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ORIGINAL ARTICLE

Thermo-acoustic Molecular Interaction Studies in Binary Liquid Mixtures of Propyl Amine and Toluene using Ultrasonic Technique at 301K

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ABSTRACT

The thermo-acoustical parameters for binary liquid mixtures of propyl amine and toluene 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 (βs) and intermolecular free length (L_f) are evaluated at the temperature 301K. The present paper represents the nonlinear variation of ultrasonic velocity and thermo-acoustical parameters lead to dipole-induced dipole interaction between propyl amine and toluene 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.

Key word: *ultrasonic velocity, acoustical parameters, molecular interaction, propyl amine, toluene*

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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.

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 Mistry, 2013. Further those properties have been widely used to study the molecular interaction between the various species in the mixture.

In the present study ultrasonic velocity, density and viscosity were measured experimentally for binary system namely propyl amine and toluene at 301K. 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 toluenee 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 ±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 ±0.0002c.p.

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

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

Intermolecular free length (L_f) has been determined as:

$$Lf = KT(\beta s)^{1/2} \quad \ldots(2)$$

Where KT is a Jacobson's constant.

Table 1: Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) of pure liquids at 301K

Liquid	Ultrasonic Velocity	Density	Viscosity
Propyl amine	1160	0.6980	0.3780
Toluene	1280	0.8570	0.5520

Table 2: Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) for the binary liquid mixture of propyl amine and toluene at 301K

Mole Fraction of propyl amine (X1)	Ultrasonic Velocity (v) ms-1	Density (ρ) Gml-1	Viscosity (η) Cp
0.0000	1280	0.8570	0.5520
0.1335	1262	0.8338	0.5271
0.2973	1244	0.8113	0.5037
0.4323	1228	0.7900	0.4813
0.5593	1214	0.7699	0.4598
0.6790	1200	0.7508	0.4385
0.7920	1186	0.7325	0.4173
0.8988	1176	0.7152	0.3979
1.0000	1160	0.6980	0.3780

Table 3: Experimental values of isentropic compressibility (βs) and intermolecular free length (Lf) for the binary liquid mixture of propyl amine and toluene at 301K

Mole Fraction of methyl amine X1	Isentropic Compressibility(βs) $Cm^2dyne\text{-}1x10^{12}$	Intermolecular Free length (L_f) A^0
0.0000	71.21	0.5299
0.1535	75.30	0.5449
0.2973	79.67	0.5605
0.4323	83.94	0.5733
0.5593	88.13	0.5895
0.6790	92.49	0.6039
0.7920	97.05	0.6186
0.8988	101.44	0.6325
1.0000	106.47	0.6479

Fig. 1-5 shos variation of ultrasonic velocity (v), density (ρ), viscosity (η), isentropic compressibility (βs) and intermolecular free length (L_f) with respect to mole fraction at temperature 301K.

RESULTS AND DISCUSSION

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

Fig 1: Variation of Ultrasonic velocity with mole fraction.

