ISSN: 2320-2882

IJCRT.ORG



INTERNATIONAL JOURNAL OF CREATIVE **RESEARCH THOUGHTS (IJCRT)**

An International Open Access, Peer-reviewed, Refereed Journal

PHYSICO-CHEMICAL STUDY OF SOME TRANSITION METAL COMPLEXES WITH GLYCINE LIGAND

Bimlesh Kumar Yadav

Research Scholar.

Department of Chemistry,

L. N. M. University, Kameshwar Nagar, Darbhanga, Bihar 846008(India)

Abstract: I study the stability constant and the values of thermodynamic functions like ΔG , ΔH and ΔS of some first series transition metals Co(II), Ni(II), Cu(II), Zn(II) and Cd(II) at two different temperatures with Glycine ligand system. The di-valent transition metals and Glycine ligand are very useful as catalyst, preparing medicines, vats, insecticides, green composts, etc.

Index Terms: Proton ligand stability constant, Thermodynamic parameters, Free energy change, Entropy change, Enthalpy change.

I. INTRODUCTION

Thermodynamic stability refers to the extent at which the complex will be transformed into another species under certain conditions, when the system has reached equilibrium. This type of stability is measured in terms of metal ligand bond energies, stability constants, etc.

The values of thermodynamic functions like ΔG , ΔH and ΔS have been determined by many workers ^[1-3]. But the determination of ΔH by calorimetric method is very useful ^[4,5]. ΔH is the amount of heat either consumed or liberated per mole of product and is related to the strength of the ligand to the metal bonds compared to that of the metal to a solvent bonds. Greater the amount of heat evolved the most stable are the reaction product.

In the present study the stochiometric stability constants of the complexes in mixed solvent are determined at two temperatures i.e. 293±1K and 303±1K. Thus, ΔG , ΔH and ΔS are calculated using appropriate formulae.

II. MATERIALS AND METHODS

2.1. Materials

(a) Bivalent metal salts of transition metals cobalt, nickel, copper, zinc and cadmium with glycine ligand.

2.2. Method

The determination of thermodynamic stability constant is carried out in large excess of an inert salt. Because the salt concentration does not vary at various positions in the equilibria, the coefficients are thought to remain constant and the equilibrium constants obtained are called stochiometric or concentration constants. As per convention the term stability is used for stochiometric stability constant.

The values of stochiometric stability constants are determined at an ionic strength in the atmosphere of large excess of inert salt. Then these values are plotted against ionic strength. And the thermodynamic stability constant is obtained by extraplotting stability constant curve at zero ionic strength.

III. RESULTS AND DISCUSSION

3.1. Relation between stability constant and thermodynamic parameters.

As the stability constant is related with a system of equilibrium, it can be used for the calculation of thermodynamic functions of the system like ΔG , ΔH and ΔS .

3.1.1. Free energy changes (ΔG)

The stability constant is related with free energy change as

$$\Delta G^{\circ} = -2.303 RT \log K \tag{1}$$

We know that $\Delta G \cong \Delta G^{\circ}$. Thus ΔG at a given temperature becomes known from equation (1). When ΔG is negative, The reaction tends to go in the forward. Generally, the measurement of K are done at different temperature at the interval 10°C and the values of ΔH are calculated with the help of the following equation.

3.1.2. Enthalpy change (ΔH)

 $\Delta H = 2.303 R T_1 T_2 (\log K_2 - \log K_1) / (T_2 - T_1)$ ⁽²⁾

The mean value is calculated.

3.1.3. Entropy change (ΔS)

Knowing the values of ΔG and ΔH (mean) we can find out the values of ΔS with the help of following relation.

$$\Delta G^{\circ} = \Delta H^{\circ} - T \Delta S^{\circ}$$

3.2. Thermodynamic parameters

The values of the change in free energy (ΔG), change in enthalpy (ΔH) and change in entropy (ΔS) have been calculated at two temperatures at ionic strength 0.10 (M) KNO₃ with the help of standard expression.

(3)

3.2.1. Free energy change (ΔG)

The change in free energy (ΔG) is calculated by Gibbs-Helmhotz equation. The equation given below relating the stability constant to the free energy change of the reaction was employed for evaluating the value of free energy change at various temperatures.

The equation is-

 $\Delta G^{\circ} = -2.303 RT \log_{10} K$

3.2.2. Enthalpy change (ΔH)

The changes in enthalpy (ΔH) were calculated by the integrated form of Vant-Hoff's equation from the values of stability constant at two temperatures.

(4)

$$\ln K_2 / K_1 = \frac{\Delta H}{R} \left[\frac{1}{T_1} - \frac{1}{T_2} \right]$$
(5)

3.2.3. Entropy change (ΔS)

The change in entropy (ΔS) at given temperature were calculated by the equation.

$$\Delta G^{\circ} = \Delta H^{\circ} - T \Delta S^{\circ} \tag{6}$$

It was based on the assumption that is Gibbs-Helmhotz equation, ΔH is constant at different temperatures.

