ARYAVART SHODH VIKAS PATRIKA
RNI TITLED NO. UPBBIL04292
RNI REG. NO. UPBBIL/2014/66218 PP. NO.- 413-415

ISSN NO.-2347-2944 (Print)
ISSN NO.-2582-2454 (Online)
Vol.-11, No.-II, Issues-14 YEAR- Dec. -2019

Ultrasound Behaviour Of 1, 4-dihydroxy Benzene In Alcohols

1. DR. Shiv Nandan 2. Sarita Sharma

1. Associate Professor, 2 Research Scholar, Department of Chemistry, N.D. College, Shikohabad, Firozabad (U.P.), India

Received- 13.09.2019, Revised- 15.09.2019, Accepted - 20.09.2019 E-mail: aaryvart2013@gmail.com

Abstract: Ultrasound velocity measurements of 1, 4-dihydroxy benzene in methanol and ethanol have been carried out for the study of solute-solvent interaction. Various acoustic parameters (intermolecular free length, isentropic compressibility, specific acoustic impedance, molar sound velocity, apparent molar adiabatic compressibility, relative association and solvation number) have been evaluated using ultrasound velocity data. The results were discussed in the light of solute-solvent interaction between the molecules.

Key Words: Ultrasound velocity, acoustic parameters, intermolecular free length, isentropic compressibility.

Several techniques such as IR, NMR, Raman spectroscopy and Ultrasound have been used for the determination of molecular and ion-solvent interaction[1-6]. The present work deals with the study of solute-solvent interaction in the solution of 1, 4-dihydroxy benzene in methanol and ethanol using ultrasonic velocity data. The values of ultrasonic velocity, specific acoustic impedance, apparent molar adiabatic compressibility, intermolecular free length and molar sound velocity decrease with increasing 1, 4-dihydroxy benzene concentration.

Experimental

All the chemicals used in the present study are of AR/BDH quality. A known amount of 1, 4-dihydroxy benzene is dissolved in methanol and ethanol so as to obtain various concentration solutions. The ultrasonic velocity in these solutions was measured using a multifrequency ultrasound interferometer (F-81 Mittal Enterprises, New Delhi) at a fixed frequency of 2MHz and a constant temperature (27^0C $\pm$ 0.05^0C). The densities of the solvent and solutions are measured using a specific gravity bottle.

The various acoustic parameters, viz. isentropic compressibility (β_s), inter molecular free length (L_f)[7], specific acoustic impedance (Z)[8], molar sound velocity (R), relative association (R_A)[9] solvation number (S_n)[10] and apparent molar adiabatic compressibility (p_k) have been evaluated by using the following relationships :

1. $\beta_s = 1/u^2\rho$
2. $L_f = k\sqrt{\beta_s}$
3. $Z = u.\rho$
4. $R = M/\rho V^{1/3}$

   Where $[M = n_1m_1 + n_2m_2/n_1 + n_2]$
5. $R_A = (\rho/\rho_0)(V_0/V)^{1/3}$
6. $S_n = n_1/n_2\left(1\beta_S/\beta_{S_0}\right)$
7. $\phi_k = \frac{100}{C_{\rho_0}}\left(\rho_0\beta_S - \beta_{S_0} + \beta_S.M/\rho_0\right)$

where $u_0, u, \rho_0, \rho, \beta_{S_0}, \beta_S$ are the ultrasonic velocity density and isentropic compressibility of the solvent and solution respectively. n_1, n_2 and m_1, m_2 are the number of moles and molecular weight of the solvent and solute respectively and K and C are the temperature dependent Jacobson's constant and concentration respectively.

