ULTRASONIC CHARACTERISATION OF AQUEOUS L- GLUTAMIC ACID AT DIFFERENT TEMPERATURES

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ABSTRACT

The ultrasonic velocity (u), density (ρ) and viscosity (η) have been measured at 2 MHz frequency in the biological mixture of L - Glutamic acid with water at different temperature using ultrasonic Pulser Receiver technique. The experimental data have been used to calculate acoustical parameter namely adiabatic compressibility (βa), free length (L_f), Moelwyn – Hughes parameter (C_1) and volume expansivity (α) with a view to investigate the nature and strength of molecular interaction in the biological liquid mixture. The variation of these parameters has been interpreted in terms of solute-solvent interaction and molecular association in aqueous biological mixture.

Index Terms: Ultrasonic velocity, bio-mixture, molecular interaction, Moelwyn-Hughes parameter, adiabatic compressibility.

I. INTRODUCTION

The measurement of ultrasonic velocity in liquid mixture and solution has been found to be an important tool to study the physico-chemical properties of liquid mixtures and solutions. Liquid, liquid mixtures and solutions find wide applications in medical, pharmaceuticals, chemical, leather, textile, nuclear and solvent, solution related industries. The study and understanding of the thermodynamic properties of liquid mixtures and solutions are more essentials for their applications in these industries. The measurement of ultrasonic velocity in the combination of density and viscosity have been used to study the molecular interactions in liquid mixtures and solutions [1-4].

L-Glutamic acid is amino acid which is synthesized from a number of amino acids including ornithine and arginine. It can be used as fuel in the brain,and can attach itself to nitrogen atoms in the process of forming glutamine , and this action also detoxifies the body of ammonia. This action is the only way in which the brain can be detoxified from ammonia. In neuroscience, glutamate is an important neurotransmitter that plays role in long term potentiation and is important for learning and memory [5].

In the present study, we report the value of ultrasonic velocity, viscosity and density of 0.00 to 0.1 molar concentration of L - Glutamic with water solution at different temperatures (293K-323K). The various physical and thermodynamic parameters like adiabatic compressibility (βa), free length (L_f), Moelwyn – Hughes parameter (C_1) and volume expansivity (α) were calculated from ultrasonic velocity, viscosity and density data. All these parameters were discussed in term of solute – solvent interaction accruing in the bio-mixture of L-Glutamic acid and water.

II. EXPERIMENTAL SECTION

L-Glutamic acid 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 L-Glutamic acid.

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 293K-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 (βa), free length (L_f), Moelwyn – Hughes parameter (C_1) and volume expansivity (α) of bio-mixtures of L-Glutamic acid with water at 293K-323K were shown graphically in figure 1 to 5.

