



THERMO-ACOUSTIC MOLECULAR INTERACTION STUDIES IN BINARY LIQUID MIXTURES OF PROPYL AMINE AND ORTHO XYLENE USING ULTRASONIC TECHNIQUE AT 311K.

R.C.Verma¹ & Vidyottma

¹Deptt.of Chemistry, Agra College,Agra (U.P.) India
Deptt.of Chemistry,B.S.A. College, Mathura (U.P.) India

e-mail : jcb.rajesh@gmail.com ,

ABSTRACT

The ultrasonic studies in liquids are great use in understanding the nature and strength of molecular interaction. The thermo-acoustical parameters for binary liquid mixtures of propyl amine and o-xylene have been estimated from the measured values of ultrasonic velocity (v), density (ρ) and viscosity (η). Using the measured data, some of acoustic parameters such as isentropic compressibility (β_s) and intermolecular free length (L_f) are evaluated at the temperature 311K. The present paper represents the nonlinear variation of ultrasonic velocity and thermo-acoustical parameters lead to dipole-induced dipole interaction between propyl amine and o-xylene molecules. The behavior of these parameters with composition of the mixture has been discussed in terms of molecular interaction between the components of the liquids.

Keyword:

INTRODUCTION

Ultrasonic study is very much useful for characterizing the physic-chemical behavior of liquid mixtures and measurements are used to study molecular interactions in liquids.(Kannappam and Chidambara Vinayagam 2006). The method of studying in molecular interaction from the knowledge of variation of acoustic parameters along with their excess values with change in mole fraction gives an Insight into the molecular process (Voleisiene & Voleisis, 2008). The increase or decrease in ultrasonic velocities have been employed in understanding the nature of molecular interaction in the pure liquid binary mixtures .(Jain and Dhar 1992) The study of liquid mixtures containing of polar and non-polar components find applications in industrial and technological process (Largemann and Dumbar 1992) .

The mixing of different give rise to solutions that generally do not behave ideally (Bhandakkar, V.D.2012) (,Bedare.,Bhandakkar and Suryavanshi 2013),(Mistry., Bhandakkar and Chimankar 2012), (Bhandakkar, Chimankar and Mistry2013)) Further those properties have been widely used to study the molecular interaction between the various species in the mixture (Verma et al (2018)).

In the present study ultrasonic velocity, density and viscosity were measured experimentally for binary system namely propyl amine and o-xylene at 306K. From the measured data , thermo-acoustical parameters have been computed and the results are analysed in the light of molecular interaction.

MATERIALS AND METHODS

Propyl amine and o-xylene were used after single distillation. Binary mixtures were prepared by mixing known volume of each liquid in air tight Stoppard glass bottle. Care was taken to avoid contamination during mixing.

Ultrasonic velocity was measured by Ultrasonic Interferometer M-80 manufactured by M/S Mittal Enterprises, New Delhi having accuracy of about $\pm 0.057\%$.

Density of pure liquid and binary mixtures was measured by using double walled Picknometer. The Picknometer was calibrated with distilled water. The value obtained were tally with the literature values. The viscosities have been determined by using Ostwald viscometer. The accuracy in viscosity measurement was ± 0.0002 c.p.

Isentropic compressibility (β_s) has been calculated from ultrasonic velocity (v) and the density (ρ) using the equation as:

$$\beta_s = 1/v^2\rho \quad (1)$$

Intermolecular free length (L_f) has been determined as:

$$L_f = KT(\beta_s)^{1/2} \quad (2)$$

Where KT is a Jacobson's constant.

Table-1: Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) of pure liquids at 311K.

Liquid	Ultrasonic Velocity	Density	Viscosity
Propyl amine	1098	0.6640	0.1310
o-xylene	1280	0.8380	0.3232

Table-2: : Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) for the binary liquid mixture of propyl amine and o-xylene at 311K.

