Studies of acoustic parameters of Thorium salts of lower fatty acids in benzene-methanol mixture

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***Abstract*— The values of various acoustic parameters such as adiabatic compressibility, intermolecular free length and specific acoustic impedance indicates that the thorium soaps of lower fatty acids behave as weak electrolyte in dilute solution (benzene-methanol) below the CMC. The plots of adiabatic compressibility, specific acoustic impedance and intermolecular free length Vs soap concentration are characterized by the CMC. There is a significant interaction between soap and solvent molecule. The soap molecules are absorbed at the interface and form a single layer of molecules and the molecules are oriented vertically, presumably with the hydrocarbon chains pointing towards the bulk phase and polar end groups outward.**

***Index Terms*— adiabatic compressibility, cmc, specific acoustic impedance**

I. INTRODUCTION

The studies on the utilization of metallic soaps are becoming increasingly important in various industries such as textiles, paints, lubricants, greases, cement and stone, lacquers, cosmetics, emulsifiers, water-proofing agents, medicines, pharmaceuticals, germicides, painting ink, varnishes, catalysts, softners, hardners, stabilizers etc. These metallic soaps can also be used as adhesive for steel cord and rubber radial tiers[1-4]. However, the applications of metallic soaps are largely depend upon the conditions and methods of preparation, so the information regarding the nature and structure of metal soaps is of great significance for their uses in various industries under different conditions.

Therefore, a detailed study of these soaps is required for their great importance in industrial and academic fields. Extensive work has been done on the alkaline and transition metal soaps but comparatively less work has been done on lanthanide and actinide soaps[5-12]. This paper deals with the calculation of different acoustical parameters from ultrasonic studies of thorium salts of lower fatty acids (butyrate, valerate, caproate and caprylate) in benzene-methanol mixture (50%-50%). .

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II. EXPERIMENTAL

Thorium soaps were prepared by direct metathesis of the corresponding sodium soaps of lower fatty acid with the required amount of aqueous solution of thorium nitrate with constant stirring. The precipitated soap was filtered off and washed first with distilled water and finally with alcohol. The soaps were first dried in an air-even at 50-60^{0}C and then under reduced pressure and further purified by recrystallisation.

The intermolecular free length, L_f adiabatic compressibility, β specific acoustic impedance, z molar sound velocity, R Vander Waal's constant, b molecular radius, r_m and area of cross section of molecule, A have been calculated by the equations :

III. RESULT AND DISCUSSION

The ultrasonic velocity of thorium soap solution increases with increasing soap concentration and increasing chain length of the soap. The plots of ultrasonic velocity Vs soap concentration are characterized by an intersection of two straight lines at a definite soap concentration, corresponds to the CMC of the soap.

The variation of various acoustic parameters such as adiabatic compressibility, intermolecular free length and specific acoustic impedance indicates that these soaps behave as weak electrolyte in dilute solution below the CMC.

The plots of adiabatic compressibility, specific acoustic impedance and intermolecular free length Vs soap concentration are characterized by the CMC.

It is concluded that there is a significant interaction between soap and solvent molecule. The values of the CMC obtained from ultrasonic measurements were in close agreement with the values obtained from other micellization properties. The values of Vander Waal's constant, b of thorium soap solutions decrease with the increase in concentration of soap while increase with increasing chain length of the soap (Table 5.5-5.8). The values of effective volume of the solution containing one mole of soap molar volume actually occupied by the molecules decreases with the increase in the concentration of the soap solution. The values of area of cross section of the molecule for thorium soaps vary with the concentration of the soap solution.

The ultrasonic velocity results confirm that thorium soaps act as weak electrolyte in dilute solutions below the CMC. The values of the CMC are in close agreement with the values obtained from other micellization studies

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Ultrasonic Velocity and acoustic parameters of Thorium Butyrate in Benzene and Methanol mixture (at 40±0.05^{0}C)

