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Electrolytic Study of Basic Beryllium Acetate in Carbon disulphide at 303K, 308K, 313K

Rajeev Kumar Sharma[1], Renu Singhal[2]

Assistant Professor, Department of Chemistry, D.S. College, Aligarh, U.P. (India)[1]

Associate Professor, Department of Chemistry, D.S. College, Aligarh, U.P. (India)[2]

Abstract: The electrolytic study of Basic Beryllium Acetate (B.B.A.) in carbon disulphide were reported at 303K, 308K, 313K, the solute solvent interaction have been carried out by computing various Physico-chemical Acoustic Parameters [Apparent Molal adiabatic compressibility (ϕk), Isentropic compressibility (β_S), Intermolecular free length (L_f), Specific Acoustic Impedance (Z), Relative Association and Solvation Number (S_n)], these parameters have been evaluated by using ultrasonic velocity, density, viscosity data. The results of these parameters indicates the strength of molecular interaction.

Keywords: Molecular Interaction, Electrolytic, viscous behavior of Basic Beryllium acetate.

I. INTRODUCTION

The Isentropic compressibility of dilute aqueous solution of electrolytes decreases with increasing conc. indicating a strong interaction of the dissolved ion with the alkanols[1-7], the non-aqueous solution of electrolytes have drawn the attention of same workers.[7-9]

Now, we are reporting a study of Ultrasound velocity, density and viscosity measurement at 30^0C, 35^0C, 40^0C have been used to calculate isentropic compressibility (β_s), Intermolecular Free Lenght (L_f)[8], Specific Acoustic Impedance (Z)[9], Molar sound velocity (R), Relative association (R_A)[10], Apparent molal adiabatic compressibility (ϕk), Wada constant (B), Shear's relaxation time (τ_s) and Solvation numbers (S_n)[11] of B.B.A. in Carbon disulphide at 30^0C, 35^0C, 40^0C.

II. EXPERIMENTAL

The solution were prepared by dissolving the accurate known quantity of B.B.A. in liquid and kept for some time. A continuous wave interferometric technique was employed for the measurement of ultrasonic velocity at 2MHz. The density and viscosity were determined using a vibrating densitometer.

DMA 48 fitted with a Hoak G thermostat and Ubbelhode viscometer. The experiments were repeated at least twice and results were reproducible with experimental error of 0.0002 kgm^3 and 0.0002 mPas respectively.

III. COMPUTATION OF DIFFERENT PHYSICAL PARAMETERS

Ultrasound Velocity (V) :

$$V = 2d \times 10^3 \text{ m/sec}$$

'V' velocity , 'd' Distance

Density : Density of all prepared sample will be determined by Calibrated pyknometer of high frequency.

$$\rho = \frac{M}{V+\pi r^2(h_1+h_2)}$$

Where –

'M' : is the wt. of the liquid filled in pyknometer used.
'r' : is the radius of capillaries
'h_1' : & 'h_2' are the height of the liquid in capillaries
'V' : volume taken the pyknometer

Viscosity (η) :

$$\eta_p = \rho\left(at - \frac{b}{t}\right)$$

Where –

'η' : is the viscosity of liquid
'ρ' : is density of liquid
't' : is the time flow of liquid
'a' & 'b' are viscometric constants

Specific Acoustic Impedance :

Z = V.ρ

Where, 'V' and 'ρ' are the ultrasonic velocity and density respectively.

Isentropic Compressibility (β_s) : The relation between ultrasonic velocity and compressibility in the liquid media.

$$\beta_s = \frac{1}{V^2\rho}$$

Where, 'V' is the ultrasound velocity and 'ρ' is the density of liquid mixtures or electrolytic solution.

Intermolecular Free Length (L_f) :

$$L_f = K\sqrt{\beta_s}$$

Where 'K' is temp. dependant constant

Relative Association:

$$RA = \left(\frac{\rho}{\rho_0}\right)\left(\frac{v_0}{v}\right)^{\frac{1}{3}}$$

where

'ρ' and 'ρ_0' are the densities of solution and solvent.
'v' and 'v_0' are their ultrasound velocity.

