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Research Article

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Nonlinear thermoacoustic investigation in binary mixture of thiamin hydrochloride with NaOH at 303K

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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 thiamin hydrochloride with NaOH 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), acoustic impedance (z), 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 thiamin hydrochloride with NaOH. The obtained result support the occurrence of Complex formation through intermolecular ionic bonding in these binary liquid mixtures.

Key words: Ultrasonic velocity, Thiamin hydrochloride, molecular interaction, hydrogen bonding.

INTRODUCTION

Ultrasonic technique has powerful tool for studying the molecular behavior of liquid mixtures[1]. The ultrasonic study of liquid and liquid mixtures has gained much importance in assessing the nature and relative strength of molecular interactions and investigating the Physiochemical behavior of such system[2]. In recent years ultrasonic investigations find large number of applications in characterizing of thermodynamic and physiochemical aspect of binary liquid mixtures[3-4]. 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[5-7].The ultrasonic velocity, density, viscosities for binary liquid mixtures have been measured by many researchers. However less effort have been made to collect the data of ultrasonic velocity, density and viscosity of binary mixtures of thiamin hydrochloride with NaOH until today.

In the present Paper we have reported the ultrasonic velocity, density and viscosity of thiamin hydrochloride with NaOH at 303K over entire range of molar concentrations. From this experimental value a number of thermodynamic parameters namely adiabatic compressibility, acoustic impedance, relaxation time, free length, free volume and internal pressure 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.

EXPERIMENTAL SECTION

Thiamin hydrochloride 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 solvent NaOH to thiamin hydrochloride.

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. 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 various concentration (0.00 M to 0.1M) and temperature of 303K.The acoustical parameters were calculated from U, η, ρ value using standard formulae[8].

RESULTS AND DISCUSSION

The measured ultrasonic velocity, density and viscosity of thiamin hydrochloride with NaOH & calculated acoustical parameters at 303K were shown in table 1 & 2 and related graphical representation of these parameters are shown in fig.1.1 to 1.7.

Table 1 : Ultrasonic velocity (U), density (ρ) and viscosity (η) value for binary mixture of Thiamin hydrochloride +NaOH at 303ºK

Mole Conc.	0	0.02	0.04	0.06	0.08	0.1
U (m/sec)	1508	1516	1504	1512	1528	1532
ρ (Kg/m^3)	1006.5	1005.7	1006.5	1008.6	1011.3	1006.2
η (mPa.Sec)	0.000741	0.000741	0.000741	0.000749	0.000751	0.000753

Table 2 : Acoustical parameters for binary mixture of thiamin hydrochloride +NaOH at 303ºK.

Mole Conc.	0	0.02	0.04	0.06	0.08	0.1
β_a ($Kg^{-1}.m.Sec^2$)	4.369E-10	4.326E-10	4.392E-10	4.337E-10	4.235E-10	4.234E-10
τ (Sec)	4.317E-13	4.275E-13	4.340E-13	4.331E-13	4.241E-13	4.251E-13
Z ($Kg/m^2.Sec$)	1.52E+06	1.52E+06	1.51E+06	1.53E+06	1.55E+06	1.54E+06
L_f (m)	4.147E-11	4.127E-11	4.158E-11	4.132E-11	4.083E-11	4.083E-11
V_f (m^3/mole)	8.294E-08	8.548E-08	8.6328E-08	8.7488E-08	9.0421E-08	1.90823E-07
P_i (N/m^2)	9.92E+08	9.72E+08	9.59E+08	9.47E+08	9.30E+08	5.18E+08