S. No.	Concentration $C \times 10^4$ (g mol dm^{-3})	Density ρ (g ml^{-1})	Ultrasonic velocity, $v \times 10^{-5}$ (cm/sec)	Adiabatic compressibility $\beta \times 10^{11}$ (cm^2/dyne)	Intermolecular free length L_f (A^0)	Specific acoustic Impedance $Z \times 10^{-4}$ (CGS unit)	Molar sound velocity $R \times 10^{-2}$ (cm/sec)
1.	1.0	0.8435	1.104	9.728	0.633	9.312	31.28
2.	2.0	0.8456	1.107	9.653	0.630	9.361	31.24
3.	3.0	0.8478	1.110	9.569	0.627	9.411	31.18
4.	4.0	0.8500	1.113	9.497	0.625	9.461	31.13
5.	5.0	0.8524	1.116	9.416	0.622	9.513	31.08
6.	6.0	0.8547	1.119	9.346	0.620	9.564	31.03
7.	7.0	0.8562	1.125	9.225	0.616	9.632	31.02
8.	8.0	0.8571	1.131	9.124	0.613	9.693	31.05
9.	9.0	0.8581	1.138	9.001	0.608	9.765	31.08
10.	10.0	0.8590	1.144	8.897	0.605	9.827	31.10

Ultrasonic velocity and acoustic parameters of Thorium Valerate in Benzene and Methanol mixture (at 40±0.05^{0}C)

S. No.	Concentration $C \times 10^4$ (g mol dm^{-3})	Density ρ (g ml^{-1})	Ultrasonic velocity, $v \times 10^{-5}$ (cm/sec)	Adiabatic compressibility $\beta \times 10^{11}$ (cm^2/dyne)	Intermolecular free length L_f (A^0)	Specific acoustic Impedance $Z \times 10^{-4}$ (CGS unit)	Molar sound velocity $R \times 10^{-2}$ (cm/sec)
1.	1.0	0.8439	1.105	9.709	0.632	9.325	31.28
2.	2.0	0.8465	1.109	9.606	0.629	9.388	31.22
3.	3.0	0.8492	1.112	9.524	0.626	9.443	31.15
4.	4.0	0.8521	1.116	9.425	0.623	9.509	31.09
5.	5.0	0.8550	1.119	9.337	0.620	9.567	31.01
6.	6.0	0.8581	1.122	9.259	0.617	9.628	30.93
7.	7.0	0.8583	1.129	9.132	0.613	9.696	30.99
8.	8.0	0.8584	1.136	9.025	0.609	9.751	31.05
9.	9.0	0.8586	1.143	8.913	0.605	9.814	31.11
10.	10.0	0.8587	1.149	8.818	0.602	9.866	31.16

Ultrasonic velocity and acoustic parameters of Thorium Caproate in Benzene and Methanol mixture (at 40±0.05^{0}C)

S. No.	Concentration C x 10^4 (g mol dm^{-3})	Density ρ (g ml^{-1})	Ultrasonic velocity, v x 10^{-5} (cm/sec)	Adiabatic compressibility β x 10^{11} (cm^2/dyne)	Intermolecular free length L_f (A^0)	Specific acoustic Impedance Z x 10^{-4} (CGS unit)	Molar sound velocity R x 10^{-2} (cm/sec)
1.	1.0	0.8441	1.105	9.699	0.632	9.327	31.27
2.	2.0	0.8468	1.110	9.588	0.628	9.399	31.22
3.	3.0	0.8500	1.113	9.497	0.625	9.461	31.13
4.	4.0	0.8532	1.117	9.390	0.621	9.530	31.06
5.	5.0	0.8563	1.120	9.311	0.619	9.591	30.97
6.	6.0	0.8591	1.124	9.217	0.615	9.656	30.91
7.	7.0	0.8607	1.130	9.099	0.612	9.726	30.91
8.	8.0	0.8620	1.138	8.961	0.607	9.810	30.94
9.	9.0	0.8625	1.144	8.857	0.604	9.867	30.98
10.	10.0	0.8633	1.152	8.726	0.599	9.945	31.02

Ultrasonic velocity and acoustic parameters of Thorium Caprylate in Benzene and Methanol mixture (at 40±0.05^{0}C)