Apparent Molal Adiabatic Compressibility (ϕ_k):

$$\phi_k = \frac{1000}{C.\rho^0}(\rho^0\,\beta_s - \beta_{s0}.\rho) + \beta_{s0}\,M / \rho^0$$

Where

'ϕ_k' : Apparent molal adiabatic compressibility
'ρ^0' : Density of solvent
'β_{s0}' : Isentropic compressibility of solvent
'M' : Molecular wt. of solute
'β_s' : Isentropic compressibility of solute at different temp.
'ρ' : Density of solution

Solvation number (S_n) : It may expressed as:

$$S_n = \frac{n_1}{n_2}\left[1 - \frac{\beta_s}{\beta_{s0}}\right]$$

'n_1' : is moles of solvent
'n_2' : is moles of solute
'β_s' : is isentropic compressibility of solute
'β_{s0}' : is isentropic compressibility of solvent

Wada Constant (B) :

$$B = \left[\frac{M}{\rho}\right]\ \beta_s^{1/7}$$

Shear's Relaxation time (τ_s) :

$$\tau_s = \frac{4}{3}\,\eta\,.\,\beta s$$

Specific Viscosity :

$$\eta_{sp} = \frac{\eta - \eta_0}{\eta_0}$$

Reduced Viscosity :

$$\eta = \frac{\eta_{sp}}{C}$$

Relative Viscosity :

$$\eta_r = \frac{\eta}{\eta_0}$$

Where 'η', 'η_0' are the viscosities of solution, solvent and C is the concentration of solution respectively. All measurement were taken at variable temperature the probable error of viscosity results is below +0.005cp.

IV. RESULT AND DISCUSSION

Ultrasonic velocity (v) in the solution of B.B.A. in Carbon disulphide increases with increase in concentration of B.B.A. The variation of velocity with conc. (c) can be expressed by the following relationship:

$$\frac{dv}{dc} = -v/2\left[\frac{1}{\rho}\left(\frac{d\rho}{dc}\right) + \left(\frac{1}{\beta s}\right)\left(\frac{d\beta s}{dc}\right)\right]$$

The result shows that while the density increase, the isentropic compressibility decreases with increasing concentration of solute and quantity (dρ/dc) is positive while (dβs/dc) is negative. Since the value of (1/(dβs/dc) are larger than the values of [1/ρ (dρ/dc)] for B.B.A. in carbon disulphide, the concentration derivatives of velocity (dv/dc) is positive i.e., the ultrasonic velocity increases with increasing the concentration of solute.[12-14]

Intermolecular free length and isentropic compressibility (βs) of Basic Beryllium acetate solution decreases with increase in the molar concentration of solute at different temperatures (Figure 1 & 2). The complementary use of isentropic compressibility data can provide interesting information of solute. Solvent interaction the results of isentropic compressibility have been explained in terms of the Bachem equation.[15]

$$\beta s = \beta s_0 + AC + BC^{3/2}$$

Where is the compressibility of solvent.

C is the concentration.

A & B are constant. The values of constant A(-157.2, -138.9, -101.1) and constant B(61.67, 67.8, 69.73) were obtained from the intercept and slope of the plots $[(\beta s - \beta s_0)/C]$ versus $C^{1/2}$ for the solution of Carbon disulphide.

Apparent molal adiabatic compressibility (ϕk) varies linearly as the square root of concentration ($C^{1/2}$).

The values of apparent molal adiabatic compressibility are negative with the increase in molar conc.

The values of limiting apparent molal adiabatic compressibility as shown in Fig. 3.

The values of ϕk for the solutions of B.B.A. in CS_2 at 303K, 308K, 313K were tabulated on Tables (1-3) and also plotted on Fig. 3. These results are in agreement with the results reported by Masson[16] for electrolytic solution.

The values of specific acoustic impedance (Z) increase with increasing the concentration of B.B.A. can be explained on the basis of lyphobic interaction but have been solute and solvent molecules and becoming the main cause of impedance in the propagation of ultrasound waves are tabulated in Table (1-3) and placed in Fig. 4. The values of salvation number (S_n), Relative association (R_A), Wada Constant (B), Shear's relaxation time increase with the concentration suggest a significant interaction between the solute, solvent molecules and the values are in agreement with the reported for solution of Cobalt Carboxylates.[17]

The result of ultrasound velocity show that the B.B.A. behave as a week electrolyte and there is a significant interaction between the B.B.A. with solvent molecules.

