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ELECTROLYTIC AND VISCOUS BEHAVIOUR OF BERYLLIUM IODIDE AT 303K

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ABSTRACT

The study of solute-solvent interaction of beryllium iodide in lower alchols (methanol, ethanol, propanol) were reported at 303K. The molecular interactions have been carried out by computing various acoustic parameters (Intermolecular free length (L_f), Isentropic compressibility (β_s), Specific acoustic impedance (z), Apparent molal adiabatic compressibility (ϕK), Relative association and solvation number ('S'_n). These parameters have been evaluated by using ultrasonic-velocity, density and viscosity datas. The results are discussed in the light of solute-solvent interaction between the molecules.

Key words: Solute-solvent interaction, electrolytic,viscous behaviour, beryllium iodide.

INTRODUCTION

The Isentropic compressibility of dilute aqueous solutions of electrolytes decreases with increasing concentration indicating a strong interaction of the dissolved ions with the lower alcohols[1-7]. The non-aqueous solutions of electroltyes have drawn the attention of same workers[7-9].

In the present paper, we are reporting a study of ultrasonic velocity, density and viscosity measurements at 30°C have been used to calculate isentropic compressibility (β), intermolecular free length (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 solvant number (S_n)[11] of Beryllium iodie in lower alcohols (methanol, ethanol and propanol) at 30°C.

EXPERIMENTAL

The solutions were prepared by dissolving the accurately known weight of Beryllium iodide in liquid and kept for some time. A continuous wave interforemeteric 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 Hook G thermostat and ubbelhode viscometer. The experiments were repeated atleast twice and results were reproducible with experimental error of 0.00002 kgm³ and 0.0002 mPaS respectively.

Computation of different physical parameters
Ultrasound Velocity (V)

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

where V = Ultrasound velocity, d = distance

Density

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

Where
'M' is the wt of the liquid filled pyknometer used
'r' is the redivs of capillaries
$2h_1$ & h_1 are the height of the liquid in capillaries
V volume taken the pyknometer

Table - 1: Ultrasonic velocity and other accoustic parameters of Beryllium iodide + Methanol at 303 K

Concentration mol/liter	Ultrasound Velocity (m/ sec.)	Density gm/ mol	Specific Accoustic (C.G.S.)	Lowering isentropic Compressibility	[`S-[`S$_{o/c}$	Viscosity (exp.) C.P.	Specific Viscosity C.P.	Reduced Viscosity C.P.	Relative association Ra	Solvation No. Sn	Wada Constant	Shear's Relaxation Time
0.01	1095	0.7859	0.8606	1.18	-118.47	0.5758	0.1058	10.5819	10047	0.09	21.36	840.67
0.02	1098	0.7912	0.8687	2.47	-123.54	0.6309	0.2116	10.5819	1.0106	0.38	21.37	923.64
0.03	1102	0.7965	0.8777	3.92	-130.77	0.686	0.3175	10.5819	1.0161	0.9	21.4	1007.96
0.04	1104	0.8018	0.8852	4.98	-124.45	0.7411	0.4233	10.5819	1.0223	1.52	21.41	1090.9
0.05	1107	0.8071	0.8935	6.2	-124.01	0.7962	0.5291	10.5819	1.0281	2.37	21.43	1175.19
0.06	1110	0.8124	0.9018	7.4	-123.37	0.8513	0.6349	10.5819	1.0339	3.4	21.44	1259.92
0.07	1113	0.8177	0.9101	8.58	-122.62	0.9064	0.7407	10.5819	1.0398	4.59	21.46	1345.1
0.08	1116	0.823	0.9185	9.75	-121.83	0.9615	0.8466	10.5819	1.0456	5.96	21.47	1430.71
0.09	1119	0.8283	0.9269	10.89	-121	1.0166	0.9524	10.5819	1.0514	7.49	21.49	1516.77
0.1	1123	0.8336	0.9361	12.18	-121.84	1.0717	1.0582	10.5819	1.0569	9.32	21.51	1604.69

