Asian Journal of Chemistry Vol. 13. No. 4 (2001), 1646–1648

NOTE

Studies of Some Acoustical Properties of 1-(2-Hydroxy-5-Methyl Phenyl)-3-(4′-Methoxy Phenyl)-1,3-Propanedione in 70% Acetone-Water Mixture at 30°C

P.B. AGRAWAL*, A.S. BURGHATE, MOHD. IDREES MOHD. SIDDIQUE and M.L. NARWADE

Department of Chemistry, Govt. V.M.V., Amravati-444 604, India

Ultrasonic velocities and densities of different concentrations of 1-(2-hydroxy-5-methyl phenyl)-3-(4′-methoxy phenyl)-1,3-propanedione in binary mixture (70% acetone-water) have been evaluated at 30°C by using single crystal interferometer at a frequency of 1 MHz. The ultrasonic velocity, density and concentration were used to calculate apparent molal volume (ϕ_V), adiabatic compressibility (β_s), apparent molal compressibility ($\phi_{k(s)}$), intermolecular free length (L_f), specific acoustic impedance (z) and relative association (R_A) through the light on the solute-solvent and solute-solute interactions.

Ultrasonic velocity and absorption studies in case of electrolyte solutions have led to a new insight into the process of ion-association and complex formation[1,2]. A number of workers such as Satyavati[3], Ramachandran[4], Prakash and Shrivastav[5], Marks[6], Agrawal and Bhatnagar[7] have made ultrasonic study of electrolytic solutions and discussed about the variation of ultrasonic velocity with concentration. Rambabu *et al.*[8] have determined the sound velocity of 1,2-dichloroethane with isomeric and branched alcohols. Tabhane *et al.*[9] have investigated the cluster approach to thermodynamic behaviour of liquid mixtures of acrolein in different solvents using Khasare's equation of state[10]. The present work deals with the study of some acoustical properties of substituted 1,3-propanedione in 70% acetone-water mixture at 30°C.

All the weighings were made on Mechaniki Zaktasy Precyzyjnej Gdansk balance, made in Poland (±0.001 g). The accuracy of density measurement was within ±0.1% kg m^{-3}. Ultrasonic interferometer from Mittal Enterprises, Model MX-3 with accuracy of ±0.03% and frequency 1 MHz was used for the measurement of ultrasonic velocities in different solutions. A special thermostatic arrangement was done for density and ultrasonic velocity measurements. Elite thermostatic water bath was used and temperature variation was maintained within ±0.1°C.

In the present investigation, different thermodynamic parameters such as adiabatic compressibility (β_s), apparent molar compressibility ($\phi_{k(s)}$), apparent molal volume (ϕ_v), intermolecular free length (L_f), specific acoustic impedance (z) and relative association (R_A) have been calculated at 30°C in 70% acetone-water mixture with the help of the following equation:

$$\beta_s = 100/U_s^2 d_s$$

$$\phi_v = (M/d_s) + (d_0 - d_s)10^3/md_sd_0$$

$$\phi_{k(s)} = (\beta_s M/d_s) + [1000(\beta_s d_0 - \beta_0 d_s)/md_sd_0]$$

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

$$Z = U_s d_s$$

$$R_A = d_s/d_0(U_0/U_s)^{1/3}$$

where d_s, d_0 and U_s, U_0 are the densities and ultrasonic velocities of solution and pure solvent respectively, M is the molecultar weight of substituted 1,3-propanedione, β_s and β_0 are the adiabatic compressibilities of solution and solvent respectively, K is Jacobson's constant and m is the molality of solution.

The variation of ultrasonic velocity in a solution depends on the intermolecular free length on mixing on the basis of a model for sound propagation proposed by Eyring and Kincaid[11].

The values of ϕ_v, $\phi_{k(s)}$ β_s, d_s, L_f, Z, U_s and R_A obtained in the present investigation at differnt concentrations are presented in Table-1. It could be seen from Table-1 that intermolecular free length increases linearly on increasing the concentration of substituted 1,3-propanedione in 70% acetone-water mixture and hence there is a decrease in the ultrasonic velocity with concentration.

