International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064, Impact Factor (2013): 4.438
www.ijsr.net

Ultrasonic Study of B-Alanine in Aqueous Solution with Different Temperature

Priyanka Shamkuwar[1], O.P.Chimankar[2], Sanjay Pawar[3], V. D. Muley[4], D. I. Shahare[5]

[1, 2]Acoustic Research Laboratory, Department of Physics, RTM Nagpur University, Nagpur 440033, Maharashtra, India

[3]Department of Physics, NSK College Nashik, Maharashtra, India

[4, 5] Department of Physics, J. M. Patel College, Bhandara, Maharashtra, India

Abstract: ***The ultrasonic velocity (u), density (ρ) and viscosity (η) have been measured at 2 MHz frequency in the binary mixtures of β-alanine with water over entire range concentration at temperature 293K-323 K using ultrasonic Pulser Receiver technique. The experimental data have been used to calculate acoustical parameter namely reduced volume ($\bar{V}$), available volume (f), internal pressure (P_i) and cohesive energy density (ε) with a view to investigate the nature and strength of molecular interaction in the binary liquid mixture. The obtained results support the occurrence of nonlinear variation and molecular association in bio-fluid.***

Keywords: internal pressure (P_i), cohesive energy density (ε), bio-fluid, molecular interaction

1. Introduction

Interaction between solute – solvent molecules brings out tremendous change in nature. Physico-chemical properties of two different liquids change when they mix together. These changes lead to various applications in industry, medicine and chemical engineering processes [1]. The interaction between liquid mixtures may be weak or strong depending on the whether the liquid is polar , non-polar , protic or aprotic. Ultrasonic investigation is a powerful tool to probe these interactions [2]. Many research works have been carried out in analyzing the structural changes of binary mixtures with ultrasonic and thermoacoustical parameters [3]. This paper focuses on the analysis of structural changes of like and unlike molecules through ultrasonic parameters.

In the present study, we report the value of reduced volume ($\bar{V}$), available volume (f) , internal pressure (P_i) and cohesive energy density (ε)of 0.00 to 0.1 molar concentration of β-alanine with water solution at 293K-323K. The various physical and thermodynamic parameters were calculated from ultrasonic velocity, viscosity and density data. All these parameters were discussed in term of molecular interaction accruing in the bio-fluid.

2. Experimental Section

β-alanine used in the present work was of Analytic Reagent (AR) grades with minimum assay of 99.9%, they are used without purification. The various concentration of solution was prepared by adding sufficient amount of solvent water to β-alanine.

The ultrasonic velocity (u) has been measured by ultrasonic Pulser Receiver MHF-400 supplied by Roop Telesonix, Mumbai operating at a frequency of 2 MHz with an accuracy of 0.1%. The viscosities (η) of binary mixtures were determined using Ostwald's viscometer by calibrating with distilled water. The density (ρ) of these binary solution were measured accurately using 25 ml specific gravity bottle in an electronic balance precisely and accurately using weighting is 0.1mg. These basic parameter u, η, ρ were measured at 323K and at various concentration (0.00M to 0.1 M). The acoustical parameters were calculated from u, η, ρ value using standard formulae.

1. Ultrasonic velocity

The formula by which ultrasonic velocity calculated is

$$u = \frac{2d}{t}$$

where, d = Separation between transducer & reflector
t = Travelling time period of ultrasonic wave.

2. Density

The density is calculated by

$$\rho = \left(\frac{W}{W_w}\right)\rho_w$$

Where, ρ - Density of liquid material at experimental temperature.
W – Weight of liquid material at experimental temperature.
W_w - Weight of water at experimental temperature.
ρ_w – Density of water at experimental temperature.

3. Viscosity

The viscosity have been calculated using relation

$$\eta = \left(\frac{\rho_l t_l}{\rho_w t_w}\right)\eta_w$$

Where, η – Viscosity of experimental liquid material.
ρ_l – Density of experimental liquid material.
t_l – Time flow for experimental liquid material.
η_w – Viscosity of distilled water.
ρ_w – Density of distilled water.
t_w – Time flow for distilled water

3. Results and Discussion

The calculated acoustical parameter namely reduced volume ($\bar{V}$), available volume (f), internal pressure (P_i) and cohesive energy density (ε) at 293K- 323K were shown graphically.