Table - 2: Beryllium iodide + Ethanol at 303 K

Concentration mol/liter	Ultrasound Velocity (m/ sec.)	Density gm/ mol	Specific Accoustic (C.G.S.)	Lowering isentropic Compressibility	[`S-[`S$_{o/c}$	Viscosity (exp.) C.P.	Specific Viscosity C.P.	Reduced Viscosity C.P.	Relative association Ra	Solvation No. Sn	Wada Constant	Shear's Relaxation Time
0.01	1185	07884	0.9343	0.96	-95.7	1.2648	0.0338	3.384	1.0046	0.00001	28.63	1998.38
0.02	1188	0.7927	0.9417	1.9	-95	1.3062	0.0677	3.384	1.0093	0.00005	28.69	2069.02
0.03	1193	0.797	0.9508	3.13	-104.2	1.3476	0.1015	3.384	1.0133	0.00012	28.76	2143.58
0.04	1196	0.8013	0.9584	4.04	-100.96	1.389	0.1354	3.384	1.018	0.0021	28.82	2214.99
0.05	1199	0.8056	0.9659	4.98	-98.76	1.4304	0.1692	3.384	1.0226	0.0032	28.88	2286.73
0.06	1202	0.8099	0.9735	5.82	-97.07	1.4718	0.203	3.384	1.0272	0.00045	28.93	2358.8
0.07	1206	0.8142	0.9819	6.84	-97.7	1.5132	0.2369	3.384	1.0315	0.00062	29	2433.23
0.08	1210	0.8185	0.9904	7.84	-97.96	1.5546	0.2707	3.384	1.0359	0.00081	29.06	2508.09
0.09	1213	0.8228	0.9981	8.68	-96.48	1.596	0.3046	3.384	1.0404	0.00101	29.12	2581.26
0.1	1216	0.8271	1.0058	9.52	-95.17	1.6374	0.3384	3.384	1.045	0.00123	29.17	2654.77

Table - 3: Beryllium iodide + Propanol at 303 K

Concentration mol/liter	Ultrasound Velocity (m/ sec.)	Density gm/ mol	Specific Accoustic (C.G.S.)	Lowering isentropic Compressibility	[\`S-[\`S$_{o/c}$	Viscosity (exp.) C.P.	Specific Viscosity C.P.	Reduced Viscosity C.P.	Relative association Ra	Solvation No. Sn	Wada Constant	Shear's Relaxation Time
0.01	1215	0.8107	0.985	0.55	-54.59	1.8875	0.0118	1.18	1.0008	0.2407	40.1	3057.75
0.02	1218	0.812	0.989	1.09	-54.46	1.9258	0.0323	1.62	1.0015	0.4975	40.27	3127.5
0.03	1222	0.8133	0.9938	1.76	-58.75	1.9641	0.0529	1.76	1.002	0.7764	40.45	3200.17
0.04	1225	0.8145	0.9978	2.29	-57.28	2.0024	0.0734	1.84	1.0028	1.0666	40.62	3270.59
0.05	1228	0.8158	1.0018	2.82	-56.4	2.0407	0.0939	1.88	1.0036	1.3727	40.79	3341.31
0.06	1231	0.817	1.0058	3.34	-55.61	2.079	0.1145	1.91	1.0042	1.6934	40.96	3412.33
0.07	1234	0.8183	1.0098	3.85	-55.07	2.1173	0.135	1.93	1.005	2.0296	41.12	3483.66
0.08	1237	0.8196	1.0138	4.37	-54.63	2.1556	0.1555	1.94	1.0058	2.3809	41.29	3555.3
0.09	1241	0.8208	1.0187	5	-55.58	2.1939	0.1761	1.96	1.0062	2.7632	41.47	3630.17
0.1	1245	0.8221	1.0235	5.63	-56.31	2.2333	0.1966	1.97	1.0067	3.1639	41.64	3705.45

Viscosity

$$\eta_p = \rho\,(at - b/\tau)$$

Where,

'η' is the viscosity of liquid
'ρ' is density of liquid
'τ' is the lime flow of liquid
'a' & 'b' are viscometric constants

Specific acoustic impedance

$$Z = V.\rho$$

Where,

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

Isentropic compressibility

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

Where,

'V' is the ultrasound velocity and 'ρ' is the density of liquid mixture.