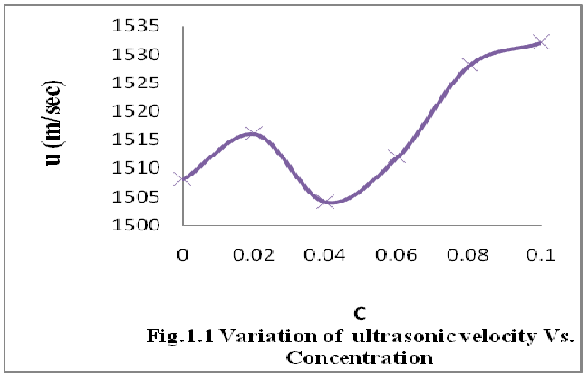

Fig.1.1 Variation of ultrasonic velocity Vs. Concentration

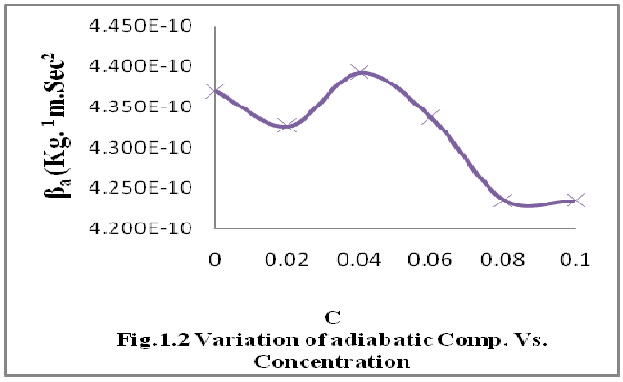

Fig.1.2 Variation of adiabatic Comp. Vs. Concentration

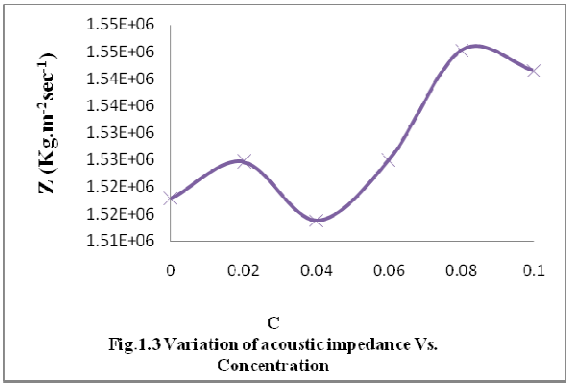

Fig.1.3 Variation of acoustic impedance Vs. Concentration

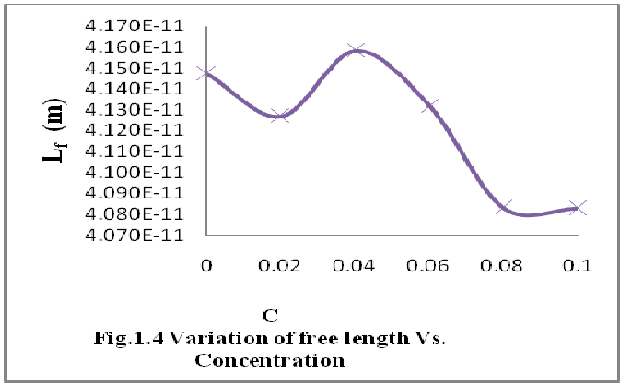

Fig.1.4 Variation of free length Vs. Concentration

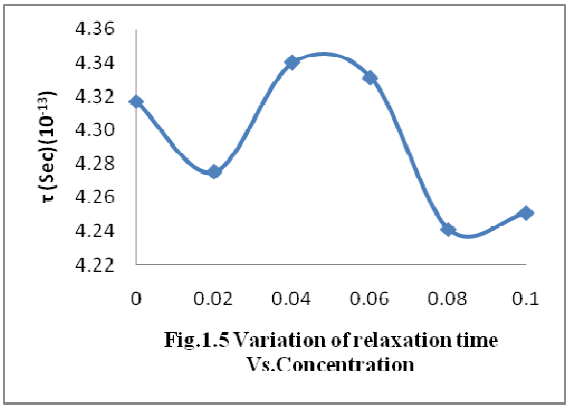

Fig.1.5 Variation of relaxation time Vs.Concentration

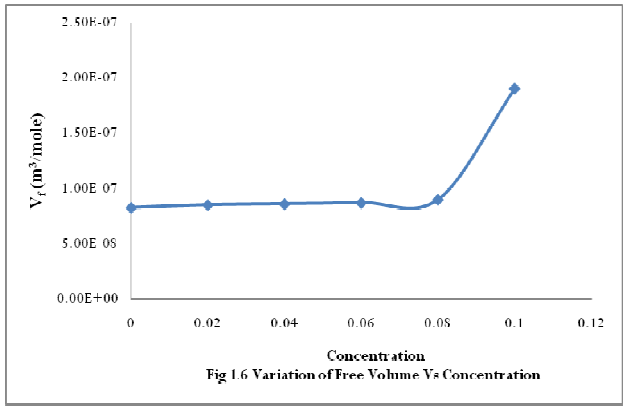

Fig 1.6 Variation of Free Volume Vs Concentration

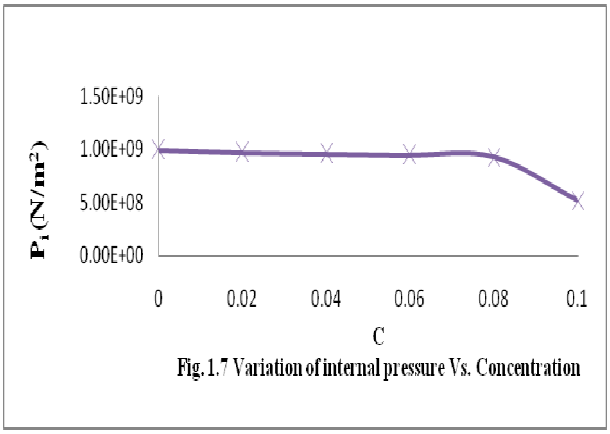

Fig.1.7 Variation of internal pressure Vs. Concentration

It is observed that ultrasonic velocity and acoustic impedance seem to exhibit almost nonlinear variation at lower concentration. This suggested the presence of molecular interaction and complex formation[9]. This behavior shows the structural making and breaking effect of thiamin hydrochloride. This also indicates the hydrophilic and hydrophobic nature of thiamin hydrochloride with NaOH. The ultrasonic velocity linearly increases at higher concentration which is due to increasing strength of intermolecular forces and hence association may takes place between interacting components because of ionic bonding. The ultrasonic velocity shows peak at 0.02 & dip at 0.04 molar concentrations. The peak at 0.02 & dip at 0.04 molar concentrations is due to the formation of strong & weak hydrogen bonds. Thus complex formation can occur at these concentrations.

The adiabatic compressibility shows nonlinear variation at lower concentration and decreasing trend at higher concentration is due to the making and breaking of ionic bonding which leads to association & dissociation among the interacting molecules between solute & solvent. Decreasing trend at higher concentration, clearly indicate associative nature of solute and solvent.

The ultrasonic velocity and adiabatic compressibility shows opposite behavior. This clearly indicates association between the solute and solvent molecules i-e solute-solvent interaction[9].

