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Acoustical Studies of Molecular Interactions in Riboflavin and NaOH at 288 K.

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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 NaOH in the concentration range (0 to 0.1 M) at 288K 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),free length (L_f), free volume (V_f) and internal pressure (P_i) with a view to investigate the nature and strength of molecular interaction in the binary mixture of Riboflavin with NaOH. The obtained result supports the occurrence of complex formation through intermolecular ionic bonding in the binary liquid mixture

Keywords:: Ultrasonic Velocity, Adiabatic compressibility, Complex formation, ionic bonding, binary liquid Mixtures.

INTRODUCTION

In the recent year, ultrasonic technique has been adequately employed to investigate the properties of any substance to understand the nature of molecular interaction in pure liquid[1], liquid mixtures[2-5] and ionic interactions in electrolyte solutions[6-8]. The interaction of B-complex vitamins with aqueous solution of electrolyte play a very important role in undertaking the nature of action of bioactive molecules and the thermodynamic behaviour of biochemical processes in our body system[9].

These interactions find several applications in food and pharmaceutical industries to prepare various drug dosages solution, tablets, capsule, soft gel and injection in solution form.

The present paper is an investigation of the behavior of binary solutions of Riboflavin in NaOH with regard to adiabatic compressibility, intermolecular free length, free volume and internal pressure from ultrasonic measurements in the concentration range (0 to 0.1 M) at 288K using ultrasonic interferometer technique.

METHODOLOGY

The chemicals Riboflavin and NaOH used in the present study were the products from E-Merck. All compounds were of AR grade with minimum assay of 99.9%. Therefore, all chemicals were used without further purification. The mixtures of these chemicals were prepared immediately before use by mixing appropriate volume. The viscosity of the liquids was measured by an Ostwald Viscometer. The Viscometer was placed in a large glass jar through which current of water was maintained with the help of a thermostat. Prior to the measurements the viscometer was calibrated with the help of distilled water. The density of liquids was measured by the Pycnometer. The measurements were made at different concentration at 288K. An Ultrasonic interferometer having the frequency of 2 MHz (Mittal Enterprises, New Delhi, Model: F-05) with an overall accuracy of ± 0.03% has been used for velocity measurement. An electronically digital operated constant temperature bath (Plasto-craft Industries, Mumbai) has been used to circulate water through the double walled measuring cell made up of steel containing the experimental solution at the desired temperature. The accuracy in the temperature measurement is ± 0.1 K.

RESULTS AND DISCUSSION

The measured ultrasonic velocity and related thermoacoustical parameters adiabatic compressibility, free length, free volume and internal pressure of Riboflavin with NaOH at 288K were shown in fig.1 to 5.

It is observed that ultrasonic velocity and adiabatic compressibility seem to exhibit nonlinear variation with increase in molar concentration. This suggested the presence of molecular interaction and complex formation between the components molecules may be due to ion-ion interaction[10-11]. This behavior shows the structural making and breaking effect of Riboflavin. This also indicates the hydrophilic and hydrophobic nature of Riboflavin with NaOH. The ultrasonic velocity shows peak at 0.02 molar concentration. The peak at this molar concentration is due to the formation of strong ionic bonds. Thus complex formation can occur at this concentration. The ultrasonic velocity and adiabatic compressibility shows opposite behavior. This clearly indicates association between solute and solvent molecules i-e solute-solvent interaction. NaOH is having Na^+ ion can form ionic bond with O^- of hydroxyl group of Riboflavin thus association and complex formation may be possible between Riboflavin and NaOH molecules through ionic bonding. Intermolecular free length shows a similar behavior as reflected by adiabatic compressibility.

