3.712	0.640	3.582	0.605	3.642	0.605	4.058
1.00	—	0.659	3.058	0.643	3.001	0.607	2.851	0.606	3.562

[X] = concentration of ligand

The ligand number (J), determined from the slope of $E_{1/2}$ *vs* log (ligand), is found to be one in all the systems.

In alkaline medium the polarographic data indicate deprotonation of phenolic hydroxylic group and bond formation between metal ion and oxygen[1] besides the coordination of azomethine nitrogen atom to lead. Since lead is known to form 4-coordinate complexes the following structures for the present complexes are suggested.

Pb—OHAPT

Pb–RPT

Pb–ST

Pb–APT

(X = OH⁻ OR NO₃⁻)
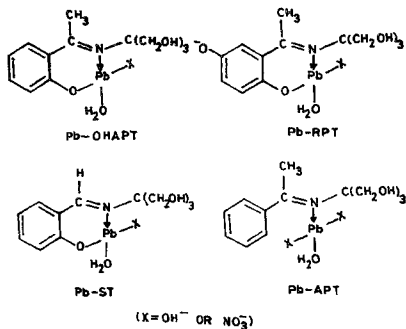
In Pb-RPT complex hydroxo group is present in the para position to the oxygen, which is taking part in bond formation with lead. The electron withdrawing effect of hydroxo group decreases the electron density on the latter (oxygen) and azomethine nitrogen thereby decreasing the bond strength between Pb and nitrogen ($= N-$). This may be the reason for the low stability constant of Pb-RPT complex in comparison with Pb-OHAPT complex since resonance and hyperconjugation are equally operative in both the structures. Though Pb–OHAPT and Pb-ST complexes are having almost identical structures, the electron-repelling tendency of methyl group present in Pb-OHAPT complex relatively increases the electron density on nitrogen ($> C = N-$) atom and thus the stability constant of Pb-OHAPT complex is greater than Pb-ST complex. The stability constant of Pb-APT complex is less than all three complexes, since the chelate ring structure is not plausible for the Pb-APT complex.

Acknowledgements

References

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