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Table 1
Basic Beryllium Acetate + Carbon disulphide at 303K

Concentration (mol/liter)	Ultrasound Velocity (m/sec.)	Density (gm/mol)	Lowering Isentropic Compressibility	$\beta s- \beta s_0 /C$	Viscosity (exp) C.P.	Specific Viscosity C.P.
.01	1156	1.2361	1.97	-196.83	0.5119	0.0057
.02	1162	1.2625	3.84	-192.24	0.5148	0.0114
.03	1168	1.2889	5.64	-187.84	0.5177	0.0171
.04	1174	1.3153	7.34	-183.62	0.5206	0.0228
.05	1180	1.3417	8.98	-179.58	0.5235	0.0285
.06	1186	1.3681	10.54	-175.69	0.5264	0.0342
.07	1192	1.3945	12.04	-171.96	0.5293	0.0399
.08	1198	1.4209	13.47	-168.37	0.5322	0.0456
.09	1204	1.4473	14.84	-164.92	0.5351	0.0513
.10	1210	1.4737	16.16	-161.60	0.5380	0.0570

Concentration (mol/liter)	Molar Sound Velocity (m/sec)	Relative Association (R_A)	Solvation Number (Sn)	Wada Constant	Shear's Relaxation Time
.01	0.5697	1.0201	0.03964	34.87	789.01
.02	0.5697	1.0401	0.154486	34.48	797.60
.03	0.5697	1.0600	0.34045	34.10	806.23
.04	0.5697	1.0799	0.59167	33.74	814.91
.05	0.5697	1.0997	0.90411	33.39	823.64
.06	0.5697	1.1195	1.27377	33.05	832.41
.07	0.5697	1.1392	1.69692	32.73	841.23
.08	0.5697	1.1588	2.17015	32.42	850.10
.09	0.5697	1.1784	2.6903	32.12	859.01
.10	0.5697	1.1980	3.25443	31.82	867.97

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Table 2
Basic Beryllium Acetate + Carbon disulphide at 308K

Concentration (mol/liter)	Ultrasound Velocity (m/sec.)	Density (gm/mol)	Lowering Isentropic Compressibility	$\beta s - \beta s_0 / C$	Viscosity (exp) C.P.	Specific Viscosity C.P.
.01	1107	1.2234	1.65	-164.58	0.4659	0.0041
.02	1112	1.2420	3.23	-161.71	0.4683	0.0093
.03	1117	1.2606	4.77	-158.93	0.4707	0.0144
.04	1122	1.2792	6.25	-156.24	0.4731	0.0196
.05	1127	1.2978	7.68	-153.63	0.4755	0.0248
.06	1132	1.3164	9.07	-151.10	0.4779	0.0300
.07	1137	1.335	10.40	-148.64	0.4803	0.0351
.08	1142	1.3536	11.70	-146.25	0.4827	0.0403
.09	1147	1.3722	12.95	-143.94	0.4851	0.0455
.10	1152	1.3908	14.17	-141.68	0.4875	0.0506

Concentration (mol/liter)	Molar Sound Velocity (m/sec)	Relative Association (R_A)	Solvation Number (Sn)	Wada Constant	Shear's Relaxation Time
.01	0.4095	1.0139	0.030435	34.76	687.67
.02	0.4634	1.0278	0.119620	34.54	694.33
.03	0.4813	1.0417	0.26452	34.33	701.03
.04	0.4903	1.0555	0.462296	34.12	707.76
.05	0.4957	1.0692	0.710268	33.92	714.52
.06	0.4993	1.0830	1.00592	33.73	721.31
.07	0.5018	1.0967	1.346907	33.54	728.13
.08	0.5038	1.1104	1.730985	33.35	734.99
.09	0.5053	1.1240	2.156062	33.17	741.88
.10	0.5065	1.1376	2.620164	33.00	748.80

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Table 3
Basic Beryllium Acetate + Carbon disulphide at 313K

Concentration (mol/liter)	Ultrasound Velocity (m/sec.)	Density (gm/mol)	Lowering Isentropic Compressibility	$\beta s - \beta s_0 / C$	Viscosity (exp) C.P.	Specific Viscosity C.P.
.01	1094	1.2134	1.22	-122.25	0.4301	0.0026
.02	1098	1.2242	2.33	-116.32	0.4319	0.0068
.03	1102	1.235	3.41	-113.52	0.4337	0.0110
.04	1106	1.2458	4.46	-111.52	0.4355	0.0152
.05	1110	1.2566	5.49	-109.86	0.4373	0.0193
.06	1114	1.2674	6.50	-108.37	0.4391	0.0235
.07	1118	1.2782	7.49	-107.00	0.4409	0.0277
.08	1122	1.2890	8.46	-105.70	0.4427	0.0391
.09	1126	1.2998	9.40	-104.46	0.4445	0.0361
.10	1130	1.3106	10.33	-103.27	0.4463	0.0403