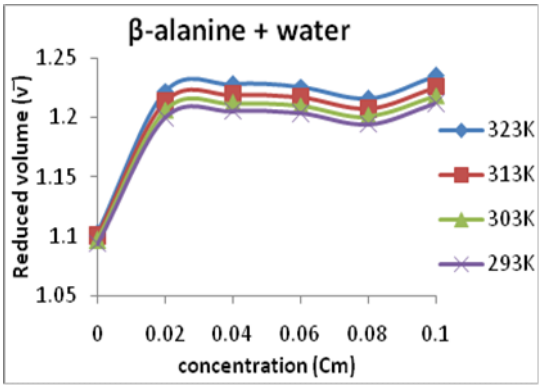

Figure 1: Variation of $\bar{V}$ with temp. & C_m

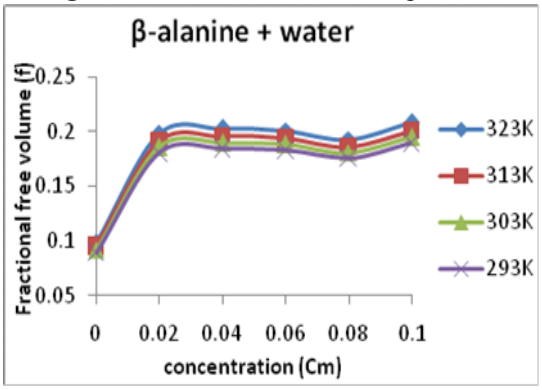

Figure 2: Variation of f with temp. & C_m

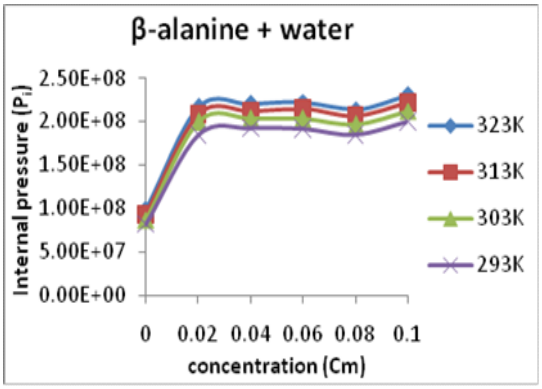

Figure 3: variation of P_i with temp. & C_m

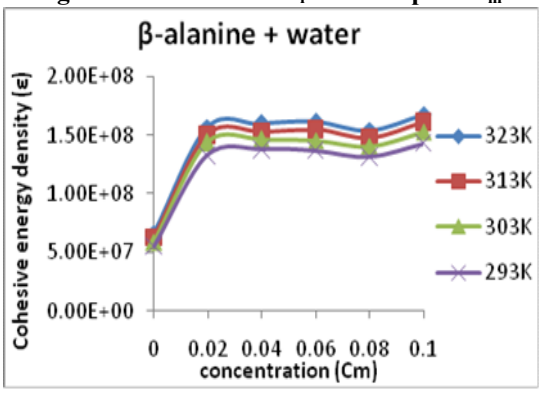

Figure 4: Variation of ε with temp. & C_m

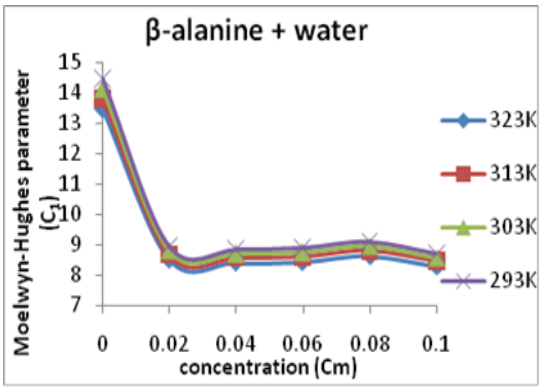

Figure 5: variation of C_1 with temp. & C_m

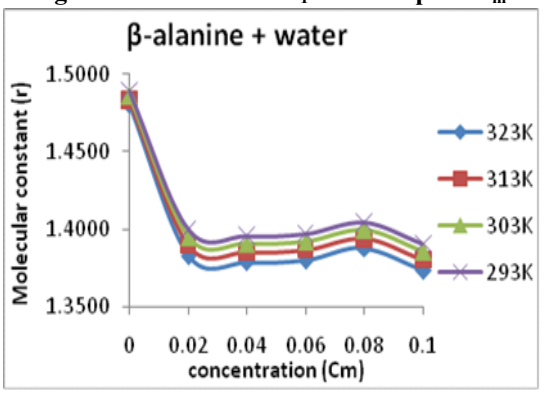

Figure 6: variation of r with temp. & C_m

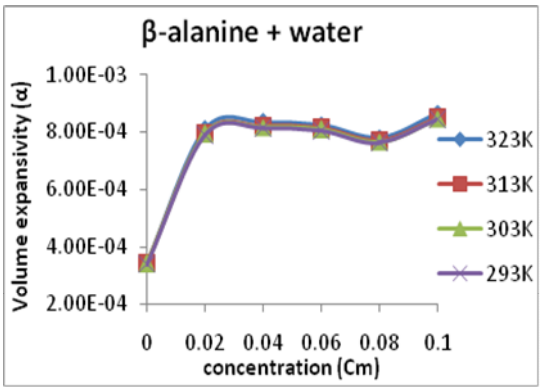

Figure 7: variation of α with temp. & C_m

Volume expansivity (α), Reduced volume ($\bar{V}$), fractional free volume (f), internal pressure due to solvent interaction (P_i) and cohesive energy density (ε) variation with molar concentration are presented graphically in figures. The trend of all the above parameters with molar concentration exhibits similar behaviour. All these parameters shows increasing trend up to molar concentration 0.02 and then remains constant.