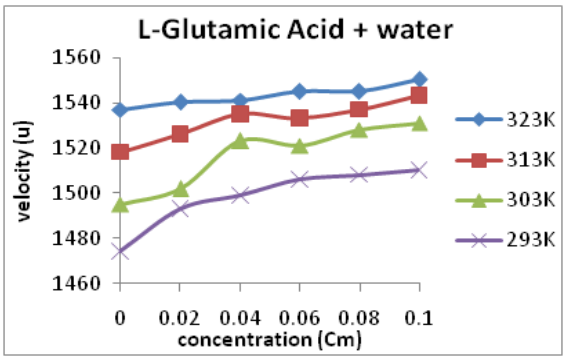

Fig. 1 Variation of u with Cm and Temperature

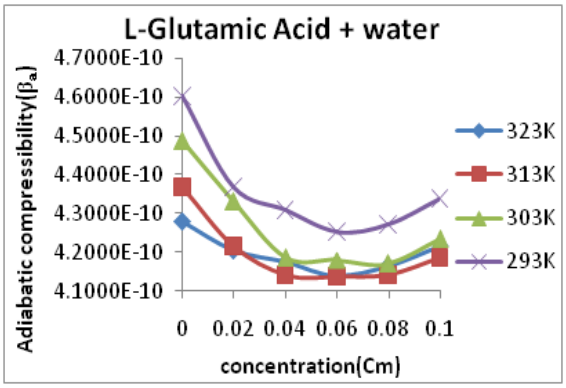

Fig. 2 Variation of β_a with Cm and Temperature

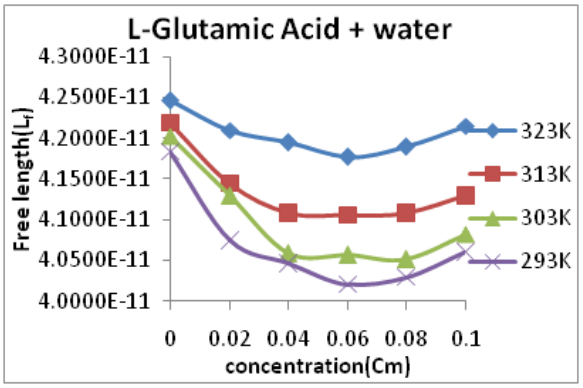

Fig. 3 Variation of L_f with Cm and Temperature

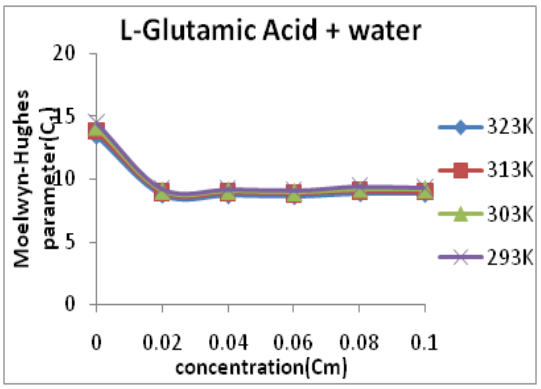

Fig. 4 Variation of C_1 with Cm and Temperature

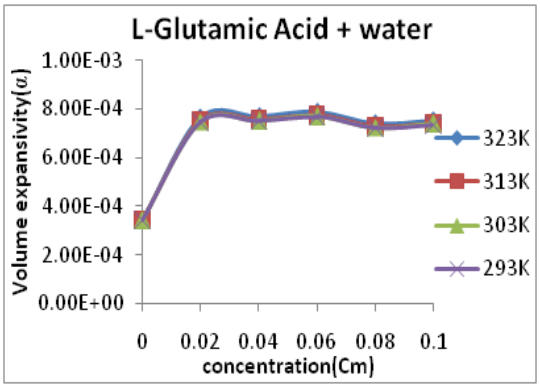

Fig. 5 Variation of α with Cm and Temperature

In the present bio-liquid mixture, the ultrasonic velocity slightly increases and adiabatic compressibility slightly decreases at particular molar concentration. This shows the association between the solute and solvent molecules. i.e. the solute-solvent interactions.

In the bio-liquid system of L-Glutamic acid in water, the variation adiabatic compressibility (β_a) and free length (L_f) shows nonlinear variation with increase in molar concentration and temperature of L-Glutamic acid. 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[6-8], which describe the structure making and breaking effect of the L-Glutamic acid. This also indicates the hydrophilic and hydrophobic nature of L-Glutamic acid in water. Moelwyn-Hughes[9-10] parameter C_1 shows a nonlinear increase or decrease with molar

concentration which signifies the nonlinear variation of volume expansivity with concentration. The high value of C_1 is due to large value of α or available volume V_a. This indicates the dissociative nature of the liquid mixture. But in the present bio-liquid system i.e. aqueous L-Glutamic acid, C_1 & α with concentration shows exactly opposite behaviour i.e. if α increases then C_1 is found to decrease with concentration and vice-versa. This result indicates the associating nature of aqueous bio-mixtures.

In this system, the ultrasonic velocity (u), increases with increasing concentration of L-glutamic acid with water.

The adiabatic compressibility and free length shows slightly minimum at concentration 0.04. This shows the complex formation and molecular dissociation. It also indicates weakening of hydrogen bond at this molar concentration[11].

The variation of volume expansivity with molar concentration and temperature shows increasing trend up to molar concentration 0.02 of aqueous L-Glutamic acid and then remains constant while the Moelwyn-Hughes parameter shows decreaing trend upto molar concentration 0.02 of aqueous L-Glutamic acid and then remains constant.

IV. CONCLUSIONS

The nonlinear variation of adiabatic compressibility, free length, Moelwyn-Hughes parameter and volume expansivity with molar concentration and temperature of L-Glutamic acid in water provides useful information about the nature of intermolecular forces existing in the mixture. The observed complex formation in the bio-liquid mixture may be due to the formation of hydrogen bonding and the tendency of solute-solvent interaction. The increase and decrease of these parameters with temperature is due to the fact that, as the temperature increases the thermal energy facilitates the breaking of bonds between the associated molecules into their monomers, therefore the molecules in the bio-liquid mixture move away from each other, reducing the interactions, which may further reduce the cohesive force. Moreover, the increase of the thermal energy increases the spacing between the molecules and increase in the entropy of its structural arrangement which tends to weakens the intermolecular forces.

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