Concentration (mol/liter)	Molar Sound Velocity (m/sec)	Relative Association (R_A)	Solvation Number (Sn)	Wada Constant	Shear's Relaxation Time
.01	0.2564	1.0091	0.0221	34.89	627.37
.02	0.3380	1.0169	0.0842	34.85	632.30
.03	0.3652	1.0246	0.1848	34.81	637.2%
.04	0.3788	1.0323	0.3228	34.77	642.22
.05	0.3869	1.0400	0.4969	34.73	647.20
.06	0.3924	1.0477	0.7058	34.69	652.21
.07	0.3963	1.0554	0.9486	34.65	657.23
.08	0.3992	1.0631	1.2239	34.62	662.28
.09	0.4015	1.0707	1.5309	34.58	667.34
.10	0.4033	1.0784	1.8684	34.55	672.43

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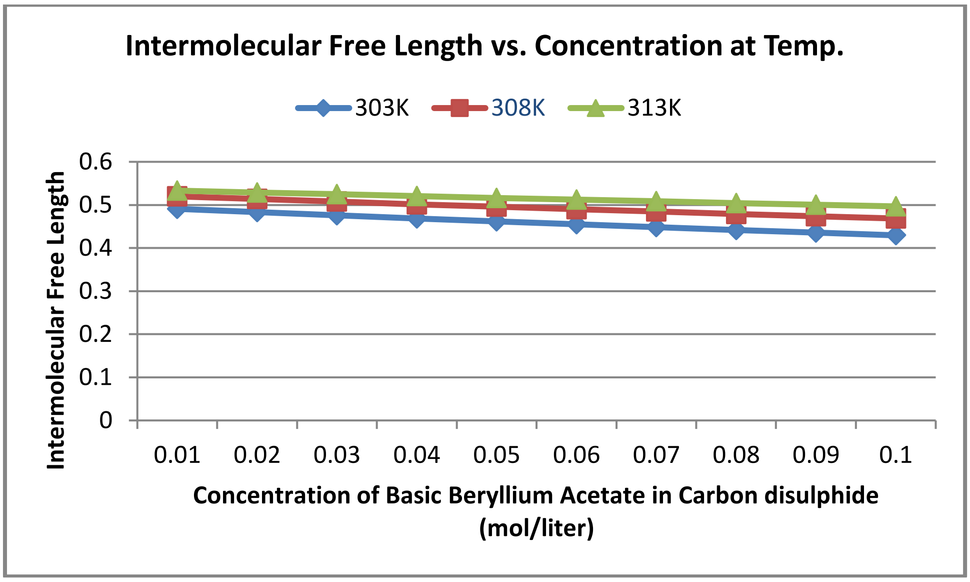

