Ultrasonic Study of Molecular Interactions in Biofluids

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Abstract:

In the present study, ultrasonic velocity (u), density (ρ) and viscosity (η) have been measured at 2 MHz frequency in the binary mixtures of Riboflavin with methanol in the concentration range (0 to 0.1 M) at 303K using Ultrasonic interferometer technique. The measured value of ultrasonic velocity, density and viscosity have been used to estimate the acoustical parameters namely adiabatic compressibility (β_a), relaxation time (τ) and free length (L_f), with a view to investigate the nature and strength of molecular interaction in the binary mixture of Riboflavin with methanol. The obtained result support the occurrence of Complex formation through intermolecular hydrogen bonding in these binary liquid mixtures.

Keywords:
Ultrasonic velocity, binary mixture, molecular interaction, hydrogen bonding.

Introduction:

The ultrasonic study of liquid and liquid mixtures has gained much more importance in assessing the nature and relative strength of molecular interactions and investigating the Physiochemical behavior of such system[7]. In recent years ultrasonic investigations find large number of applications in characterizing of thermodynamic and physiochemical aspect of binary liquid mixtures[4-5]. The acoustical and thermodynamic parameter have been used to study different kinds of associations, molecular motion and various types of interaction and their strengths influenced by the size of pure component and the mixtures[8,6,9].

The ultrasonic velocity, density and viscosity for binary liquid mixtures have been used for many researchers .However no effort have been made to collect the ultrasonic velocity, density and viscosity of binary mixtures of riboflavin with methanol up to now.

In the present Paper, we have reported the ultrasonic velocity, density and viscosity of riboflavinwith methanol at 303K over entire range of molar concentrations .From these experimental value a number of thermodynamic parameters namely adiabatic compressibility, relaxation time and free length have been calculated .The variation of these parameters with molar concentration was found to be useful in understanding the nature of interactions between the components.

Material and methods:

Riboflavin used in the present work was of Analytical Reagent (AR) grades with a minimum assay of 99.9%, they are used without purification. The various concentration of solution was prepared by adding sufficient amount of methanol to riboflavin.

The ultrasonic velocity (u) have been measured in ultrasonic interferometer (Model-F-05) supplied by Mittal enterprises, New Delhi 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 double distilled water with an accuracy of ±0.001Sec. The density (ρ) of this binary solution was 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 and ρ were measured at various concentration (0.00 M to 0.1M) and temperature of 303K.The acoustical parameters were calculated from u, η and ρ value using standard formulae.

Results and discussion:

The measured value of ultrasonic velocity, density and viscosity and related thermo acoustical parameters of riboflavin with methanol at 303 K were shown graphically in fig.1 to 6. It is observed that ultrasonic velocity and acoustic impedance shows nonlinearly increasing trend whereas adiabatic compressibility and free length shows nonlinearly decreasing trend with increase in molar concentration. This indicates the complex formation and weak association may be brought about through the hydrogen bonding possible between the molecules[1]. This behavior is the result of structural changes occurring in the mixture.

The opposite trend of ultrasonic velocity and adiabatic compressibility indicate association among the interacting riboflavin and methanol molecules. Nonlinear increasing trend of density with molar concentration indicates the structure-making property (Hydrophilic nature) of solvent due to the formation of H-bonds [2-10].

Relaxation time shows nonlinearly increasing behavior with increase in molar concentration. This may be due to significant molecular interaction between the riboflavin and methanol molecules[3].

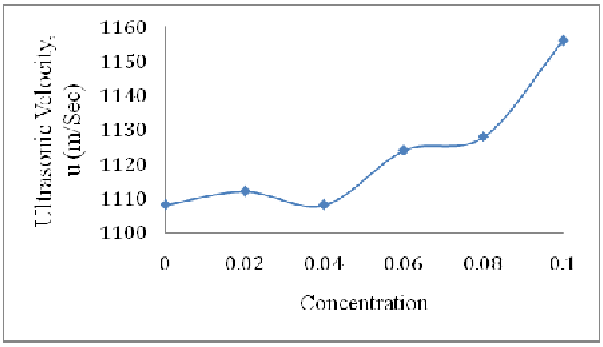

Figure 1: Variation of ultrasonic velocity with conc.

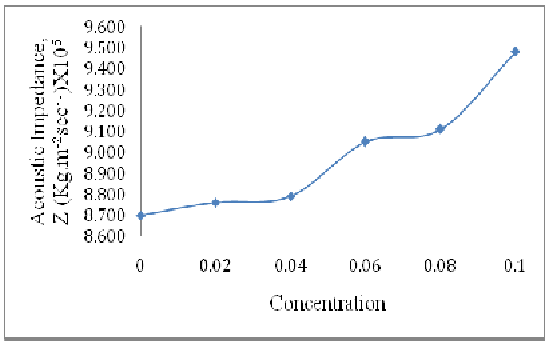

Figure 2: Variation of acoustic imp. with conc.

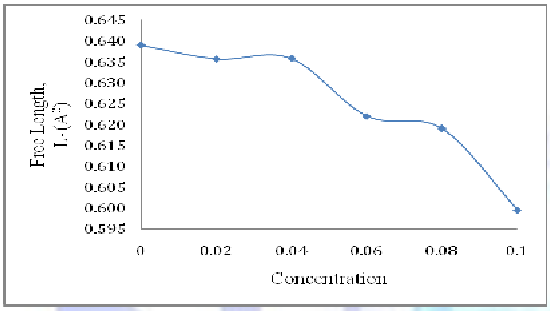

Figure 3: Variation of Adiab. Comp. with concentration

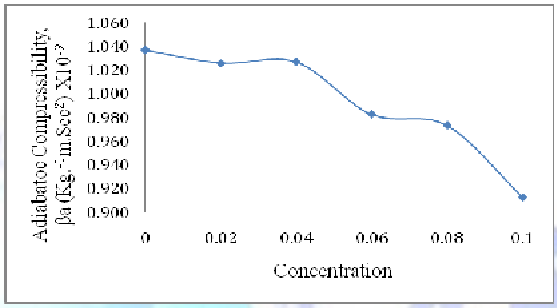

Figure 4: Variation of free length with concentration

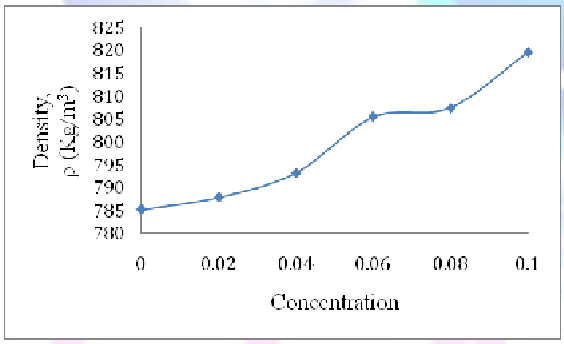

Figure 5: Variation of Density with concentration.

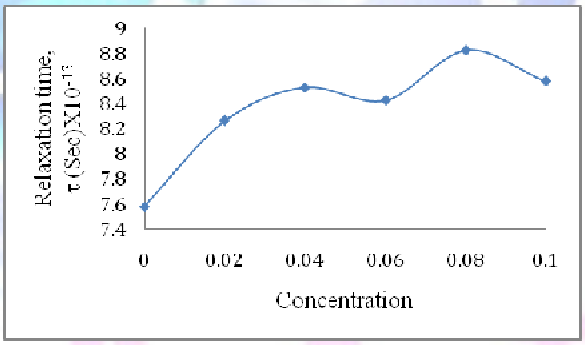

Figure 6: Variation of relaxation time with concentratoin

Conclusions:

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

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