S. No.	Concentration C x 10^4 (g mol dm^{-3})	Density ρ (g ml^{-1})	Ultrasonic velocity, v x 10^{-5} (cm/sec)	Adiabatic compressibility β x 10^{11} (cm^2/dyne)	Intermolecular free length L_f (A^0)	Specific acoustic Impedance Z x 10^{-4} (CGS unit)	Molar sound velocity R x 10^{-2} (cm/sec)
1.	1.0	0.8442	1.107	9.662	0.630	9.345	31.29
2.	2.0	0.8470	1.111	9.569	0.627	9.410	31.22
3.	3.0	0.8501	1.116	9.452	0.623	9.487	31.16
4.	4.0	0.8533	1.121	9.328	0.619	9.565	31.13
5.	5.0	0.8566	1.125	9.225	0.616	9.637	31.01
6.	6.0	0.8598	1.130	9.107	0.612	9.716	30.94
7.	7.0	0.8608	1.136	9.009	0.608	9.779	30.96
8.	8.0	0.8612	1.144	8.873	0.604	9.852	31.02
9.	9.0	0.8611	1.153	8.734	0.599	9.928	31.11
10.	10.0	0.8612	1.156	8.688	0.598	9.955	31.14

Other acoustic parameters of Thorium Butyrate

S. No.	Vander Waal's constant, b (C.C.)	Molecular radius r_m (A^0)	V_{mole} (C.C.)	Area of cross section of molecule A $(A^0)^2$	$r = \frac{V\,mole}{V}$
1.	666.46	4.041	166.62	51.322	2.549
2.	664.80	4.038	166.20	51.246	2.542
3.	663.15	4.034	165.79	51.098	2.536
4.	661.50	4.031	165.38	51.022	2.530
5.	659.21	4.026	164.80	50.895	2.521
6.	657.93	4.024	164.48	50.845	2.516
7.	656.91	4.022	164.23	50.794	2.512
8.	656.28	4.020	164.07	50.744	2.510
9.	655.65	4.019	163.91	50.718	2.507
10.	655.11	4.018	163.78	50.693	2.505

Other acoustic parameters of Thorium Valerate

S. No.	Vander Waal's constant, b (C.C.)	Molecular radius r_m (A^0)	V_{mole} (C.C.)	Area of cross section of molecule A $(A^0)^2$	$r = \frac{V\,mole}{V}$
1.	731.48	4.168	182.870	54.549	2.797
2.	729.31	4.165	182.328	54.470	2.789
3.	727.03	4.160	181.758	54.340	2.780
4.	724.59	4.155	181.148	54.209	2.771
5.	722.21	4.151	180.553	54.105	2.762
6.	719.67	4.146	179.918	53.974	2.752
7.	719.30	4.145	179.825	53.948	2.751
8.	719.15	4.145	179.788	53.948	2.750
9.	718.93	4.144	179.733	53.922	2.749
10.	718.92	4.144	179.730	53.922	2.749

Other acoustic parameters of Thorium Caproate

S. No.	Vander Waal's constant, b (C.C.)	Molecular radius r_m (A^0)	V_{mole} (C.C.)	Area of cross section of molecule A $(A^0)^2$	$r = \frac{V\,mole}{V}$
1.	795.95	4.287	198.988	57.708	3.044
2.	794.23	4.284	198.557	57.627	3.037
3.	791.32	4.279	197.83	57.493	3.026
4.	788.43	4.274	197.108	57.541	3.015
5.	785.58	4.269	196.395	57.224	3.004
6.	783.10	4.264	195.775	57.091	2.995
7.	781.81	4.262	195.453	57.037	2.986
8.	780.79	4.260	195.198	56.983	2.986
9.	780.42	4.259	195.105	56.957	2.984
10.	779.86	4.258	194.965	56.930	2.982

Other acoustic parameters of Thorium Caprylate

S. No.	Vander Waal's constant, b (C.C.)	Molecular radius r_m (A^0)	V_{mole} (C.C.)	Area of cross section of molecule A $(A^0)^2$	$r = \frac{V\,mole}{V}$
1.	927.54	4.512	231.885	63.925	3.547
2.	924.56	4.507	231.140	63.783	3.536
3.	921.29	4.502	230.323	63.642	3.523
4.	917.93	4.496	229.483	63.472	3.510
5.	914.49	4.491	228.623	63.331	3.497
6.	911.27	4.485	227.818	63.162	3.485
7.	910.21	4.484	227.553	63.134	3.481
8.	909.98	4.483	227.495	63.105	3.480
9.	907.93	4.480	226.983	63.021	3.472
10.	907.71	4.470	226.928	62.740	3.471