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Intermolecular Interaction in the Binary Mixture of B-alanine with Water at 323K

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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 323 K using ultrasonic Pulser Receiver technique. The experimental data have been used to calculate acoustical parameter namely adiabatic compressibility (βa), acoustic impedance (z), free length (L_f) with a view to investigate the nature and strength of molecular interaction in the binary liquid mixture. The obtained result support the occurrence of complex formation through intermolecular hydrogen bonding in there binary liquid mixtures.

Keywords- Ultrasonic Velocity, Binary Mixture, Molecular Interaction, Hydrogen Bonding

I. INTRODUCTION

In recent year, the measurement of ultrasonic velocity has been adequately employed in understanding the nature of molecular interactions in pure liquids and liquid mixtures. The ultrasonic velocity measurements are highly sensitive to molecular interactions and can be used to provide qualitative information about the physical nature and strength of molecular interaction in liquid mixture [1-3].

Ultrasonic velocity in a liquid is fundamentally related to the binding forces between the atoms or the molecules and has been adequately employed in understanding the nature of molecular interaction in pure liquids[4-8]. The variation of ultrasonic velocity and related parameters throw much light on the structural changes associated with the liquid mixtures having weakly interacting components as well as strongly interacting components. The acoustical study provides information about the intermolecular processes and structure of liquid state [9-11].

In the present study, we report the value of ultrasonic velocity, viscosity and density of 0.00 to 0.1 molar concentration of β-alanine with water solution at 323K. The various physical and thermodynamic parameters like adiabatic compressibility (βa), acoustic impedance (z), free length (L_f) were calculated from ultrasonic velocity, viscosity and density data. All these parameters were discussed in term of solute – solvent interaction accruing in the binary mixture of β-alanine and water.

II. 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.

III. RESULTS AND DISCUSSION

The ultrasonic velocity, adiabatic compressibility, free length and acoustic impedance of binary mixtures of β-alanine with water at 323K were shown graphically in fig.1 to 4.

In the binary liquid system of β-alanine in water, the variation of ultrasonic velocity, adiabatic compressibility (β_a) and acoustic impedance (Z) shows nonlinear variation with increase in molar concentration of β-alanine. This may be attributes to molecular association and complex formation.

The complex formation and molecular association may be brought about through a hydrogen bonding possible between the molecules [12], which describe the structure making and breaking effect of the β-alanine. This also indicates the hydrophilic and hydrophobic nature of β-alanine in water.

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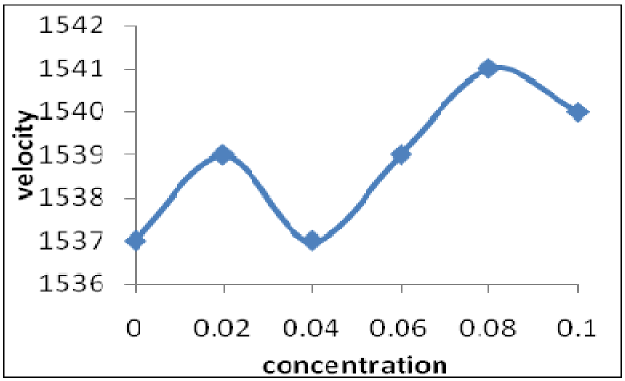

Fig. 1.Variation of velocity with concentration

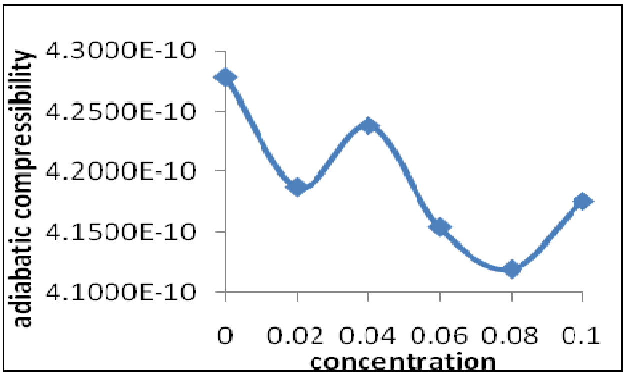

Fig. 2.Variation of adiabatic compressibility with concentration

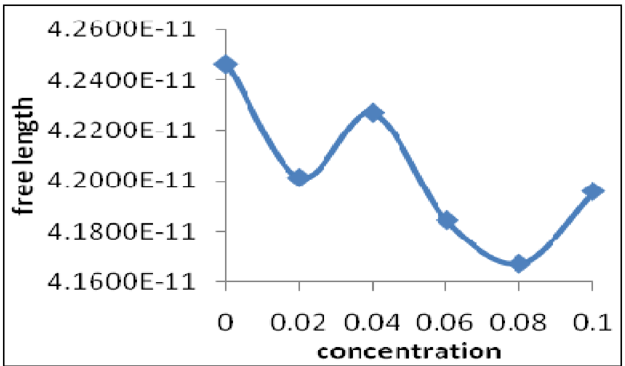

Fig. 3.Variation of free length with concentration

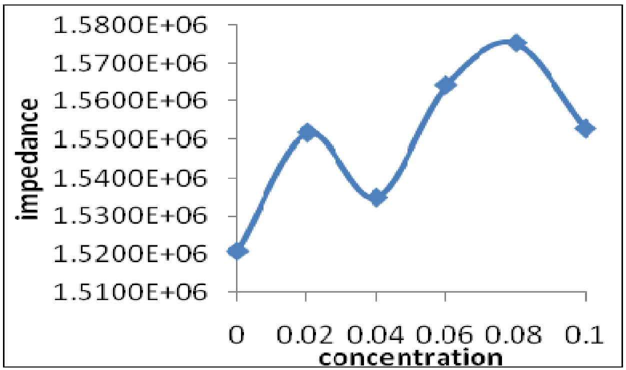

Fig. 4.Variation of impedance with concentration

Ultrasonic velocity and acoustic impedence shows dip at 0.04 molar concentration, where as the adiabatic compressibility and free length shows peak at corresponding concentration. This shows the complex formation and molecular dissociation. It also indicates weakening of hydrogen bond at this molar concentration [13].

Specific acoustic impedance is defined as impedance offered to the sound wave by the components of mixture. Mathematically it is directly proportional to ultrasonic velocity and inversely proportional to that of adiabatic compressibility and shows similar behavior to that of ultrasonic velocity and opposite to adiabatic compressibility. The non-linearly decrease impedance with molar concentration shows that molecular interaction in aqueous β-alanine solution is dissociative[14].

IV. CONCLUSIONS

The nonlinear variation of ultrasonic velocity and other thermo acoustical parameters with molar concentration of β-alanine in water provides useful information about the nature of intermolecular forces existing in the mixture. The observed complex formation in the binary liquid mixture may be due to the formation of hydrogen bonding and the tendency of solute-solvent interaction.

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