Oriental Journal of Chemistry Vol. **26**(4), 1581-1583 (2010)

Spectrophotometeric studies of formation constant of lanthanide complexes

GOURAV CHAWLA[1], H.K. PANDEY[1], SEEMA GAKHAR[2] and ARTI CHAWLA[1]

[1]Rare Earth Research Laboratory, P. G. Department of Chemistry,
Govt. Dungar College, Bikaner (India).
[2]Department of Chemistry, M. N. Institute of Applied Science, Bikaner (India).

(Received: October 16, 2010; Accepted: November 14, 2010)

ABSTRACT

The formation constant of Tm(III)-systems with different sulphonanilide ligand namely 3-carboxy-4-hydroxy-2'-chloro benzene sulphonanilide, 3-carbmethoxy-4-hydroxy-2'-chloro benzene sulphonanilide and 3-carbethoxy-4-hydroxy-2'-chloro benzene sulphonanilide have been determined with the help of spectrophotometeric method. Results shows that the stability of lanthanide complexes is found similar to $[Ag(NH_3)_2]^+$ type of complex

Key words: Formation constant, Tm(III)-sulphonanilide complex.

INTRODUCTION

Lanthanides are known to form complexes less readily due to deeply buried f-orbitals and the shielding of 4f-orbital by 5d, 6s, 6p-orbitals are responsible for difference in properties of transition metal and lanthanide metal[1-3].

These deeply buried 4f-orbitals are not much affected by ligand environment and give rise to narrow f-f transition, but their bonding tendency with various types of ligands is also found in literature[4-5].

Formation constant (K) shows the stability of complex [(6-10)], although lanthanide complexes are thermodynamically and kinetically less stable as compared to transition metal complexes and actinide complexes.

EXPERIMENTAL

Spectrophotometric method[11-13] is based on the fact that most of the complexes absorb light differently than the metal ions from which they are formed. The relationship between the absorbance or optical density at particular wavelength and concentration is expressed by Beer's law[14-15].

In this method, standard grade chemicals-$TmCl_3.6H_2O$ (molecular weight-275.29) has been used for studies. Three sulphonanilide ligands (prepared in this lab.) have been used for preparation of systems with Tm(III) and the solution spectra of these systems have been recorded by using a standard spectrophotometer (at 790 nm).

Three representative ligands (L_1, L_2 & L_3) have been used for this study.

L_1 = 3-carboxy-4-hydroxy-2'-chloro benzene sulphonanilide

L_2 = 3-carbmethoxy-4-hydroxy-2'-chloro benzene sulphonanilide

L_3 = 3-carbethoxy-4-hydroxy-2'-chloro benzene sulphonanilide

Results have been given in table 1.01 to table 1-3 & the computed values of the formation constant from the spectroscopic data have been tabulated in table 1-3.

RESULTS AND DISCUSSION

The values of formation constant have been found to be from 2.9118 to 3.6532 (table-1.03) which shows the following order-

$Tm(III) - L_1 > Tm(III) - L_3 > Tm(III) - L_2$

The formation constant data show that the stability of lanthanide complexes is similar to Pr(III) and Nd(III) and $[Ag(NH_3)_2]^+$ type of complexes, which have been reported by earlier workers[16-17] at room temperature.

Table 1: observed values of absorbance at various concentrarion of tm(iii) with sulphonanilides

Metal ion concentration (in %) with sulphonanilides	Values of absorbance in mixed solutions with different sulphonanilide		
	With L_1	With L_2	With L_3
10	0.001	0.001	0.002
20	0.004	0.007	0.006
30	0.005	0.008	0.011
40	0.010	0.013	0.013
50	0.021	0.016	0.019
60	0.014	0.012	0.009
70	0.012	0.010	0.007
80	0.009	0.007	0.006
90	0.004	0.005	0.003