Intermolecular free length

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

Where,

'K' is temperature dependent constant

Relative Association

$$R_A = \left(\frac{\rho}{\rho_o}\right)\left(\frac{V_o}{V}\right)^{1/3}$$

Where,

'ρ' and ρ_o are the densities of solutions and solvent. 'V' and 'V_o' are their ultrasound velocity respectively.

Molal adiabatic compressibility

$$\phi K = \frac{1000}{C\,\rho_o}\left(\rho_o\,\beta - \beta_{so}\,\rho\right) + \beta_{so}\,\frac{M}{\rho^o}$$

Where

'ρ_o' and 'β_so' are compressibility and density of pure solvent and 'β_s' and ρ are the compressibility and density of the solution respectively.

'C' is the concentration in mole/litre of solute.
'M' is the molecular wt. of solute.

Solvation Number

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

Specific and reduced viscosity
Specific viscosity

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

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 measurements were taken at variable temps. The probable error of viscosity results is below + 0.005 cp.

Wada Constant (B)

$$B = (M / \rho)\, \beta_s^{-1/7}$$

Shear's relaxation time (f)

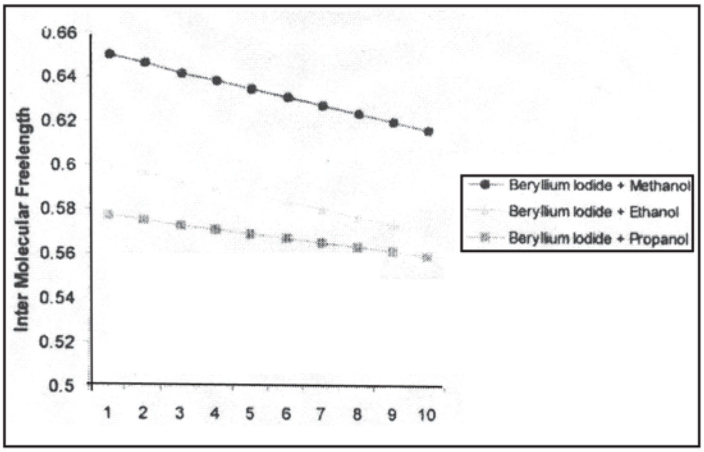
$$\tau_s = \frac{4}{3}\eta.\beta_s$$

RESULTS AND DISCUSSION

Ultrasonic velocity (V) in the solution of beryllium in lower alcohols (methanol, ethanol and propanol) increases with increase in concentration of beryllium iodide. The variation of velocity with concentration (C) can be expressed by the following relationship.

$$dv/dc = - v / 2[1/ \rho\, (d\rho / dc) + 1 / \beta_s\, (d\beta_s / dc)]$$

the results show that while the density increases, the isentropic compressibility decreases with increasing concentration of solute and quantity (dρ/dc) is positive while ($d\beta_s$/dc) is negative. Since the values of [1/β_s/dc)] are larger than the values of [1/ρ(dρ/dc) for beryllium iodide in lower alcohols. The concentration derivatives of velocity (dv/dc) is



Conc. of Beryllium iodide in lower alcohols (Mole/liter)

Fig. - 1: Intermolecular Freelength Vs Concentration at 303 K

positive *i.e.* the ultrasonic velocity increases with increasing the concentration of solute[12-14].

Inter molecular freelength and isentropic compressibility (β_s) of beryllium iodide solution decreases with increase in the molar concentration of solute (Fig. - 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 Bachem's equation[15].

$$\beta_s = \beta_{s0} + AC + BC^{3/2}$$

where β_{s0} is the compressibility of solvent C is the concentration and A & B are constants, the values of constants A(-4.5, -12.8, -16.5) and B(-.3057, 0.4663, 0.5095) were obtained from the intercept and slop of the plots [(β_s - β_{s0})/c] versus $C^{1/2}$ for the solution of alcohols.