Results and Discussion

Ultrasound velocity (u) in the solution of 1, 4-dihydroxy benzene in methanol and ethanol increase with increase concentration of 1, 4-dihydroxy benzene. The variation of velocity with concentration (c) can be expressed by following relationship.

$$du/dc = -u/2\left[1/\rho\left(d\rho/dc\right) + 1/\beta_S\left(d\beta_S/dc\right)\right]$$

Corresponding Author

ISSN NO.-2347-2944 (Print)
ISSN NO.-2582-2454 (Online)
Vol.-11, No.-II, Issues-14 YEAR- Dec. -2019

In general results show that while the density increase, the isentropic compressibility decrease with increasing concentration of solute and the quantity (dp/dc) is positive while ($d\beta_s/dc$) is negative. Since the values of [$1/\beta_s(D\beta_s/dc)$] are larger than the values of [$1/p(dp/dc)$] for 1, 4 dihydroxy benzene solutions in methanol and ethanol, the concentration derivation of velocity, (du/dc) is positive i.e. the ultrasonic velocity increase with increasing the concentration of solute.[11-13]

The isentropic compressibility (β_s) of 1, 4-dihydroxy benzene solutions decreases with increase in the molar concentration of solute.

The complimentary use of isentropic compressibility data can provide interesting information on solute solvent interaction. The results of isentropic compressibility have been explained in terms of Bachem's equation.[14]

$$\beta_S = \beta_{S_0} + AC + BC^{3/2}$$

where β_s is the compressibility of the solvent, C is the molar concentration and A & B are constants. The values of constants A (-15.34 and -14.3) and B (1.455 and 2.551) were obtained from the intercept and shope of plots, [$(\beta_s - \beta_{s_0})$/C] versus $C^{1/2}$ for the solutions of alcohols.

Apparent molar adiabatic compressibility (ϕ_k) varies linearly as the square root of concentration ($C^{1/2}$). The values of apparent molar adiabatic compressibility are negative with the increase in molar concentration. The values of limiting apparent molar adiabatic compressibility (ϕ_k^0 were evaluated extra plating the graph of ϕ_k versus $C^{1/2}$ (as shown in figure). The values of ϕ_k [-28.90 and -26.80 $cm^2/dyne.10^9$] for the solution of 1, 4-dihydroxy benzene in methanol and ethanol respectively. These results are in agreement with results reported by Masson[15] for electrolytic solutions.

Table-1: Ultrasonic velocity and other acoustic parameters

Concentration (C) Mol. l^{-1}	Density (ρ) g/ml	Ultrasound Velocity (u) ms^{-1}	Isentropic compressibility (β_s) $cm^2/dyne.\ 10^{12}$	Apparent Molar adiabatic compressibility ϕ_k $cm^2/dyne$ 10^{12}	Specific Acoustic Impedance (Z) Z x 10^{-5} (C.G.S.)	Intermolecular Free length (L_f) A^0	Molar Sound velocity (R) Ms^{-1}	Solvation Number (S_n)	Relative Association (R_A)
System-1, 4-Dihydroxy benzene + Methanol at 27°C ± 0.05°C									
0.0909	0.7986	1119.0	100.26	-29.157	0.8913	0.6277	421.28	3.61	1.0125
0.1000	0.7976	1119.5	100.03	-29.294	0.8929	0.6270	421.20	3.81	1.1035
0.1111	0.7988	1119.5	99.88	-22.741	0.8942	0.6266	432.04	3.76	1.0150
0.1250	0.8003	1120.0	99.61	-30.150	0.8963	0.6257	420.35	3.86	1.0167
0.1428	0.8023	1120.5	99.27	-30.581	0.8989	0.6247	420.61	3.95	1.0189
0.1666	0.8049	1121.5	98.77	-31.220	0.9026	0.6231	420.37	4.11	1.0216
0.2000	0.8086	1122.5	98.15	-31.494	0.9076	0.6211	419.88	4.18	1.0258
0.2500	0.8141	1124.5	97.14	-32.074	0.9454	0.6179	419.32	4.31	1.0316
0.3333	0.8233	1127.0	95.62	-32.180	0.9278	0.6131	418.26	4.54	1.0416
System-1, 4-Dihydroxy benzene + Ethanol at 27°C ± 0-05°C									
0.0909	0.7942	1191.5	88.62	-26.132	0.9462	0.5904	619.44	2.56	1.0125
0.1000	0.7952	1192.0	88.50	-26.795	0.9478	0.5898	619.12	2.68	1.0136
0.1111	0.7964	1192.5	88.29	-27.245	0.9497	0.5891	618.96	2.77	1.0150
0.1250	0.7979	1193.0	88.05	-27.513	0.9518	0.5833	618.55	2.83	1.0167
0.1428	0.7999	1193.5	87.76	-27.715	0.9546	0.5873	617.95	2.86	1.0167
0.1666	0.8025	1194.5	87.33	-28.128	0.6585	0.5859	617.27	2.94	1.0222
0.2000	0.8025	1195.5	86.78	-28.295	0.9638	0.5840	616.20	2.97	1.0266
0.2500	0.8117	1197.5	85.91	-28.635	0.9720	0.5811	614.91	3.03	1.0330
0.3333	0.8209	1200.3	84.55	-28.724	0.9853	0.5765	611.07	3.04	1.0439

