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Polarographic Study Of Pb(II)- Ranitidine Hydrochloride Complex

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Abstract

The Polarographic study of Lead complex of H_2 antagonists drug Ranitidine hydrochloride Carried out at dropping mercury electrode (DME). Study of Pb(II)- Ranitidine complex carried out with different concentration of drug at two temperatures (293K & 303K). Complexes were formed in 1:1 and 1:2 Ratios. $[Pb(Ranitidine)_2]^{+2}$ complex is more stable than $[Pb(Ranitidine)]^{2+}$. Since Pd(II) - Ranitidine complex shows reversible wave so thermodynamic parameters ($\Delta G°$, $\Delta H°$, $\Delta S°$) have been evaluated by Deford and Hume's method.

Keywords: Pd(II) - Ranitidine complex, Direct current polarography, Deford and Hume's method, Thermodynamic parameter.

Introduction-

Ranitidine is in a class of medications called H 2 blockers. It decreases the amount of acid made in the stomach. Chemically it is N[2-[[[5-[(dimethylamino)methyl]-2-furanyl]methyl]thio]ethyl]-N-methyl-2-nitro-1,1-ethenediamine HCl. It has the following structure -

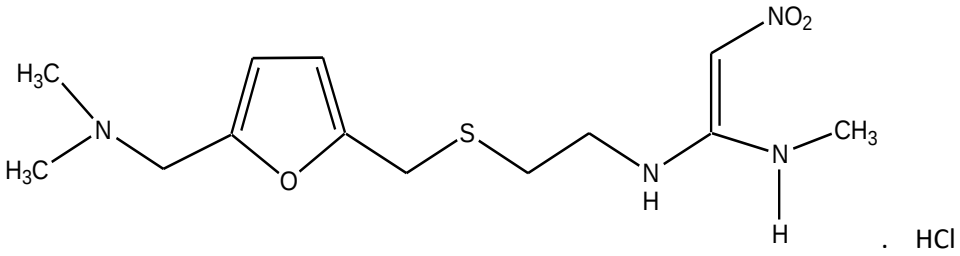


Fig. 1 - Ranitidine hydrochloride (HCl)

Molecular formula - $C_{13}H_{23}ClN_4O_3S$

Molar mass - 350.86472

Melting point - 69-70 °C

Ranitidine HCl is a white to pale yellow crystalline powder with slightly bitter taste. Freely soluble in water, methanol and ethanol, sparingly soluble in ethanol, very slightly soluble in chloroform and dichloro-methane.

Some metal complexes of compounds with biological activity may be more reactive than the corresponding free compounds, so metal drug complexes are being widely studied by different techniques[1-2].

Earlier, the studies of lead complexes with different drugs like Buproping hydrochloride[4], Amino Acids and Isatins[5], Anti-inflammatory drug Paracetamol [6] etc have been done.

Lead is a serious cumulative body poison[7] and enters into our body system through air, water, and food. Inorganic lead binds itself with the SH group in enzymes or proteins and acts as an enzyme inhibitor. Acute lead poisoning in humans causes severe damage in the kidneys, liver, brain, reproductive system and central nervous system, and sometimes causes death. Mild lead poisoning causes anemia, headache and sore muscles and the victim may feel fatigued and irritable. Chronic exposure to lead causes nephritis, scaring and the shrinking of kidney tissues. Lead is emitted into the biosphere in considerable amounts, owing to its increased industrial use and application as a fuel additive[8].

Due to effect of lead on health, it becomes necessary to study the Lead – Ranitidine complex. Present paper represents the study of complex formation of Lead (II) with Ranitidine hydrochloride Polarographically.

EXPERIMENTAL

Apparatus -

A digital DC recording Polarography (CL-357) was used to record the current – voltage curves. Measurements were performed with three electrode assemblies, dropping mercury (DME) as working electrode, platinum electrode as counter electrode and a saturated calomel electrode as reference electrode. Capillary of 120mm length and 0.05mm diameter was used.

The dropping mercury electrode had the following characteristics m = 2.422 mg/sec., t = 3.5 sec./drop, h = 60 cm. Elico digital pH meter was employed to measure pH of solution. The current responses and applied potentials were recorded at scan rate100 mv/min.

Materials and reagents -

Analytical grade salt Lead Nitrate [$PbNO_3$] of strength 1.25×10^{-2} M was used for present study. Aqueous buffers of different pH values were prepared. pH was adjusted by 0.1 M HCl and 0.1 M NaOH. 1.0 M KNO_3 was used as supporting electrolyte for $PbNO_3$. All solutions were prepared in triple distilled water. Triton X-100 (0.001%) was used to suppress polarographic maxima. The depolariser (metal) and ligand (drug) were taken in different ratio.