Mole Fraction of propyl amine (X_1)	Ultrasonic Velocity (v) ms-1	Density (ρ) Gml-1	Viscosity (η) Cp
0.0000	1280	0.8380	0.3232
0.1703	1254	0.8189	0.2914
0.3239	1228	0.7985	0.2625
0.4630	1204	0.7774	0.2363
0.5897	1181	0.7558	0.2117
0.7055	1159	0.7337	0.1890
0.8117	1138	0.7112	0.1681
0.9095	1117	0.6885	0.1488
1.0000	1098	0.6640	0.1310

Table-3: Experimental values of isentropic compressibility (β_s) and intermolecular free length (L_f) for the binary liquid mixture of propyl amine and o-xylene at 311K.

Mole Fraction of methyl amine X1	Isentropic Compressibility(β_s) Cm ² dyne-1x10 ¹²	Intermolecular Free length (L_f) A ⁰
0.0000	72.83	0.5453
0.1703	77.65	0.5740
0.3239	83.04	0.5999
0.4630	88.73	0.6234
0.5897	94.86	0.6448
0.7055	101.46	0.6643
0.8117	108.57	0.6823
0.9095	116.10	0.6988
1.0000	124.91	0.7141

Graphs: Fig. 1-5 shows variation of ultrasonic velocity (v), density (ρ), viscosity (η), isentropic compressibility(β_s) and intermolecular free length (L_f) with respect to mole fraction at temperature 311K.

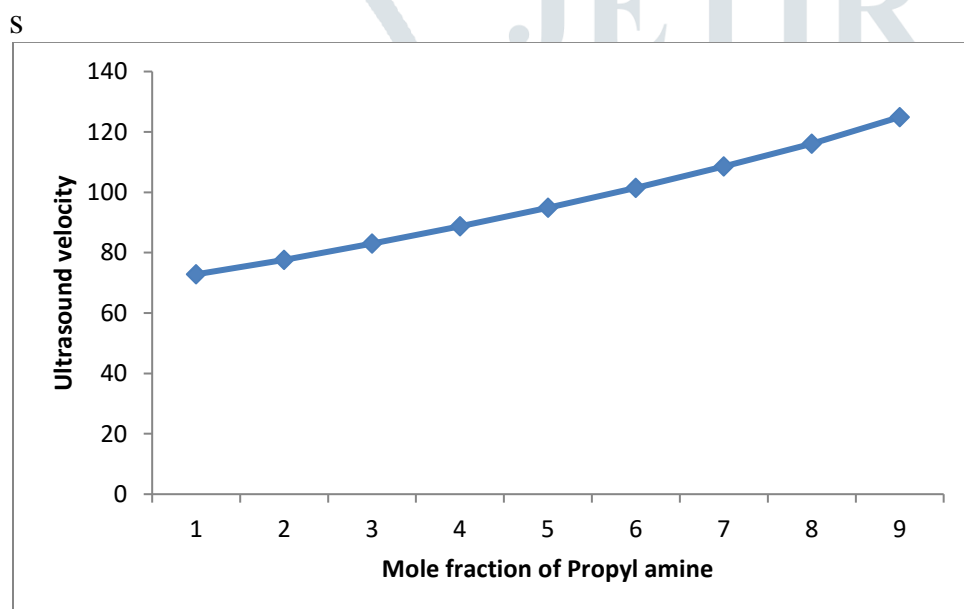


Fig.1: Variation of Ultrasonic velocity with mole fraction.