TABLE-1
VALUES OF DIFFERENT THERMODYNAMIC PARAMETERS AT DIFFERENT CONCENTRATIONS

m. conc. (mole lit^{-1}) × 10^{-3}	1.0	1.5	2.0	2.5	3.0	3.5
U_s (m/sec^{-1})	1446.3300	1394.5100	1389.4700	1386.24	1383.99	1379.22
ds (g cm^{-3})	0.8112	0.8197	0.8202	0.8210	0.8218	0.8267
β_s (bar^{-1}) × 10^{-6}	58.9301	62.7338	63.1512	63.3841	63.5284	63.5894
L_f (A^0) × 10^2	4.62024	4.7670	4.7828	4.7916	4.7971	4.7994
ϕ_v (cm^3 $mole^{-1}$) × 10^{-5}	2.2866	1.4702	1.0774	0.8578	0.7115	0.5897
$\phi_{k(s)}$ (cm^3 $mole^{-1}$ bar^{-1}) × 10^{-2}	0.2768	0.2113	0.1603	0.1291	0.1080	0.0915
R_A	0.8243	0.8431	0.8447	0.8461	0.8474	0.8535
Z (m sec^{-1} g cm^{-3})	1173.2600	1143.2600	1139.6400	1138.10	1137.36	1140.20

d_s = 0.9956 g cm^{-3}, U_0 = 1497.60 m s^{-1}, M = 284 g, β_0 = 44.7846 × 10^{-6} bar^{-1},
K = Jacobson's constant = 6.0186 × 10^4 at 30°C.

This indicates that there is weak interaction between ion and solvent molecules, suggesting a structure promoting a behaviour of the added electrolyte. This may also imply the increase in number of free ions, showing the occurrence of ionic dissociation due to weak ion-ion interactions. The increase of β_s with the increase of concentration of solution may be due to departure of solvent molecules around the ions[12], supporting weak ion-solvent interactions. It is also observed that $\phi_{k(s)}$ and ϕ_v decrease with increasing the concentration. The positive value of $\phi_{k(s)}$ shows the electrostatic force in the vicinity of ions, causing electrostatic solvation of ions.

Relative association (R_A) is influenced by two factors: (i) the breaking up of the solvent molecules on addition of electrolyte to it resulting in decrease in value of R_A and (ii) the solvation of ions that are simultaneously present, resulting in increase in the value of R_A. The increase of R_A with concentration suggests that solvation of ions predominates over the breaking up of the solvent aggregates (water-water, water-acetone) on addition of substituted 1,3-propanedione. Patil and Kaulgud[13] have observed nonlinear variation of sound velocity and compressibility with respect to mole fraction.

It is also observed from Table-1 that there is linear variation of R_A and Z values with respect to concentration of solution. From the graph between ϕ_v and $\phi_{k(s)}$ *vs.* $\sqrt{c}$, $\phi_v^0 = 4.9498 \times 10^{-5}$ and $\phi_{k(s)}^0 = 43.591$. The positive values show the interaction between solute-solvent.

ACKNOWLEDGEMENTS

The authors are grateful to Head of Chemistry Department and Principal of Govt. V.M.V., Amravati for providing necessary facilities.

REFERENCES

1. S.K. Kor and S.S. Batti, *Indian J. Pure and Appl. Phy.*, **7**, 784 (1969).
2. S.V. Soitkar and S.N. Jajoo, *Acoustic Lett.*, **7**, 191 (1984).
3. A.V. Satyavati, *J. Acoustic.*, **38**, 340 (1984).
4. K. Ramachandran, *Indian J. Pure and Appl. Phy.*, **6**, 75 (1968).
5. S. Prakash and S.P. Shrivastav, *Indian J. Chem.*, **2**, 499 (1964).
6. G.W. Marks, *J. Acoust. Soc. of Am.*, **38**, 327 (1960).
7. S.B. Agrawal and B.P. Bhatnagar, *Acoust. J. Phys.*, **31**, 567 (1978).
8. K. Rambabu, P. Venkateswarlu and G.K. Raman, *Asian J. Chem.*, **1**, 147 (1989).
9. V.A. Tabhane, V.D. Bhandarkar and S.B. Khasare, *Indian J. Pure and Appl. Phys.*, **33**, 248 (1995).
10. S.B. Khasare, *Indian J. Pure and Appl. Phys.*, **31**, 224 (1993).
11. H. Eyring and J.F. Kincaid, *J. Chem. Phys.*, **6**, 620 (1938).
12. J.D. Pandey, A. Shukla, R.D. Rai and K.J. Mishra, *J. Chem. Eng. Data*, **34**, 29 (1989).
13. K.J. Patil and M.V. Kaulgud, *J. Acoustic.*, **28**, 130 (1973).

(*Received*: 11 April 2001; *Accepted*: 5 September 2001) AJC-2430