Apparanet molal 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 concentration. The values of limiting apparent molal adiabatic compressibility (Fig. - 3) The values of ϕK for the solutions of beryllium iodide in methanol, ethanol, propanol 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.

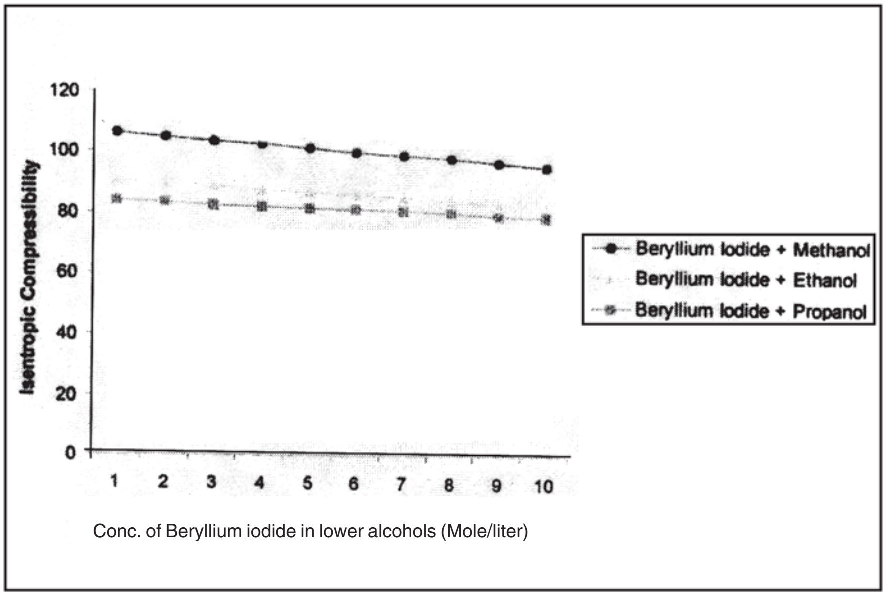


Fig. - 2: Isentropic compressibility Vs Concentration at 303 K

The value of specific acoustic impedance (z) increases with increasing the concentration of beryllium iodide can be explained on the basis of lyphobic interaction between solute and solvent molecules and becoming the main cause of impedance in the propagation of ultrasound waves are tabulated in Tables 1-3. The values of solvation no. (Sn), 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.

The results of ultrasound velocity show that the beryllium behave as a weak electrolyte and there is a significant interaction between the beryllium iodide with solvent molecules.

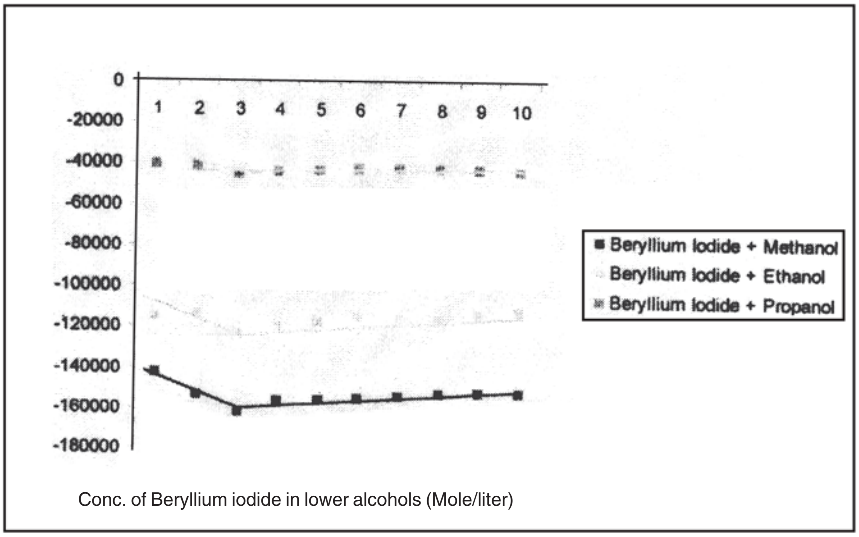


Fig. - 3: Apparent molal adiabatic compressibility Vs Concentration at 303 K

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