Original Research Paper

Volume-7 | Issue-11 | November-2017 | ISSN - 2249-555X | IF : 4.894 | IC Value : 79.96

Chemistry

ULTRASONIC STUDIES ON SOLUTE-SOLVENT INTERACTION IN ALCOHOLIC SOLUTION OF MAGNESIUM IODIDE

Gajendra Pal Singh	Department of Chemistry
Ruchi Agarwal	Bareilly College, Bareilly

ABSTRACT Ultrasonic velocity, density and viscosity measurements have been used to calculate isentropic compressibility (β_s), intermolecular free length (L_f), molar sound velocity (R) relative association (R_A) apparent molal adiabatic compressibility (Φ_k) Wada's constant (B) Shear's relaxation time (β_s) of solutions of magnesium iodide (MgI_2) in ethanol and 1-propanol. In each case, ultrasound velocity increases while isentropic compressibility (β_s) and intermolecular free length (L_f) decreases with the increase in molar concentration of MgI_2. As usual, apparent molal adiabatic compressibility (Φ_k) has been found to be negative in both cases. The results were interpreted in terms of ion-solvent interactions on the basis of acoustic properties.

KEYWORDS : Ultrasonic velocity, magnesium iodide (MgI_2), ion-solvent interactions

Introduction : The compressibility of dilute aqueous solutions of electrolytes decreases with increasing concentration of the dissolved ions in the water molecules (1-4). The non-aqueous solution of electrolytes have drawn the attention of some workers (5-8). The findings of the studies on ultrasound velocity, density and viscosity measurements have been used to calculate isentropic compressibility (β_s) intermolecular free length (L_f) molar volume (Vm) Rao's constant (R) Wada's constant (B), apparent molal adiabatic compressibility (Φ_k), Shear's relaxation time(τ_s) of MgI_2 with ethanol and 1-propanol.

Experimental details : A continuous wave (CW) interferometric technique was applied for the measurements of the ultrasonic velocity at 2 MHz frequency using ultrasonic interferometer model (F-81) and the data measured were accurate upto $\pm$ 0.2%. The density and viscosity were determined using a vibrating densitometer and modified Ostwalds viscometer. The experiments were performed in replicates and results obtained are reported in (Table-1, 2). The temperature was maintained by circulating water around solution cell using a thermostat, controlled at temperature 303k.

Both the liquids ethanol and 1- propanol was distilled to remove the impurities. Periodic densities of these were measured. The desired purily was achieved by redistiling and obtaining the required standard densities as reported in literature (9).

Magnesium iodide used for preparation of alcoholic solution were of Analar grade. The salt was heated at 105^{0}C and placed in vacuum desiccator after purifying through standard method (10). 0.01M to 0.10M concentration of homogenous MgI_2 solutions were prepared with intervals of 0.01M by dissolving it in solvent chosen and make the required fluid system.

Result and Discussion : The velocity of compressed acoustic wave is related to the density and isentropic compressibility by following equation.

Computation of different physical parameters;

$$B_s = \left(\frac{1}{V^2\rho}\right)$$

$$Z = V.\rho$$

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

$$R = \frac{M}{\rho}.V^{1/3}$$

$$R_A = \left(\frac{\rho}{\rho_0}\right)\left(\frac{V_0}{V}\right)^{1/3}$$

$$\phi_K = \frac{1000}{C.\rho_0}(\rho_o.B_s - B_S^o.\rho) + \beta_S^o.\frac{M}{\rho_o}$$

Where V = ultrasound velocity, z = specific acoustic impedance,
β_s = isentropic compressibility, L_f = intermolecular free length
R = molar sound velocity, R_A = relative association
Φ_K = apparent molal adiabatic compressibility
while β_s^0 and ρ_o are compressibility and density of pure solvent and β_s and ρ are the compressibility and density of the solution respectively, whereas.

'C' is the concentration in mole/litre of solute and M being the molecular weight of solute.

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

$$B = \left(\frac{\bar{M}}{\rho}\right)\beta_S^{-1/7} \qquad \tau_S = \frac{4}{3}.\eta.\beta_s$$

Here S_n is the solution number n_1 and n_2 are the moles of solute and solvent respectively. B is Wada's constant τ_s is the Shear's relaxation time and is the viscosity.