Procedure-

Electrochemical measurement were performed in the solution (10ml) containing Ranitidine hydrochloride, Pb((II), Triton X-100(maximum suppress maxima), 1.0 M KNO_3 The solution (10ml) were purged with nitrogen for at least 15 minutes. prior to each experiment. The polarograms were recorded in following order- pure supporting electrolyte, after Pb (II) addition and addtion of each aliquot of Ranitidine hydrochloride.

Results and Discussions -

The system Lead (II) - Ranitidine hydrochloride was investigated polarographically at 20° C and 30° C. Half wave potential of Pb(II) (–0.460 V vs. SCE) in 1.0 M KNO_3 supporting electrolyte, has been determined with successive addition of Ranitidine hydrochloride Half wave potential of Pb(II) shifts towards more negative side and diffusion current of metal (i_d) decreases, with increasing concentration of complexing agent suggesting complex formation. Pb(II) undergoes 2e- reduction process at d.m.e. The reduction is found to be reversible and diffusion controlled. The plots of log $[i/(i_d-i)]$ vs $E_{d.e.}$ were linear with lower slope values suggesting electrode reactions to be reversible.

Overall formation constant (log β) of the complexes have been determined by Deford and Hume's[9] method using polarographic measurements.

The plots of Fj (X) vs. X (where X is the concentration of Ranitidine hydrochloride) are represented in Fig. (2,3). By seeing them we can say that at 20° C the Pb(II) - Ranitidine complexes are in 1:2 ratio and at 30° C Pb(II)- Ranitidine hydrochloride complexes are in 1:1 ratio. Value of intercept gives the value of β, where as the value of logβ represents the stability constant. The values of Fj (X) with respect to Ranitidine hydrochloride concentration are summarised in table (1,2). From the plots of Fj (X) vs. X values of stability constants $\log\beta_1$ and $\log\beta_2$ have been evaluated. More will be the value of stability constant more will be stability of complex. From the values of stability constants, thermodynamic parameters have also been evaluated Pb(II) forms complexes with Ranitidine hydrochloride in 1:1 and 1:2 ratio at 20 °C. The stability constants[10] of $[Pb(Ranitidine)_2]^{2+}$ are greater than $[Pb(Ranitidine)]^{2+}$ at 20°C temperature, it suggest that

Pb(II) - Ranitidine hydrochloride complexes are more stable in 1:2 ratio than in 1:1 at 20°C. Stability constants are reported in table (3).

Table (1)

Pb(II)- Ranitidine hydrochloride system at 20°C

$PbNO_3 = 1.25 \times 10^{-2}$ M,

Temp = 20°±1°C, $E_{1/2}$ (M) = -0.469 volts vs S.C.E.

$C_x \times 10^{-3}$	Id (μA)	$\Delta E_{1/2}$ (Volt)	log(Im/Ic)	$F_0(x)$	$F_1(x) \times 10^2$	$F_2(x) \times 10^4$
1.6	4.5	0.472	0.0188	1.2781	1.7386	5.2416
2.2	4.4	0.473	0.0286	1.4135	1.8797	4.4535
2.8	4.2	0.475	0.0488	1.5913	2.1184	4.3280
3.5	4.1	0.476	0.0593	1.8410	2.4029	4.2941
4.1	4.0	0.478	0.0700	2.1038	2.6922	4.3712
4.8	3.8	0.480	0.0923	2.4527	3.0265	4.4303
5.4	3.7	0.481	0.1038	2.7516	3.2438	4.3405

$\beta_1 = 2.3873 \times 10^5$

$\beta_2 = 4.6526 \times 10^5$

Here-

$E_{1/2}$ (M) = Half wave potential of Lead

Im = Diffusion current of polarographic wave for Lead

β_1 & β_2 = Overall formation constant or Overall stability constant for 1:1 & 1:2 Pb(II)- Ranitidine hydrochloride complexes at 20°C.