Assuming ΔH to be constant at given temperatures, the value of ΔS were evaluated at given temperatures.

The values of stepwise free energy changes (ΔG), Enthalpy change (ΔH) and entropy change (ΔS) are summarized in table 1.3.

The values of protonation constant and stepwise stability constant obtained by different computational methods at temperatures $293\pm1K$ and $303\pm1K$ are summarized in table no. 1.1.

The different methods are-

- (a) Half-integral method
- (b) Mid-point calculation method
- (c) Straight line plot method.

Stepwise and over all stability constant at temperature $293\pm1K$ and $303\pm1K$ respectively of complex compounds of various metals are summarized in table 1.2.

Table no. 1.1

Values of protonation constant of ligand and stepwise stability constant of Co(II), Ni(II), Cu(II), Zn(II) and Cd(II) with ligand Glycine at given temperature 293±1K and 303±1K.

System		Temp 293±1K		Temp 303±1K		
		log K ₁	log K ₂	log K ₁	log K ₂	
	a.	10.94			10.84	
Glycine	b.	-			-	
	с.	10.94			10.88	
Co(II)	a.	6.82	6.70	6.14	6.12	
	b	6.86	6.74	6.10	6.06	
	с.	<u>6.</u> 80	6.72	6.12	5.10	
Ni(II)	a.	7.50	6.96	7.32	8.24	
	b.	7.56	6.90	6.40	6.30	
	с.	7.48	6.66	6.28	6.22	
	a.	7.90	6.88	7.96	7.10	
Cu(II)	b.	7.92	6.92	7.96	7.20	
	с.	7.82	6.90	7.54	7.12	
Zn(II)	a.	6.50	6.18	6.26	5.10	
	b.	6.56	6.12	6.24	6.06	
	с.	6.48	6.06	6.22	5.16	
	a.	6.60	6.12	6 <mark>.08</mark>	5.52	
Cd(II)	b.	6.50	6.04	6.63	5.02	
	с.	6.64	6.14	6.12	5.28	

Table no. 1.2.

Stepwise and over all stability constant at temperature 293±1K and 303±1K respectively of complex compounds of various metals.

System	Temp 293±1K			Temp 303±1K			
	log K ₁	log K ₂	logβ	log K ₁	log K ₂	logβ	
H-Glycine	10.99		10.99	10.86	-	10.86	
Co(II)-Glycine	6.82	6.72	13.54	6.12	5.76	10.88	
Ni(II)-Glycine	7.52	6.84	14.36	7.48	6.92	14.40	
Cu(II)-Glycine	7.88	6.90	14.78	7.82	7.14	14.96	
Zn(II)-Glycine	6.52	6.12	12.64	6.24	5.44	11.68	
Cd(II)-Glycine	6.58	6.10	12.68	6.28	5.24	11.52	

Table no. 1.3.

Values of stepwise free changes, enthalpy changes and entropy changes in the formation of complexes of different metals with the ligand Glycine

	Temp 293±1K		Temp 303±1K					
System	ΔG_1	ΔG_2	ΔG_1	ΔG_2	ΔH_1	ΔH_2	ΔS_1	ΔS_1
	in k.cal							
Co(II)	-8.90	-7.84	-8.24	-8.46	-2.60	-3.60	18.60	16.40
Ni(II)	-9.12	-8.92	-8.26	-8.24	-3.80	-4.00	18.20	15.80
Cu(II)	-9.58	-9.18	-9.40	-9.28	-4.20	-4.00	16.20	15.20
Zn(II)	-8.12	-7.18	-8.12	-7.96	-4.40	-3.40	17.20	16.40
Cd(II)	-7.36	-7.16	-7.42	-7.50	-3.60	-3.00	17.80	15.80

IV. CONCLUSION

For the ligand the stability constants of metals show the sequence-

Cu>Ni>Co>Zn>Cd.

This is the natural order as found by Irving & William.

The negative values of ΔG° and ΔH° for metal ion chelates show that the chelate formation is a spontaneous process.

V. ACKNOWLEDGEMENT

I am thankful to the principal of M.L.S.M. College, Darbhanga, Bihar for providing necessary facilities in chemistry lab for testing experimental data.

REFERENCES

- [1]. A. G. Sharpe.: The Chemistry of Cyano complexes of the transition metals. Academic London (1976)
- [2]. Munshi, K. N. et al : J. Indian Chem. Soc. 54, P. 659 (1977)
- [3]. Sandhu, R. S. et al : Thermo Chimica Acta 16, 245 (1978)
- [4]. Vyas D. N. et al : J. Indian Chem. Soc. 54, 353 (1977)
- [5]. Mellor: "Chelating agents and metal chelates" P. 42, Academic Press New York (1964)