The variation of velocity with concentration in an electrolytic solution depend on the concentration derivatives of β_s and ρ are follows:

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

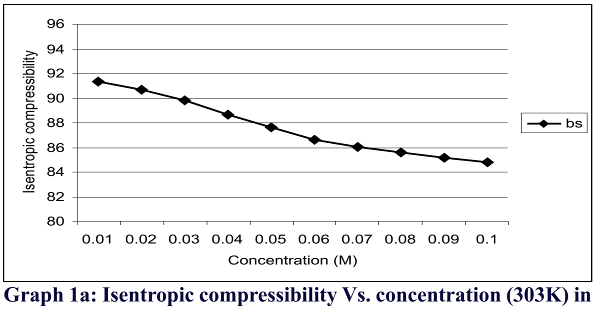
The quantity $\frac{d\rho}{dc}$ is always positive while $\frac{d\beta s}{dc}$ appears to be negative for electrolytic solution as in the present case. Since the factors have opposite signs, therefore, the velocity increases while isentropic compressibility decreases with the increase in molar concentration in the present investigation. The values of apparent molal adiabatic compressibility (ϕ_k) are negative at all concentrations at the chosen temperature, and are shown in tables 1 and 2 and graphs 1a, 1b, 2a and 2b. The negative value of ϕ_k indicate electrostatic and solvolytic interaction as well as the loss of structural compressibility of solvent molecules due to the increased population of alcoholic groups in both the alcohols.

The molar sound velocity (R) relative association (R_A). Wada's constant (B), Shear's relaxation time (τ_s) have been calculated for each electrolytic systems. The value of each of these constants have been tabulated in the tables and is found to vary with the increasing concentration of Magnesium Iodide (MgI_2).

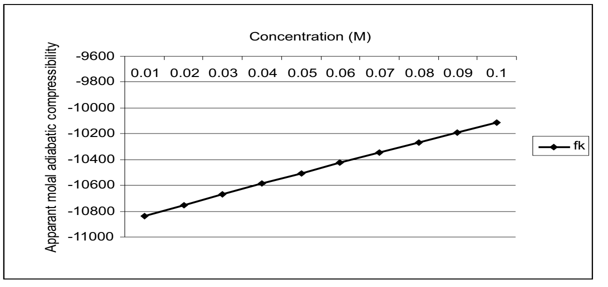
Conclusion :
Isentropic compressibility and apparent molal adiabatic compressibility both showed linear relationship to the concentration, thereby the solute-solvent is clearly examinable in the system. The outcome of the results revealed, laid further scope for study of various cationic halides interaction in aqueous and other alcoholic mediums.

Table 1 : MgI2 + Ethanol at 303K (+0.05K)

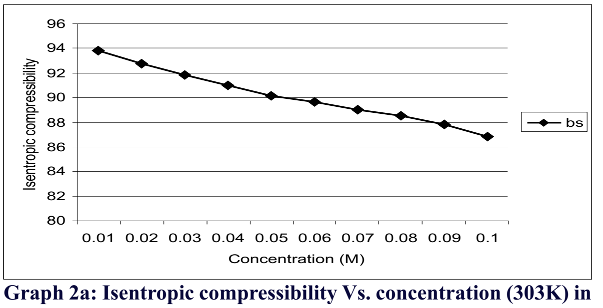
Conc. 'C' (M)	V	ρ	Z	βs	$\beta s0$	L_f	η	η_{sp}	R	ϕk	R_A	S_n	B	τ_s
0.01	1179	0.7905	931.99	91.37	1.12	0.6638	1.2283	0.0097	0.90	-10837.6	1.0030	0.0105	28.46	1910.10
0.02	1182	0.7912	935.19	90.66	2.12	0.6608	1.2486	0.0258	1.20	-10753.7	1.0060	0.0418	28.52	1944.40
0.03	1187	0.7938	942.24	89.84	3.23	0.6579	1.2687	0.0413	1.42	-10669.8	1.0090	0.0951	28.58	1981.10
0.04	1197	0.7971	949.35	88.69	4.36	0.6534	1.2892	0.0580	1.48	-10587.1	1.0120	0.1684	28.64	1999.80
0.05	1194	0.7998	954.96	87.65	5.47	0.6511	1.3073	0.0742	1.53	-10509.6	1.0151	0.2616	28.70	2016.10
0.06	1195	0.8008	956.96	86.65	6.51	0.6489	1.3290	0.0900	1.56	-10424.9	1.0180	0.3745	28.76	2058.40
0.07	1197	0.8036	961.91	86.05	7.59	0.6438	1.3496	0.1080	1.56	-10346.2	1.0218	0.5049	28.82	2091.70
0.08	1199	0.8075	968.19	85.61	8.63	0.6409	1.3671	0.1254	1.57	-10267.9	1.0246	0.6542	28.89	2138.70
0.09	1202	0.8104	974.11	85.14	9.55	0.6379	1.3908	0.1410	1.59	-10190.8	1.0278	0.8251	28.93	2167.10
0.10	1205	0.8139	980.75	84.80	10.62	0.6347	1.4106	0.1556	1.61	-10114.5	1.036	0.0103	29.02	2202.50