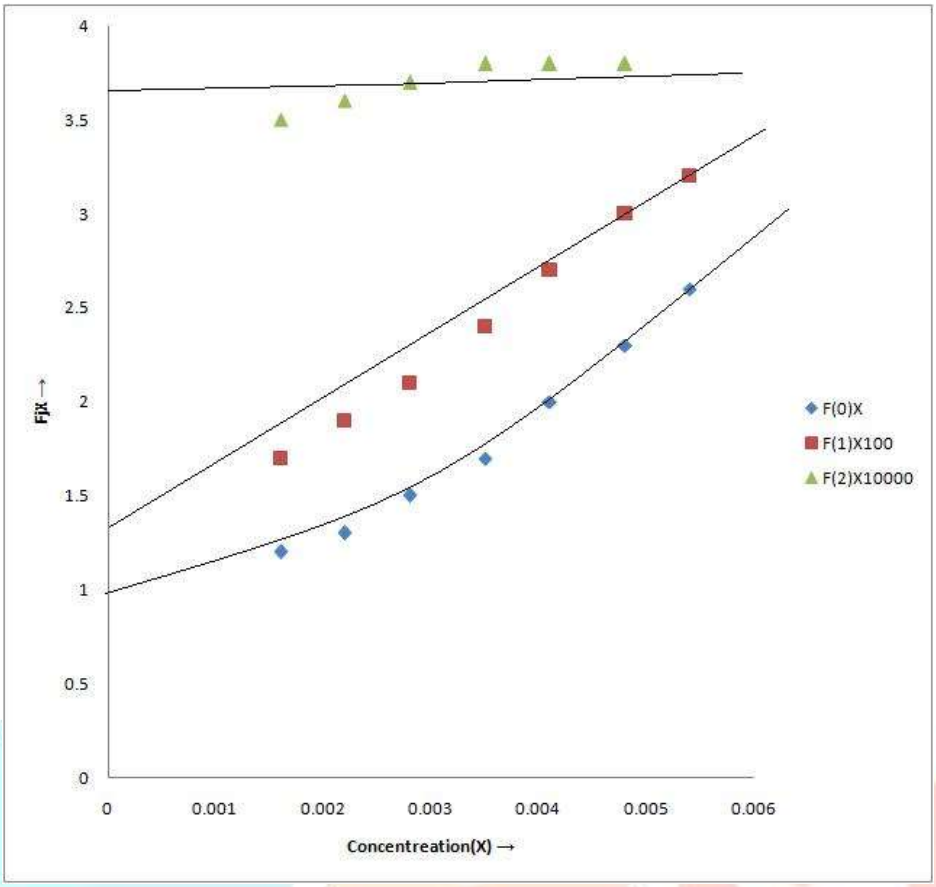


Fig. 2- $F_j(X)$ vs. (X) for Pb^{+2}- Ranitidine hydrochloride system at T=20^{O}C

Table (2)

Pb(II)- Ranitidine hydrochloride system at 30°C

$PbNO_3 = 1.25 \times 10^{-2}$ M,

Temp = 30°±1°C, $E_{1/2}$ (M) = -0.464 volts vs S.C.E.

$C_x \times 10^{-3}$	Id (μA)	$\Delta E_{1/2}$ (Volt)	log(Im/Ic)	$F_0(x)$	$F_1(x) \times 10^2$
1.6	4.9	0.470	0.0087	1.5433	3.4961
2.2	4.7	0.471	0.0268	1.7803	3.5469
2.8	4.5	0.473	0.0457	2.0400	3.7145
3.5	4.3	0.475	0.0655	2.4133	3.9680
4.1	4.2	0.477	0.0757	2.7955	4.1794
4.8	4.1	0.479	0.0861	3.3029	4.2977

5.4	3.9	0.481	0.1079	3.8601	4.3966

$\beta_{1=}$ $2.6190x10^{6}$

Here-

$E_{1/2}$ (M) = Half wave potential of Lead

Im = Diffusion current of polarographic wave for Lead

β_1 = Overall formation constant or Overall stability constant for 1:1 Pb(II) - Ranitidine hydrochloride complexes at 30°C.

