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ORIGINAL ARTICLE

Thermodynamic and Acoustical Parameters of Calcium Iodide with Acetone, n-Propanol, n-Butanol

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ABSTRACT

Determination of Viscosity (η) density (ρ), ultrasonic velocity (U) intermolecular free length (L_f), molar sound velocity (R), solvation number (S_n) and relative association (R_a) Specific acoustic impedance (Z), isentropic compressibility (β_s), adiabatic compressibility (β)apparent molal compressibility (ϕ_k), and different molal volume ϕ_v. The dependent of their properties on Significant Interaction between solute and solvent molecules.

Key words: *Ultrasonic velocity, calcium Iodide, acetone, n-propanol, n-butanol, ultrasonic interferometer, viscometer, solvation number (S_n), relative association(R_a), isentropic compressibility (β_s), adiabatic compressibility (β) Adiabatic compressibility, specific acousticimpedance, Intermolecular free length.*

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INTRODUCTION

Acoustic, an important branch of science, deals with the phenomena of sound. It has been termed as science of description, creation and comprehension of human experience. Ultrasound is the branch of acoustic science which deals with phenomena of frequency above the upper audible limit approximately 20,000 cycles/second, ultrasound wave frequencies above these ranges cannot be perceived by the human ear. The human ear range can perceive a vibration within a definite range, 16 upto 20,000 cycles/second. The ultra sounds frequencies lie between 20 kilo cps to 500 kilo cycle/second are known as ultrasound waves sound waves with frequencies beyond 20,000 cycle/second are known as supersonic waves that can travel through liquid & solids. Corlin (1960)[1]. Clickstlin (1960)[2] and crow & Ford (1955)[3], have made studies in application of low energy ultrasonic waves, low energy vibrations are mainly.

Determination of ultrasonic velocity in pure aqueous[4,5] non-aqueous[6,7], and mixed[8-12], electrolytic solution give information about physico-chemical behavior of liquid mixture such as molecular association and dissociation mixed[13]. Liquids rather than single pure liquid are of almost practical importance in most chemical and industrial processes as they provide a wide range of mixture of two or more components in varying proportions so as to permit continuous adjustment of the derived properties of the medium.

The present paper is an investigation of the behavior of binary solutions of Calcium iodide with acetone, n-propanol, n-butanol with regard to adiabatic compressibility (β), intermolecular free length (L_f), specific acoustic impedance (Z) and relative association (R_a) from ultrasonic measurement at 32ºC.

EXPERIMENT

Determination of acoustic parameters such as ultrasonic velocity, specific acoustic impedance (Z), isentropic compressibility etc. are measured by analytical reagent (AR) grade.The purity of the used chemicals was checked by density measured at 32ºC, the values of density obtained tally with the literature values, Binary liquids mixtures of different known compositions were prepared in airtight-stoppered measuring flask to minimize the leakage of volatile liquids. The weighing was done using electronic balance with precision ± 0.01mg. The double walled bicapillary Pyknometer was used for the measurement of densities of solvents and solution with an accuracy of ± 0.0005gm/cm^3. An ubbelohde viscometer, having frequency of 2MHz (Mittal Enterprises, New Delhi, Model: F-81) with an accuracy of ± 0.05%18-19, Detailed of Experimental techniques are given elsewhere[14-17].

THEORY AND CALCULATION

The various thermodynamic parameters such as density (ρ), viscosity (η), ultrasonic velocity (U), Isentropic compressibility (β_s), adiabatic compressibility (β), intermolecular free length (L_f), Specific acoustic impedance (Z), apparent molal compressibility (ϕ_k), solvation number (S_n) and relative association (R_a) have been calculated at 32ºC, using these solutions with the help of following equations-

$$Z = U \times \rho$$

$$L_f = K \times \beta^{-1/2}$$

$$\beta = U^2 \times \rho^{-1}$$

$$R_a = (\rho / \rho^0)(U^0 / U)^{1/3}$$

$$S_n = n_1 / n_2 (1 - \beta / \beta^0)$$

$$\phi_k = 1000(\rho^0 \beta - \beta^0 \rho) / C\rho^0 + (\beta^0 \times M) / \rho^0$$

Where ρ, ρ^0 and U, U^0 are the densities and ultrasonic velocities of solution and solvent, respectively; K is Jacobson constant; M molecular weight of solute; β^0 and β the adiabatic compressibility of solvent, and solution, C is concentration in mole/Liter; while n_1 and n_2 are the number of moles of solvent and solute, respectively.