Table 2: Values of absorbance in different mixed solutions

Concentration of Tm(III)	Concentration of sulphonanilide	Absorbance in mixed solutions of Tm(III) with sulphonanilide		
		L_1	L_2	L_3
M/40	M/40	0.023	0.021	0.019
M/50	M/40	0.019	0.020	0.016
M/60	M/40	0.017	0.017	0.014
M/70	M/40	0.015	0.015	0.011
M/80	M/40	0.014	0.012	0.010

Table 3: Computed values of formation constant from observed data

Ligand No	Initial conc. of Tm (III) in moles/lit a	Initial conc. of ligand in moles/lit a	Equilibrium conc. of complex in moles/lit x	Equilibrium conc. of Tm (III) in moles/lit a-x	Equilibrium conc. of ligand in moles/lit a-x	$K = \frac{x}{(a-x)(a-x)}$	log K
1	M/50	M/50	M/45	M/50 -M/45	M/50 –M/45	4500	3.6532
2	M/50	M/50	M/64	M/50 -M/64	M/50 –M/64	816.32	2.9118
3	M/50	M/50	M/40	M/50 -M/40	M/50 –M/40	1000	3.0000

$[Ag(NH_3)_2]^+$ type of complex (logK =3.24 -3.81)

1:1 Pr(III)-oxy diacetic acid (logK=2.53)

1:1 Nd(III)-oxy diacetic acid(logK=2.67)

1:1 Pr(III)-sulphonanilide ligand (logK=2.9118-3.3551)

Low stability constant makes the isolation of these complexes in solid state difficult.

ACKNOWLEDGEMENTS

The authors are grateful to Principal Dungar College, Bikaner for providing necessary facilities and to Dr H P Yadev, Dr (Mrs.) S Gupta, Dr A Gupta & Dr S Jain for fruitful discussion and keen interest in the work.

REFERENCES

1. J D Lee, Concise inorganic chemistry, Chapman & Hall; XIVth edition (1992).
2. Hucheey J E, Inorganic Chemistry, Harper International S I Edition, IIIrd edition (1983).
3. W U Malik, G S Tuli, R D Madan, Selected topics in inorganic chemistry, S Chand publication, VIth edition (1993).
4. I Grenthe and V C Fernelius, *J. Am. Chem. Soc.;* **82**: 6285 (1960).
5. E J Whelwright, F K Spedding and G J Schwarzenbech, *Am. Chem. Soc.*; **75**: 4196 (1953).
6. R Chiarizia, P R Danesi, G Scibona and L Magon, *Journal of Inorganic and Nuclear Chemistry*; **35**(10): 3595 (1973).
7. A K Bandophdhyay, A K Chaudhary*, J Ind.Chem.*; **26**A: 853 (1987).
8. S S Shetyl, M S Mayadeo, Samyak *J Chem.*; **2**: 30 (1998)
9. Gadpayle M R, Meshram Y K , *Acta ciencia Indica*, **32**(3): 175 (2006)
10. G.H. Murhekar, A.R.Raut, M.P.Wadekar, V.W.Banewar and V.M. Raut, *Oriental J.of Chem.,* **25**(4): 1093 (2009).
11. Robert V Fox, R Duane Ball, Peter De B Harrington, Harry W Rollins, John J Jolley and Chien M Wai, *The Journal of Supercritical Fluids*; **31**(3): 273 (2004).
12. Harry G Brittain, S Mantha and Michael F Tweedle, *Journal of the Less Common Metals*; **126**: 339 (1986).
13. Erno Brucher and Gabor Laurenczy, *Journal of Inorganic and Nuclear Chemistry;* **43**(9): 2089 (1981).
14. Herbert B Silber, Ferenc Gaizer, Thang Pham and Max Strozier, Journal of the Less Common Metals; 126, 315 (1986).
15. Cengiz Soykan, Ramazan Coskun and Sevda Kirbag, *European Polymer Journal;* **4**3(9): 4028 (2007).
16. Paula Gameiro, Catarina Rodrigues, Teresa Baptista, Isabel Sousa and Baltazar De Castro, International Journal of Pharmaceutics; **334**(1-2): 129 (2007).
17. Rajesh Nagar, P C Driwedi and R C Sharma, *Indian J Chem*; **28**A: 722 (1989).