The intermolecular free length (L_f) decrease while the specific impedance (Z) increase with an increase in the solute concentration. The indicates that there is a significant interaction between the solute and solvent molecules. The increase in the values of specific acoustic impedance (Z) with increasing 1, 4-dihydroxy benzene concentration can be explained on the basis of lyophobic interaction between solute and solvent molecules

ISSN NO.-2347-2944 (Print)
ISSN NO.-2582-2454 (Online)
Vol.-11, No.-II, Issues-14 YEAR- Dec. -2019

which increases the inter molecular distance making relatively under gaps between the molecules and becoming the main cause of impedance in the propagation of ultrasound waves. The values of molar sound velocity (R) vary linearly 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.

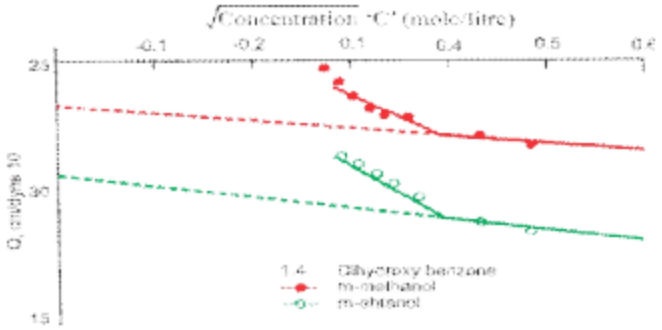

Fig.: Apparent molal adiabaticcompressibility
Vs
Concentration

The results of ultrasonic velocity show that the 1, 4-dihydroxy benzene behaves as a weak electrolyte and there is a significant interaction between the 1, 4-dihydroxy benzene solvent molecules.

REFERENCES

1. Srivastava, T.N., Singh R.P. & Swaroop, B., Indian J. Pure & Appl. Phys., 21, 1983, 67.
2. Lin, W & Tsay, S.J., J. Phys. Chem. (U.S.A.) 74, 1970, 1037.
3. Grunwald & Coburn, W.C., J. Am. Chem. Soc. (U.S.A.) 1958, 1332.
4. Pimental G.C. & Maclellan, A.L., The hydrogen bond (Freeman W.H. & Co. San Francisco) 1960, 67.
5. Prakash S., Prasad N. & Prakash, O., J. Chem. Engg. Data (U.S.A.) 22, 1977, 51.
6. Prakash S., Prasad N. Acustica (Germany) 36, 1976, 313.
7. B. Jacobason, Acta Chem. Scand., 6 1952, 1485.
8. I.E. Elpiner, Ultrasound Physical, Chemical and Biological Effects. New York Consultants Bureau, 1960. P. 371.
9. A. Waeissler, J. Chem. Phys. 15. 1947, 210.
10. A. Passynskii, Act Physicco Chem. (U.R.S.S.) 8, 1933, 357; J. Phys. Chem. (U.S.S.R.), 11, 1938, 451,
11. S. Prakash & C.V. Chaturvedi, Ind. J. Chem. 10, 1972, 669.
12. K. Rambrahman & M. Suryanarayan, Ind. J. Pure Appl. Phys. 6, 1968, 422.
13. I. G. Miknailor, M. V. Rozina & V. A Snutilov. Akust. Zh. 10, 1964, 213.
14. Bachem C., Physica (Netherlands), 101, 1935, 541,
15. D.O. Masson, Phil. Mag., B, 1929, 218.
16. P. Padmini & B. Rao, Indian, J. Phys. 34. 1960. 565.

*****