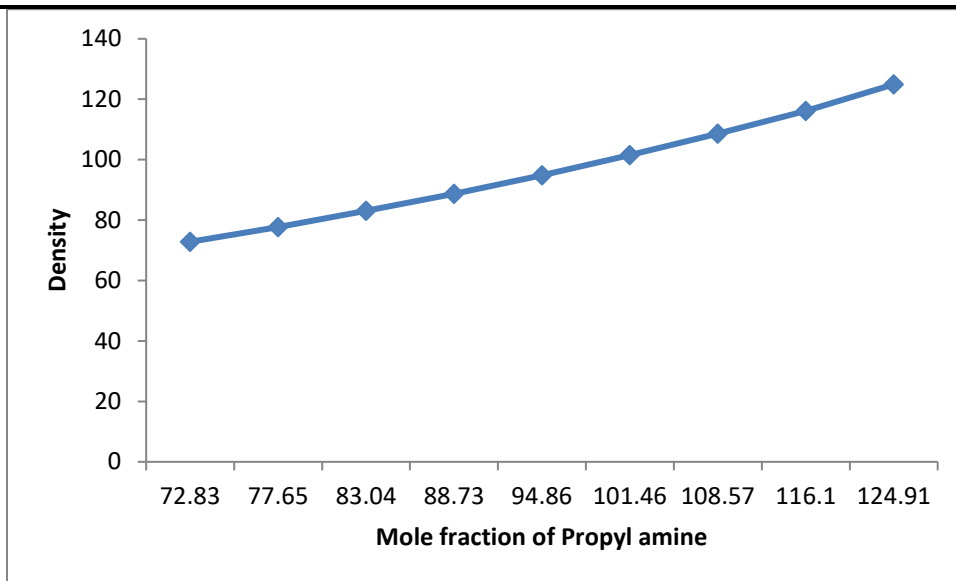


Fig.2: Variation of density with mole fraction.

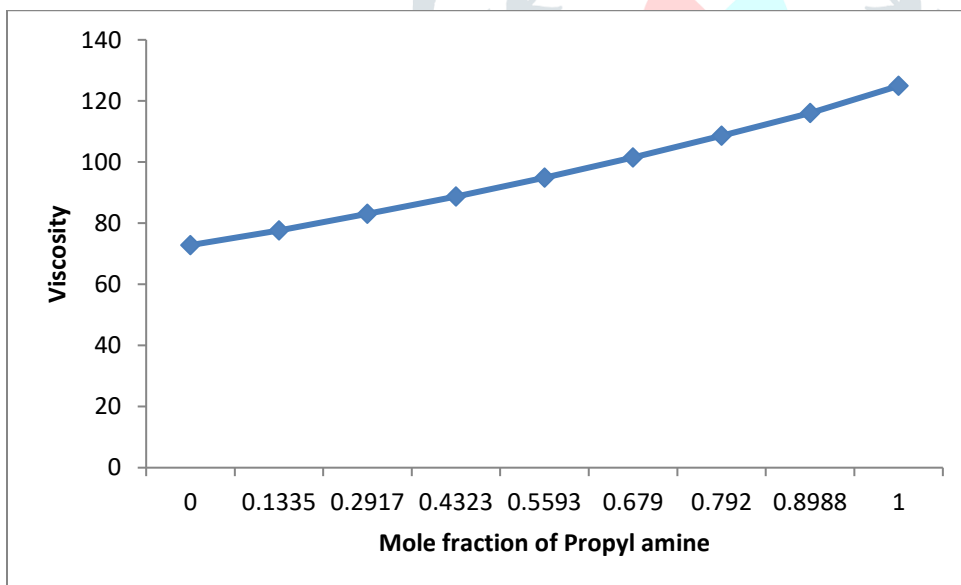


Fig.3: Variation of viscosity with mole fraction.