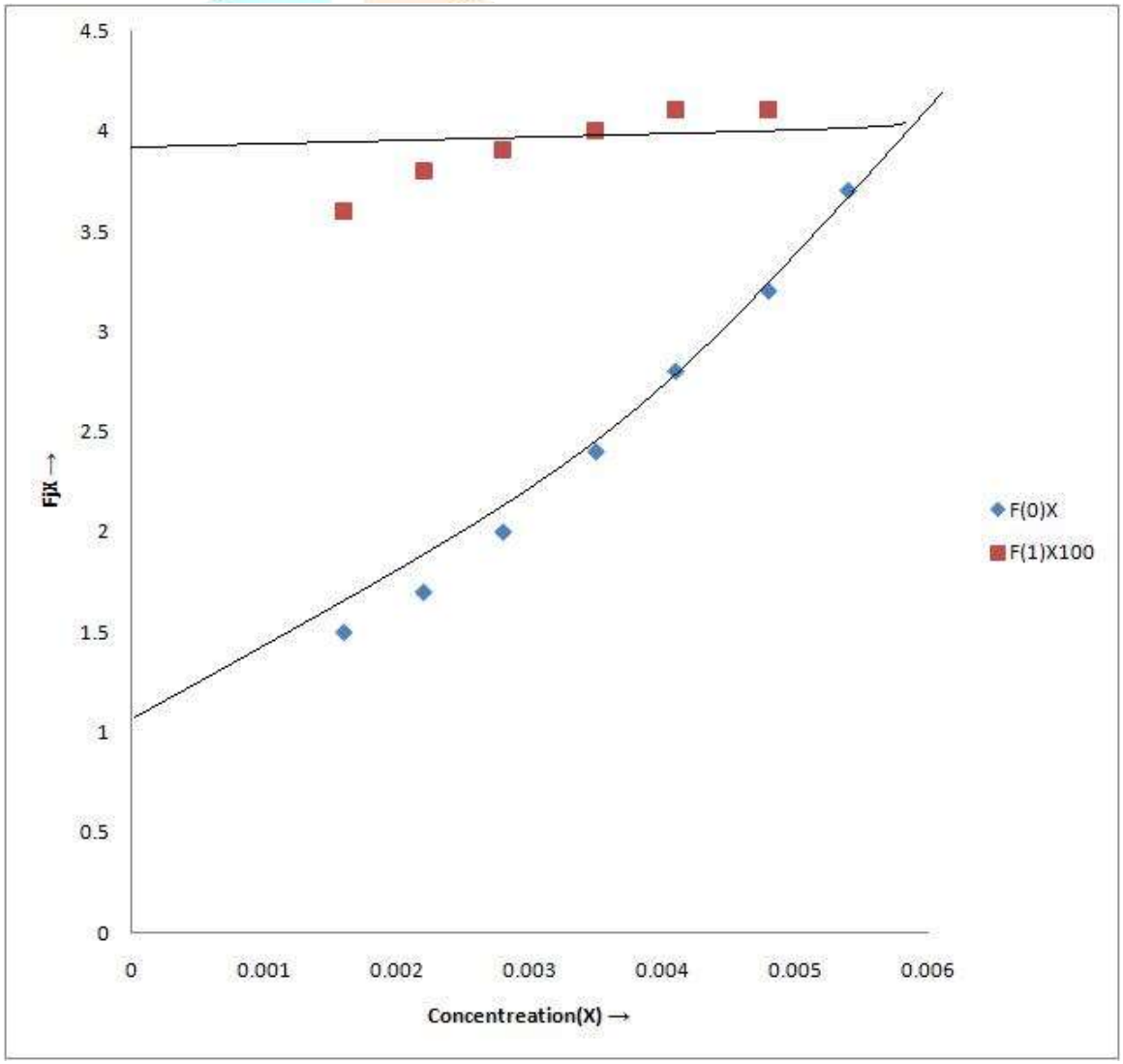


Fig. 3 - $F_j(X)$ vs. (X) for Pb^{+2}- Ranitidine hydrochloride system at T=30^{O}C

Table (3)

Stability constant for Pb (II) - Ranitidine hydrochloride

System	Composition of complex	Stability constants	
		20°C	30°C
$[Pb(Ranitidine)]^{2+}$	1:1	2.38739	2.61909
$[Pb(Ranitidine)_2]^{2+}$	1:2	4.65265	-

Table (4)

Thermodynamics parameters for Pb (II) - Ranitidine hydrochloride at 20°C

System	Composition of complex	Thermodynamic parameters		
		ΔG° Kcal/mole	ΔH° Kcal/mole	ΔS° Cal/degree/mole
$[Pb(Ranitidine)]^{2+}$	1:1	-13.3935	39.3864	1.8013
$[Pb(Ranitidine)_2]^{2+}$	1.2	-26.1019	-	-