Table 1: System-Calcium iodide with acetone = Temp. 32ºC

Cmol/lit	ρ g/cm^3	η c.p.	U m/sec	$\beta \times 10^{12}$ cm^2/dyne	$Z \times 10^5$ g/s.cm	L_f	R_a	S_n
0.0015	0.7746	0.1409	1158	96.27	0.8918	0.6213	1.0019	1.77
0.0030	0.7736	0.2838	1170	94.18	0.9023	0.6170	1.0022	1.98
0.0046	0.7786	0.4368	1181	92.08	0.9146	0.6051	1.0023	2.03
0.0061	0.7800	0.5778	1190	90.53	0.9282	0.6024	1.0024	2.16
0.0077	0.7810	0.7171	1202	88.62	0.9387	0.6962	1.0026	2.29
0.0092	0.7830	0.8741	1210	87.23	0.9474	0.6915	1.0028	2.42
0.0107	0.7890	0.0237	1220	85.16	0.9624	0.5835	1.0030	2.56
0.0123	0.7906	1.1740	1232	83.37	0.9735	0.5783	1.0032	2.69
0.0138	0.7930	1.3280	1246	81.23	0.9879	0.5708	1.0033	2.82

Table 2: System–Antimony Iodide with n-propanol = Temp. 32ºC 0.05ºC

Cmol/lit	ρ g/cm³	η c.p.	U m/sec	$\beta \times 10^{12}$ cm²/dyne	$Z \times 10^{5}$ g/s.cm	L_f	R_a	S_n
0.0021	0.7764	0.0634	1220	86.54	0.9470	0.5892	0.9973	0.6269
0.0043	0.7796	0.1387	1230	84.86	0.9587	0.5834	0.9980	0.6398
0.0065	0.7824	0.1926	1242	82.98	0.9716	0.5769	0.9988	0.6527
0.0087	0.7854	0.2614	1252	81.33	0.9754	0.5712	0.9996	0.6656
0.0109	0.7884	0.3090	1270	78.74	1.0012	0.5620	1.004	0.6685
0.0131	0.7908	0.3576	1274	77.49	1.0074	0.5575	1.0011	0.6914
0.0133	0.7916	0.4565	1286	76.40	1.0178	0.5536	1.0019	0.7043
0.0175	0.7956	0.8195	1296	74.83	1.0309	0.5479	1.0027	0.7172
0.0197	0.7996	0.5588	1308	73.09	1.0457	0.5415	1.0035	0.7301

Table 3: System–Calcium Iodide with n-butanol = Temp. 32ºC 0.05ºC

Cmol/lit	ρ g/cm³	η c.p.	U m/sec	$\beta \times 10^{12}$ cm²/dyne	$Z \times 10^{5}$ g/s.cm	L_f	R_a	S_n
0.0043	0.8060	0.0634	1285	75.14	1.0355	54.90	1.0035	0.6269
0.0087	0.8090	0.1387	1291	74.15	1.0445	54.54	1.0065	0.6398
0.0131	0.8112	0.1926	1295	73.51	1.0505	54.30	1.0085	0.6527
0.0175	0.8136	0.2614	1301	72.62	1.0583	53.97	1.0089	0.6656
0.0218	0.8160	0.3090	1306	71.95	1.0655	53.72	1.0106	0.6785
0.0262	0.8200	0.3576	1309	71.17	1.0729	53.43	1.0129	0.6914
0.0306	0.8214	0.4565	1310	70.98	1.0753	53.36	1.0162	0.7043
0.0350	0.8236	0.9195	1315	70.22	1.0829	53.07	1.0177	0.7172
0.0393	0.8280	0.5588	1323	69.51	1.0914	52.80	1.0223	0.7301