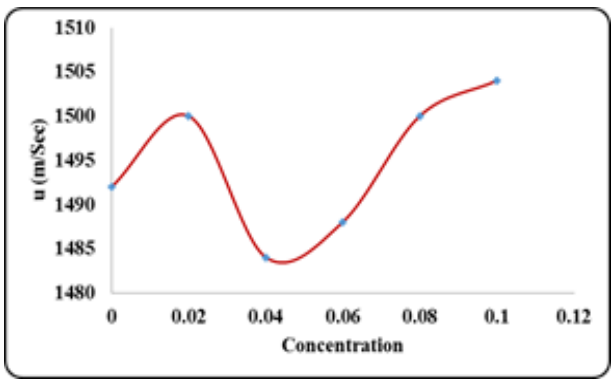

Fig.-1 variation of ultrasonic velocity with Concentration

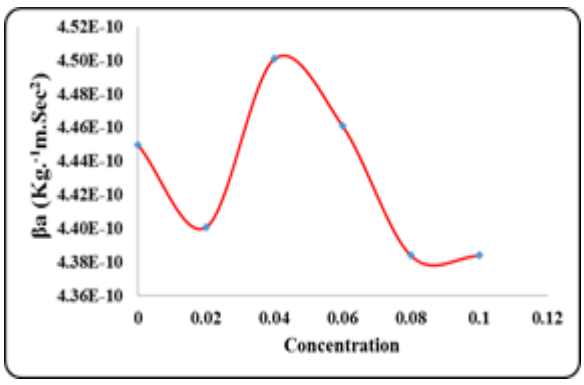

Fig.-2 variation of adiabatic Comp. with Concentration

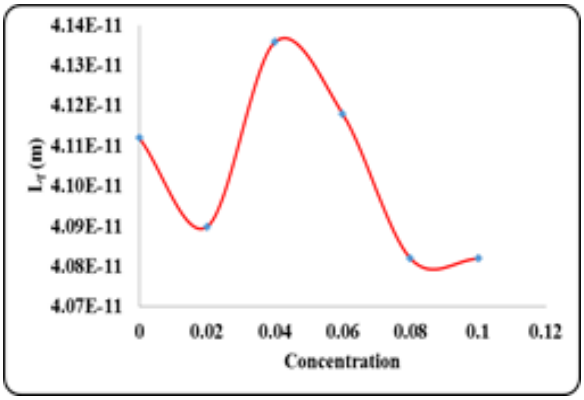

Fig.-3 variation of Free length with Concentration

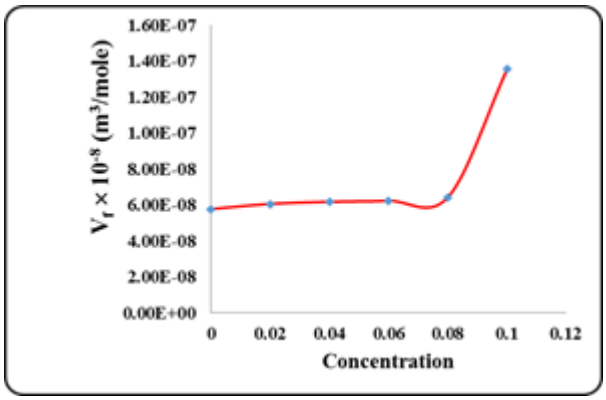

Fig-4 Variation of Free Volume with Concentration

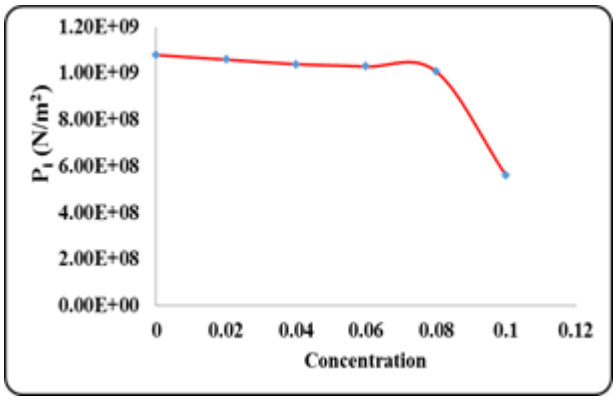

Fig.-5 variation of internal pressure with Concentration

Free length varies nonlinearly with increasing molar concentration suggest the significant interaction between solute and solvent molecules due to which structural arrangement is also affected[12].

The free volume increases & internal pressure decreases with increases in molar concentration indicate the association through ionic bonding. It shows the increasing magnitude of interaction between the Riboflavin and NaOH[13].

CONCLUSION

The non-linear variation of thermo-acoustical parameters with molar concentration reveals that, there exist intermolecular forces in the binary liquid mixture. The complex formation and molecular association in this mixture may be due to formation of ionic bonding in the molecules and the tendency of solute-solvent interaction. The complex formations are responsible for heter-molecular interaction in the liquid mixture.

Conflicts of interest: The authors stated that no conflicts of interest.

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