The variation of Moelwyn-Hughes parameter (C_l),molecular constant (r), repulsive exponent (n), with molar concentration have been found to exhibit reverse trend as that of earlier figures. These parameters show decreases until molar concentration 0.02 and then remain constant with increase in concentration of β-alanine in water.

Moelwyn-Hughes [4] parameter C_1 shows a nonlinear increase or decrease with molar concentration which signifies the nonlinear variation of volume expansivity with concentration [5]. The high value of C_1 is due to large value of α. This indicates the dissociative nature of the liquid

mixture. But in the present bio-liquid system i.e. aqueous β-alanine. C_l & α with concentration shows exactly opposite behaviour i.e. if α increases then C_l is found to decrease with concentration and vice-versa. This result indicates the associating nature of bio-fuid [6].

High value of repulsive exponent (n) shows the bulk nature of molecule. Repulsive exponent is found to show a nonlinear decrease and increase with concentration in all the aqueous β-alanine mixture. The decrease in n with concentration shows the dissociation nature of molecules and the increase in n with concentration thus would show associating nature of molecules [7].
Molecular constant r measures the molecular cohesion. If r low then liquid state causes a molecular dissociative effect due to increasingly loose packing of the molecules resulting in a very weak intermolecular cohesion. The molecular constant r has the dimension reciprocal of volume. Moreover, the value of r with concentration is order in all the bio-liquid. The reduction in the value of r shows an increasing molecular order and the increase in r with concentration shows decrease in molecular order.
Reduced volume ($\bar{V}$) and free available volume (f) are identical in nature. Reduced volume ($\bar{V}$) shows a nonlinear increase and decrease with concentration in all the bio-liquid. The increased values of $\bar{V}$ & f with concentration show the enhancement in the disorder in the bio-liquids, because of the increased mobility of the molecules. Similarly a decrease in $\bar{V}$& f with concentration would indicate the reduction in the disorder in the bio-liquids, owing to the decrease in the mobility of the molecules. If the available volume has a small value then fractional free volume would also have a small value. This shows the larger size of the molecules in bio-liquid state [8,9].

The increase in P_i with increase in concentration indicates the orientation of the solvent molecules around the ions. This may be due to the influence of electrostatic field of ions i.e. bio-solution becomes harder to compress. This also shows association tendency of the molecules in aqueous β-alanine solution. Hence the reduction in P_i with rise in concentration of bio-fluid shows the dissociation tendency of the molecules in the bio-solutions [10].

The cohesive energy of a material is the energy required to disassemble it into its constituent parts, also known as binding energy. It depends upon the nature of the atoms present in the material. In all the binary liquid mixtures the cohesive energy density (ε) increases or decreases with molar concentration. The increase in ε with concentration shows the degree of dissociation in the molecules to decrease [11].

4. Conclusions

The observed complex formation and molecular association in these bio-liquid mixtures may be due to the formation of hydrogen bonding in the molecules and the tendency of solute – solvent interaction and weak association arising due to hydration. The cohesion among the molecules increases or decreases by breaking or making the open structure in all the bio-liquid. The variation of these thermoacoustic parameters with increase in molar concentration of β-alanine in water reveals the molecular order, molecular structure, anharmonicity and microheterogenity in the biofluids.The variation of these thermo-acoustic parameters reveals the nature of bio-liquids, their ability of association and dissociation, microheterogenity and possibility of presence of aggregate. This study also supports the validity of description of some thermo-acoustic parameters in bio-liquids. It offers the simplest scale for determination of molecular order structure, interaction and an anharmonicity in bio-liquid state.

References

[1] A.Michaweh, A. Alsaygh, and M. A. Moshfeghian, 2004, Fliud Phase Equilibria, 224, 157- 167.
[2] V. Tiwari and J. D. Pandey , 1980, Indian J. Pure Appl. Phys. , 18, 41-48.
[3] S.Ponnacy and Beulah J.M. Rajkumar, Journal of Acoustical Society of India, Vol. 40, No.4, 2013, 261-266.
[4] Sharma B K, J Acoust Soc India, (1995), 23(2), 85and 23(3), 1, Acustica, (1995), 81, 194.
[5] Keer H V, Z. Physik Chem (LPZ), (1972) 22, 251.
[6] Chimankar OP, Shriwas R, Jajodia S and Tabhane VA, Archievers of Physics Research, 2010, 2(6), 285-289.
[7] Chimankar OP, Shriwas R and Tabhane VA, J. Chem.Pharm. Res.,2011, 3(3), 587-596.
[8] Chimankar OP, Tabhane VA and Baghel GK, Proceedings of 8th WSEAS International Conference on Acoustics and Music , Vancour, Canada, 2007 , 19-21.
[9] Kannappan AN and Palani R, INt. J. of Pure and Applied Physics, 2007, 45, 573-579.
[10] Baluja S and Karia F, J. of Chem.,Bio.,and Phy. Sci. , 2012, 2 (1), 101-107.
[11] Kannappan V and Santhi Jaya R, Ind. J. of Pure and Appl. Physc., 2005, 43, 167-171.