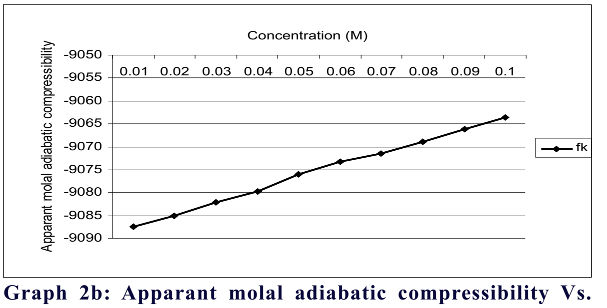
Graph 1a: Isentropic compressibility Vs. concentration (303K) in MgI2+ethanol system.



Graph 1b: Apparant molal adiabatic compressibility Vs. concentration (303K) in MgI2+ethanol system.



Graph 2a: Isentropic compressibility Vs. concentration (303K) in MgI2+1-propanol system.



Graph 2b: Apparant molal adiabatic compressibility Vs. concentration (303K) in MgI2+1-propanol system.

Table 2 : MgI2 + 1-proponol at 303K (+0.05K)

Conc. 'C' (M)	V	ρ	Z	βs	$\beta s0$	L_f	η	η_{sp}	R	ϕk	R_A	S_n	B	τ_s
0.01	1289	0.8010	1044.09	93.18	0.82	0.6063	1.6108	0.0099	0.90	-9087.4	1.0060	0.0132	35.20	2322.70
0.02	1291	0.8029	1036.54	92.79	1.87	0.6023	1.6316	0.0244	0.92	-9085.0	1.0081	0.0390	35.28	2351.6
0.03	1297	0.8050	1296.19	91.84	2.82	0.5981	1.6509	0.0467	0.93	-9082.2	1.0098	0.0580	35.26	2379.9
0.04	1301	0.8075	1300.19	91.00	3.70	0.5950	1.6732	0.0599	0.96	-9079.7	1.0124	0.0784	35.45	2398.9
0.05	1305	0.8190	1304.18	90.15	4.67	0.5917	1.6940	0.0704	0.97	-9076.1	1.0150	0.0766	35.52	2424.4
0.06	1308	0.8140	1307.28	90.10	5.88	0.5896	1.7150	0.0909	0.97	-9073.3	1.0177	0.1077	35.61	2456.3
0.07	1309	0.8133	1308.17	89.35	6.34	0.5830	1.7344	0.1050	0.98	-9071.4	1.0199	0.1208	35.70	2488.8
0.08	1312	0.8155	1311.18	88.52	7.35	0.5791	1.7523	0.1244	0.08	-9069.0	1.0230	0.1460	35.81	2490.5
0.09	1316	0.8189	1315.18	87.80	8.99	0.5743	1.7758	0.1461	1.10	-9068.1	1.0260	0.1692	35.92	2539.4
0.10	1319	0.8230	1318.37	86.63	9.70	0.5700	1.7919	0.1590	1.17	-9063.5	1.0279	0.1877	35.99	2589.6

References:

1. Rao Srinivas, A., Ravi Chandran G., and Namblnarayanan, T.K., Ind. J. of Pure and Appl. Phys. 29, 792-795 (1991).
2. Yadav, S.S., and Kumar, R., J. of Ind. Coun. of chem. 34, 131-133 (1995)
3. Aswar, A.S., Kulkarni, S.G. and Rohankar, P.G., Ind. J. of Chem. 39A, 1214-1217 (2000).
4. Rohankar, P.G. and Aswar, A.S.; Ind. J. of Chem. 41A, 312 (2000).
5. Yadav, S.S., Sharma, R.K. and Bhardwaj, C.K., Mol. Sci. Res. Ind. 3(1s), 97 (2006).
6. Raush China, G.P. and Kaurova, A.S., Akush, Zh., 12 (17), 118 (1966).
7. Subranamanyam, S.V., Phys. Letters, 1(3), (1962).
8. Syal, V.K., Chauhan, S., and Chauhan, M.S., Ind. J. of Pure and Appl. Phys. 33, 920 (1995).
9. Jacobson, B., Acta. Chem. Scand., 6, 1485 (1952)
10. Nigam, R.K., Singh, R.P., Mishra, R. and Singh, M., Can. J. Chem. 58, 1468(1980).