Fig. 1

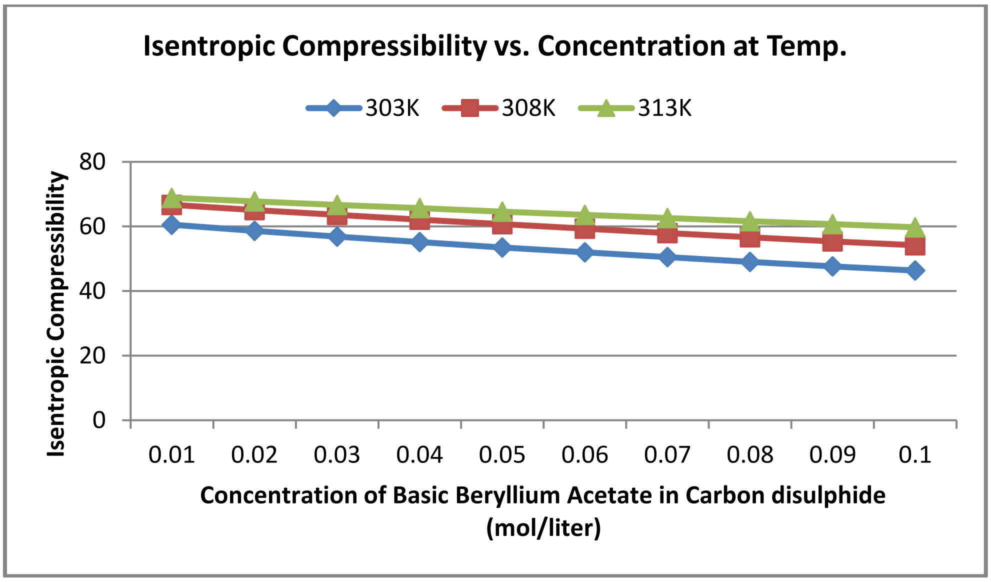

Fig. 2

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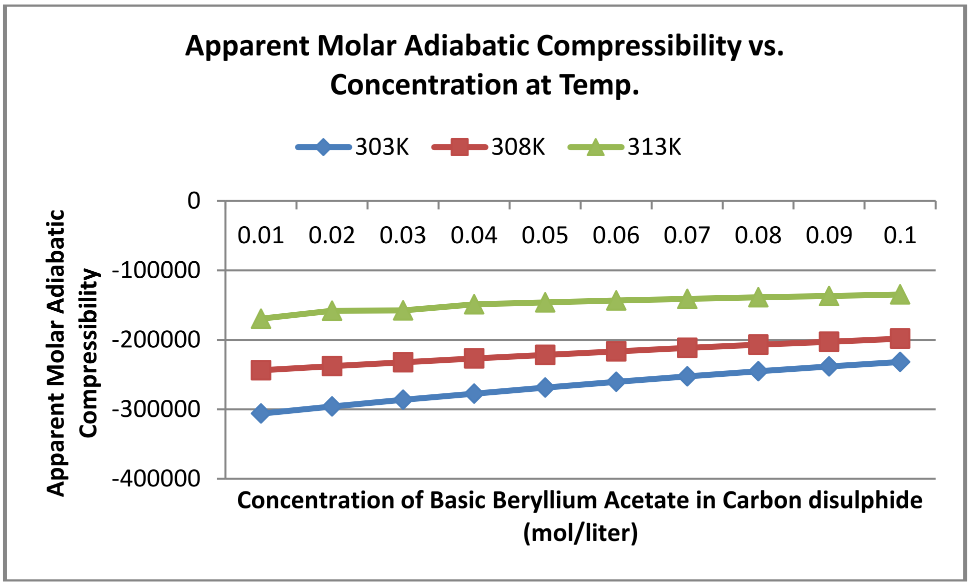

Fig. 3

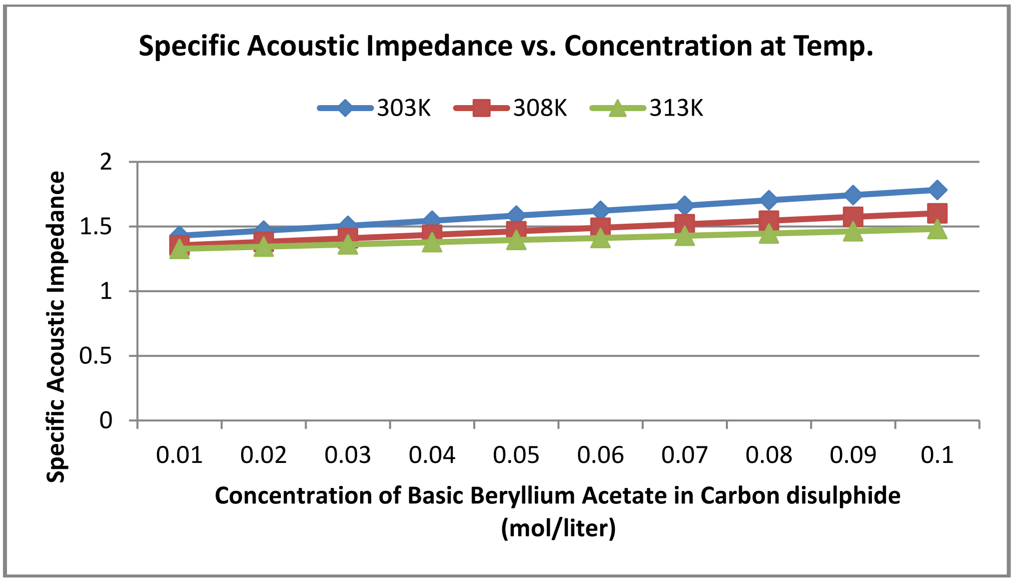

Fig. 4