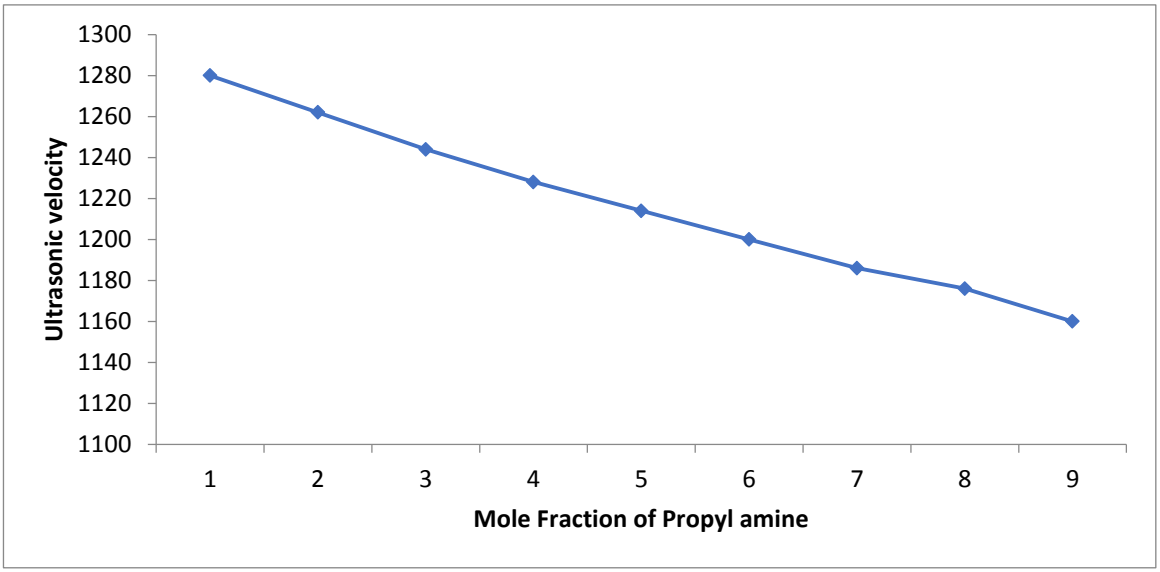


Fig. 2: Variation of density with mole fraction

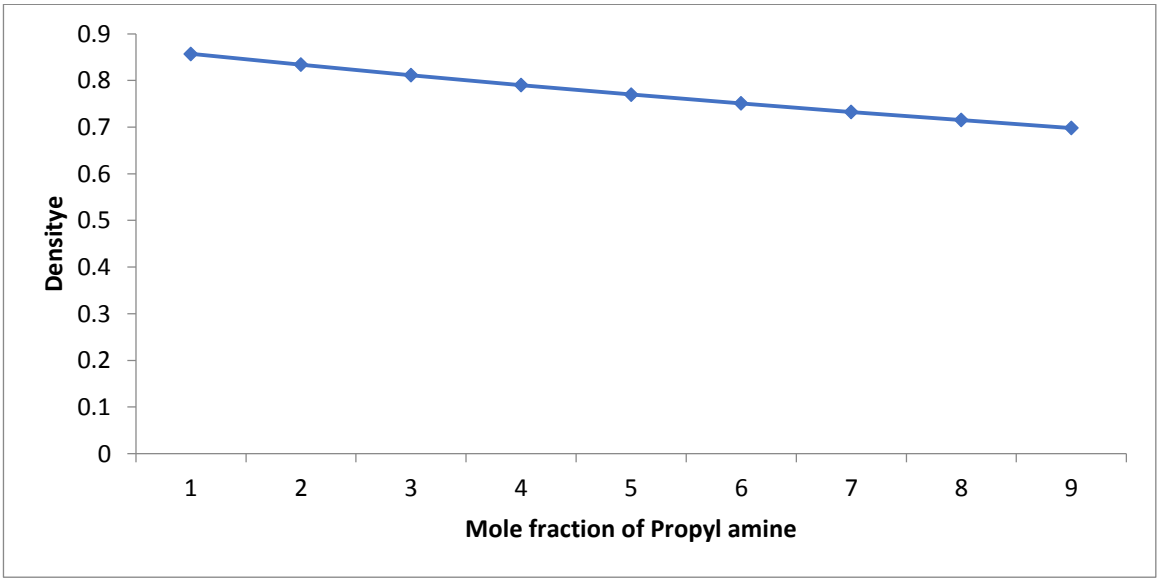


Fig. 3: Variation of viscosity with mole fraction

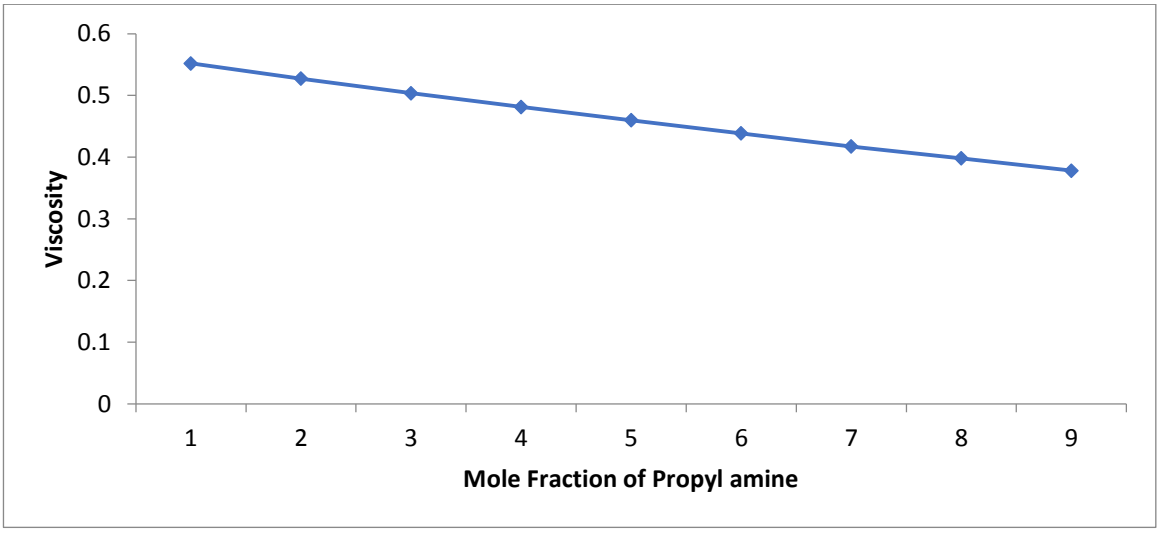


Fig. 4: Variation of isentropic compressibility with mole fraction

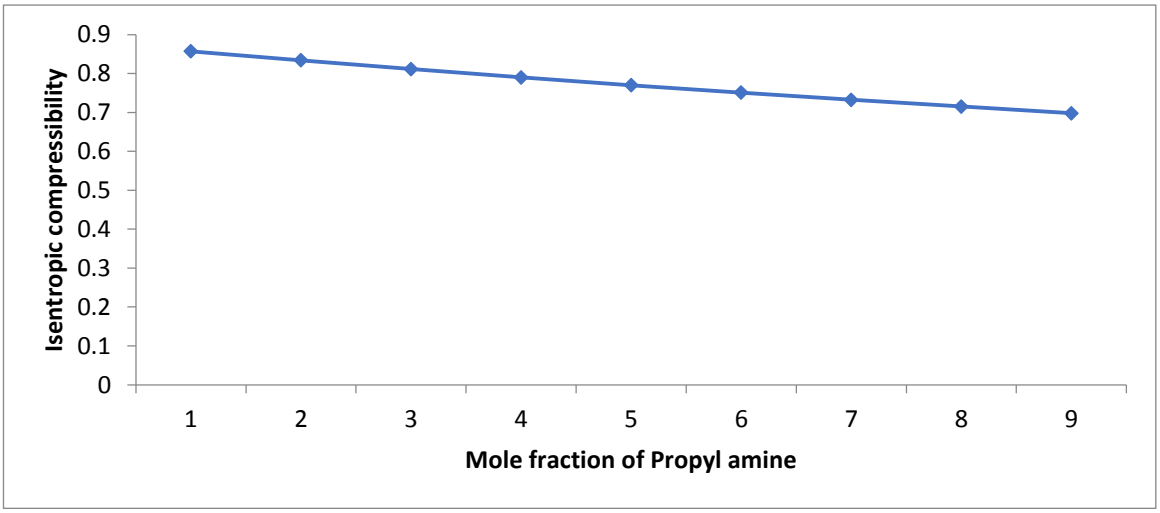
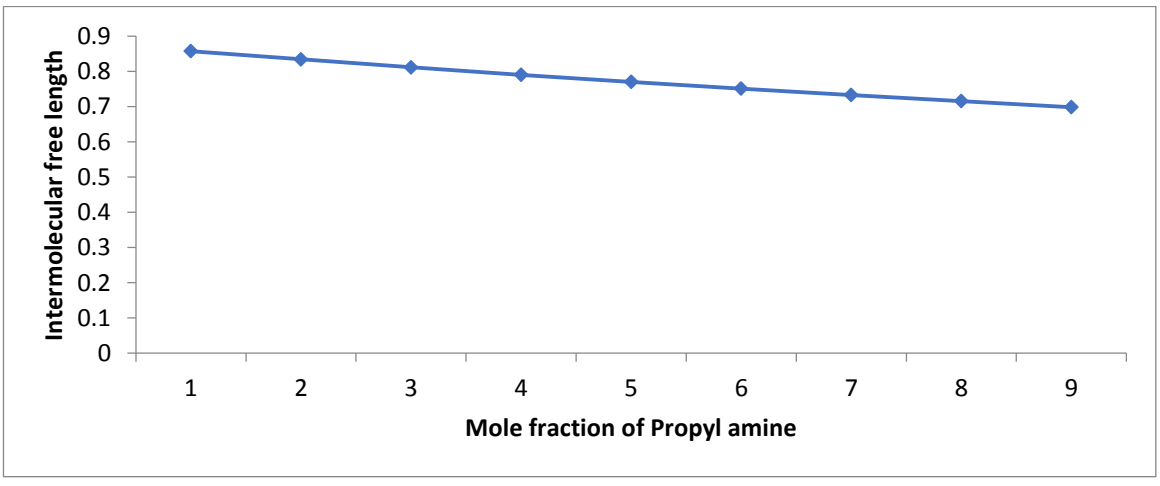


Fig. 5: Variation of intermolecular free length with mole fraction



From Table-2 it is observed that, the density (ρ) and viscosity (η) decreases with increase in mole fraction for propyl amine and toloene system and ultrasonic velocity (v) decreases with increasing mole fraction. The decreases 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 toluene is non-polar molecule does not possess dipole moment, when it interacts with propyl amine which is polar molecule possess dipole moment then benzene possess induced dipole moment. This induced dipole-dipole interaction between toluene and propyl amine molecules.

CONCLUSION

From ultrasonic velocity, related acoustic parameters for propyl amine with toluene for various concentrations at 298K, it has been found that there exists a dipole-induced dipole interaction between methyl amine and benzene.

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