Intermolecular free length shows a similar behavior as reflected by adiabatic compressibility. Free length varies nonlinearly with increasing molar concentration at lower concentration suggest the significant interaction between solute and solvent molecules due to which structural arrangement is also affected[10].The free length decreases at higher concentration is due to loss of dipolar dissociation, breaking up ionic bonding and differences in size and shape of the component molecules[9].

Nonlinear variation of relaxation time with increase in molar concentration is due to the existence of significant molecular interaction between the solute and solvent molecules[11].

The free volume increases & internal pressure decreases with increases in molar concentration indicate the association through hydrogen bonding. It shows the increasing magnitude of interaction between the component molecules.

CONCLUSION

The molecular association between thiamin hydrochloride and NaOH arise due to ionic bonding. This association plays a very important role in medical and Pharmaceutical industries.

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REFERENCES

[1] R.Palani & K.Jayachitra, Ind . *J.Pure and Appl. Phys*., **2008**,(46),251-254.
[2] C. Shanmuga Priya etal, *International J.of Advanced Sci. & tech*, **2010**,(18), 59-74.
[3] Mehra and Sajnami, Ind . *J.Pure and Appl. Phys*., **2000**,(38),760.
[4] R. Palani , S.Saravanan and R. Kumar, *Rasayan J.Chem*, (**2009**), 2(3), 622-629.
[5] T.Sumathi & J. Uma Maheswari, Ind . *J.Pure and Appl. Phys*., **2009**,(47),782-786.
[6] M.Sethu Raman, V.Ponnuswamy,P.Kolandaivel, K.Perumal,**2007**,135,46-52
[7] V.A.Tabhane, O.P.Chimankar ,S.Manja,*J.Pure & appl Ultrasonic* **1999**,21,67-70.
[8] O. P. Chimankar, R.Shriwas, S. Jajodia, R. Shriwas. & V. A. Tabhane *Advances of applied Science Research*, **2011**, 2 (3) 500-508.
[9] O. P. Chimankar, S. Jajodia, R. Shriwas. & V. A. Tabhane *Archives of Applied Science Research*, (**2011**), 3 (3) **,** 252-256.
[10] Saneel K. Thakur & Shivani Chauhan, *J. Chem. Pharm. Res*., **2011**, 3(2), 657-664.
[11] T. Sumathi, S.Punithasri & S.Ananthi, *Asian J. of Biochemical & Phar. Res*.,**2012** , 2(2), 218-225.