RESULT AND DISCUSSION

We have measured ultrasonic parameters as ultrasonic velocity (U), density (ρ). viscosity is given in table 1, 2 and 3. This table shows their three parameters are increased with concentration of Calcium iodide; this indicates that strong interaction is observed at higher concentration of Calcium iodide and suggests more association between solute and solvent molecules in the system. The variation of ultrasound velocity (U) with solute concentration (C) can be expressed in terms of the concentration derivatives of density (ρ)and adiabatic compressibility (β) by the relationship.

$$dU/dC = U/2[1/\rho(dP/dC) + 1/\beta(d\beta/dC)]$$

The result shows that the density increases while the adiabatic compressibility decreases with increasing solute concentration. The adiabatic compressibility decreases as well as concentration increases of the solute and solvents. These solutions are surrounded by a layer of solvent molecules, firmly bound and oriented towards the ions. The orientation of solvent molecules around the ions is attributed to the influence of the electrostatic field of ions and thus the internal pressure increases which lowers the compressibility of the solution i.e. the solution becomes harder to compress. The intermolecular free length (L_f) is extracted to decrease as a result of mixing of the two components decreases with the increases in solute concentration. When intermolecular free length (L_f) decreases while specific acoustic impedance (Z) increases with increase the solute concentration (Table 1, 2 and 3) which can be explained on the basis of lyophobic interaction between the solute and solvent molecule, which increases the intermolecular distance leaving relatively wider gaps between the molecule and thus becoming the main cause impediment to the propagation of ultrasound waves and effect the structural arrangement.In this system, relative association is influenced by two factors (i) the breaking up of the solvent molecules on addition of electrolyte to it and (ii) the solvation of ion that are simultaneously present; the former resulting in a decrease and later increase of relative association.

In the present investigation, it has been observed that relative association (R_a), Solvation number (S_a) are calculated using the Passynsky equation and are listed in tables. The (S_a) values are found to increase with the increase in solute, which also suggests close association between solute and solvent.

REFERENCES

1. Carlin B. York (1960): Ultrasonic, 2nd Edn. McGraw Hill, New.
2. Glichstein C. : Basic ultrasonics Rider, New York/Chapman and HallLondon (1960).
3. Craw Ford A.E. : Ultrasonic Engineering Butter WorthsLondon(1955).
4. D.K. Jha and B.L. Jha : J. Pure Appl. Phys. 28, (1990) 346.
5. M.V. Kaulgud and K.S. Mohanrao : Indian J. Chem., 27A, (1988) 12.
6. O. Prakash, S. Prasad, S.V. Pandey and S. Prakash : Indian J. Pure Appl. Phys., 20, (1982) 631.
7. T.N. Shrivastav, R.P. Singh and B. Swaroop : Indian J. Pure Appl. Phys., 21, (1983) 67.
8. P.S. Nikam and M. Hasan : Indian J. Pure Appl. Phys. 24, (1986) 502.
9. P.S. Nikam and M. Hasan : J. Chem. Engg. Data, 33, (1988) 165.
10. P.S. Nikam and A.R. Hiray : Indian J. Pure Appl. Phys. 29, (1991) 601.
11. J.D. Pandey, A. Shukla, R.K. Rai and K. Mishra : J. Chem. Engg. Data, 34, (1989) 29.
12. P.S. Nikam, N. Nikam, M. Hasan and B.S. Suryavanshi: Asian J. Chem. 6, (1994) 237.
13. P.S. Nikam, N. Nikam, M. Hasan and A.R. Hiray : Asian J. Chem. 7, (1995) 500.
14. R. Mehra and A.K. Gaur : J. Ind. Council Chem., 26 (2009) 85.
15. Saxcena, Indu Kumar and Vijay Devi Rikkam (2015): Determination and Density of solvent mixture by magnetic float densitometer and study value change and some acoustical parameters from ultrasonic velocity, Golden Research Through 2015, 4(9): 1-12.
16. A.K. Dash and R. Paikaray (2014): Acoustical study in binary liquid mixture containing dimethyl acetamide using ultrasonic and viscosityprobes. Der chem. Sinica, 5(1): 81-88.
17. R. Mehra and A.K. Gaur : J. Chem. Engg. Data. 53, 683 (2008).