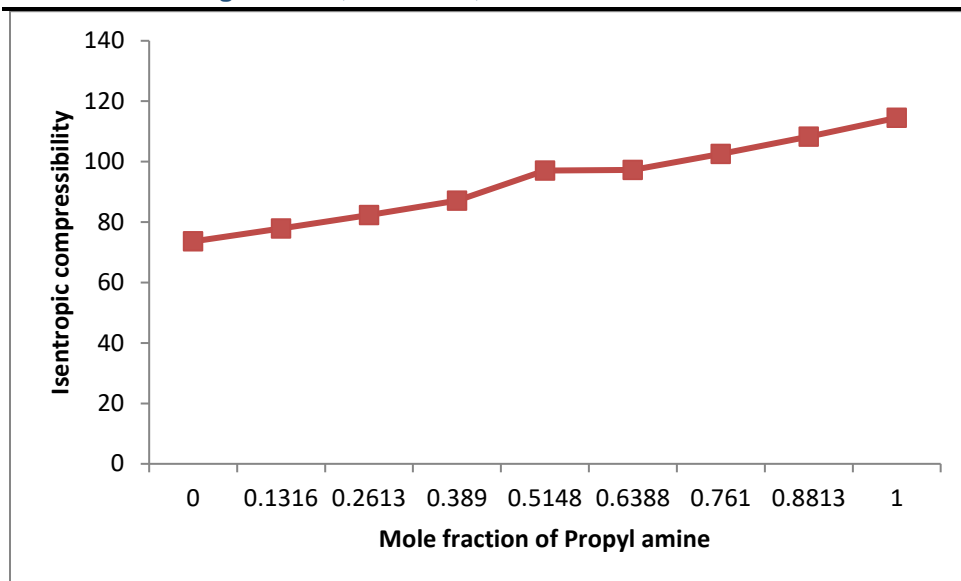


Fig.4: Variation of isentropic compressibility with mole fraction.

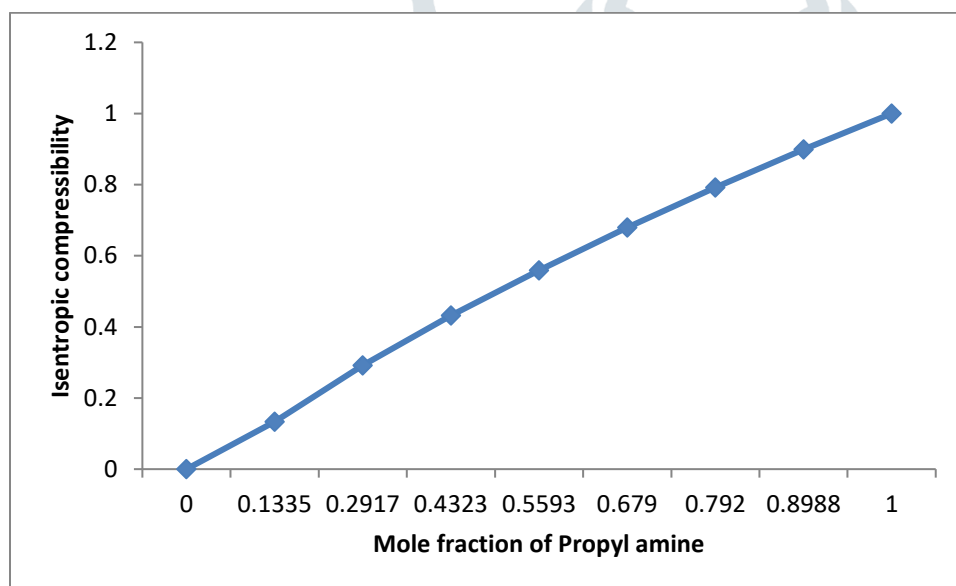


Fig.5: Variation of intermolecular free length with mole fraction.

RESULTS AND DISCUSSION

The experimentally measured values of ultrasonic velocity, density and viscosity for pure liquids at 311K are presented in Table-1. Experimental values of ultrasonic velocity, density and viscosity for binary mixture at 311K are given in Table-2. The thermodynamic parameters such as isentropic compressibility (β_s) and intermolecular free length (L_f) are listed in Table-3. The variation of ultrasonic velocity, density and viscosity at 311K are shown in Fig.1,2 and 3 respectively. While other thermodynamic parameters such as isentropic compressibility (β_s) and intermolecular free length (L_f) at 301K are shown in Fig. 4 and 5 respectively.

From Table-2 it is observed that, the density (ρ) and viscosity (η) decreases with increase in mole fraction for propyl amine and o-xylene system and ultrasonic velocity (v) decreases with increasing mole fraction. The decrease in ultrasonic velocity are due to the increase in isentropic compressibility and intermolecular free length of the liquid mixtures. This may lead to presence of dispersive force (London force) between the molecules of the liquid mixture. The isentropic compressibility and intermolecular free length are the deciding factors of ultrasonic velocity in binary mixtures.

As benzene is non-polar molecule does not possess dipole moment, when it interacts with propyl amine which is polar molecule possess dipole moment then o-xylene possess induced dipole moment. This induced dipole-dipole interaction between o-xylene and propyl amine molecules.

CONCLUSION

From ultrasonic velocity, related acoustic parameters for methyl amine with o-xylene for various concentration at 311K, it has been found that there exists a dipole-induced dipole interaction between propyl amine and o-xylene.

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