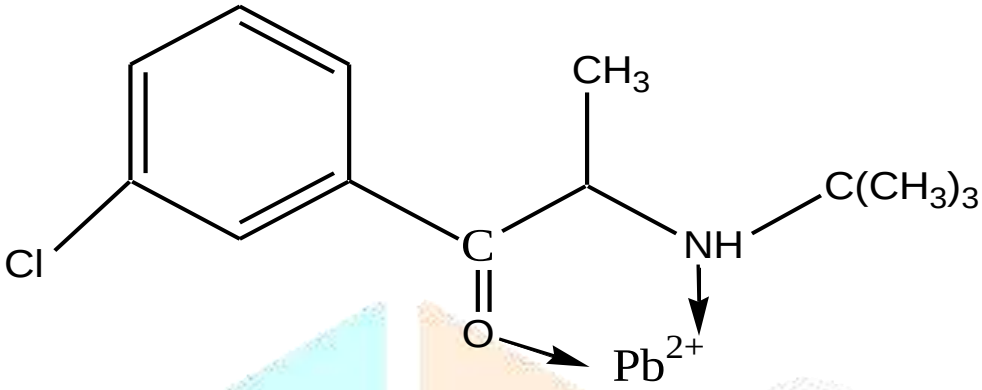
Thermodynamic Parameters

As we know from chemical thermodynamics that the complex which have less value of Gibb's free energy change is more stable, here for $[Pb(Ranitidine)_2]^{2+}$ Gibb's free energy change is more negative, which suggest that $[Pb(Ranitidine)_2]^{2+}$ complex is more stable than $[Pb(Ranitidine)]^{2+}$.Gibb's free energy change, Enthalpy change and Entropy change are listed in table (4).

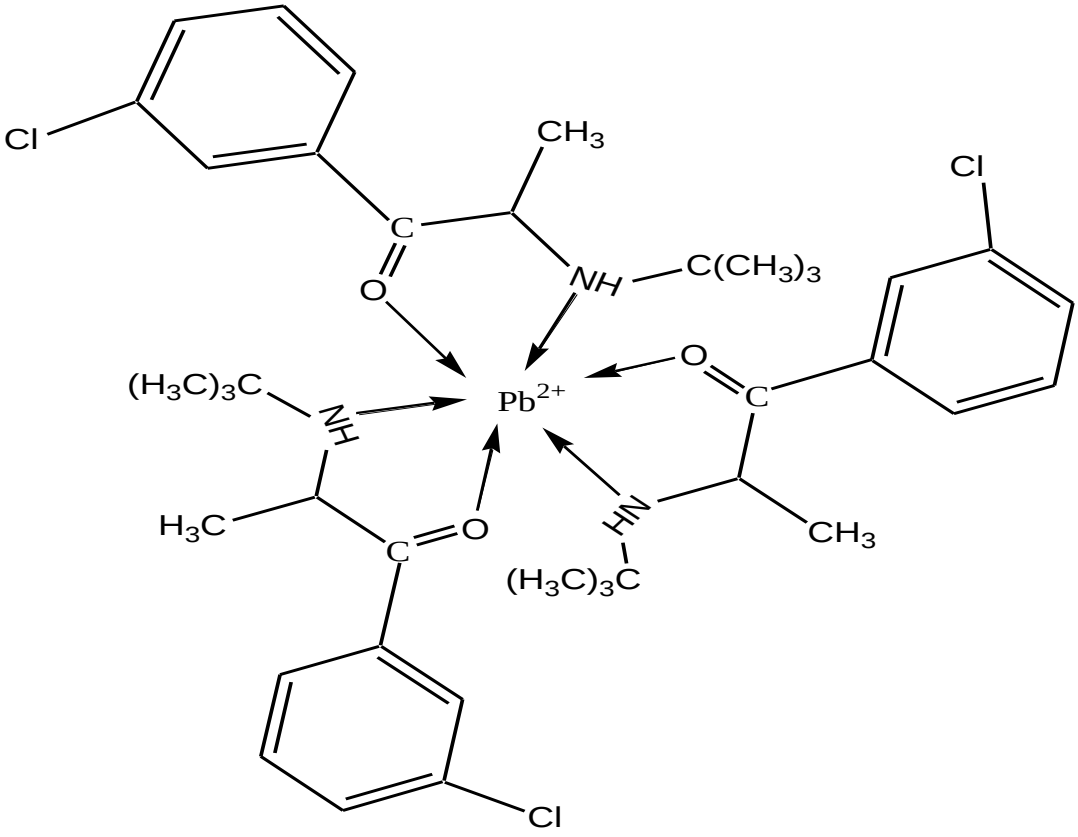
Proposed structure of complexes-

The tentative structure of lead-Ranitidine complexes in both 1:1and 1:2 ratio.

1:1 Ratio



1:3 Ratio



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