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ORIGINAL ARTICLE

Thermo-Acoustic Molecular Interaction Studies in Binary Liquid Mixtures of Propyl Amine and Benzene using Ultrasonic Technique at 306K

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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 benzene 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 306K. The present paper represents the nonlinear variation of ultrasonic velocity and thermo-acoustical parameters lead to dipole-induced dipole interaction between propyl amine and benzene 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, benzene*

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INTRODUCTION

Ultrasonic study is very much useful for characterizing the physico-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 2012; Bedare, *et al.*, 2013; Mistry, *et al.*, 2012 & 2013) 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 benzene 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 benzene 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:

$$Bs = 1/v2\rho$$

Intermolecular free length (Lf) has been determined as:

$$Lf = KT(\beta s)1/2$$

Where KT is a Jacobson's constant.

Table 1: Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) of pure liquids at 306K

Liquid	Ultrasonic Velocity (v) m/s	Density (ρ) gmi^{-1}	Viscosity (η) cp
Methyl amine	1130	0.6840	0.2540
Benzene	1260	0.8550	0.4370

Table 2: Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) for the binary liquid mixture of propyl amine and benzene at 306K

Mole Fraction of propyl amine (X_1)	Ultrasonic Velocity (v) ms^{-1}	Density (ρ) gml^{-1}	Viscosity (η) cp
0.0000	1260	0.8550	0.4370
0.1316	1244	0.8299	0.4139
0.2613	1227	0.8068	0.3909
0.3890	1210	0.7842	0.3682
0.5148	1194	0.7621	0.3455
0.6388	1178	0.7411	0.3227
0.7610	1163	0.7210	0.2998
0.8813	1147	0.7022	0.2768
1.0000	1130	0.6840	0.2540

Table 3: Experimental values of isentropic compressibility (βs) and intermolecular free length (L_f) for the binary liquid mixture of propyl amine and benzene at 306K

Mole Fraction of Propyl amine X_1	Isentropic Compressibility(βs) $Cm^2dyne\text{-}1x10^{12}$	Intermolecular Free length (L_f) A^0
0.0000	73.61	0.5441
0.1316	77.86	0.5594
0.2613	82.32	0.5752
0.3890	87.09	0.5916
0.5148	97.04	0.6082
0.6388	97.23	0.6251
0.7610	102.54	0.6420
0.8813	108.24	0.6596
1.0000	114.49	0.6783

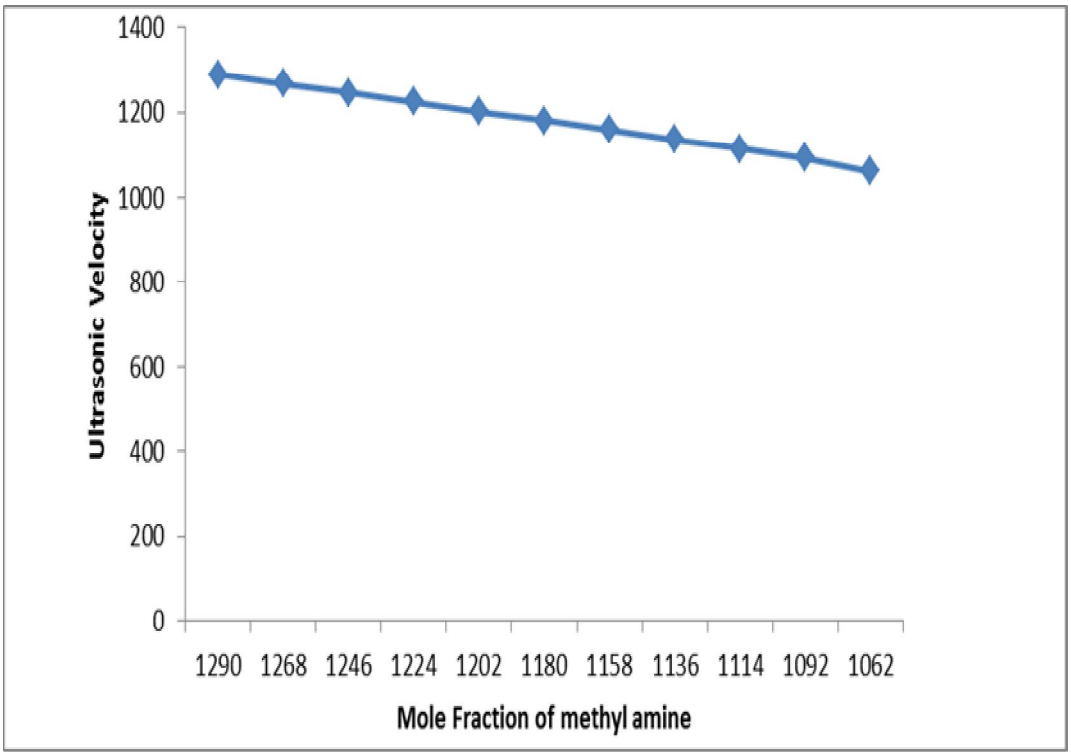

Fig. 1: Variation of Ultrasonic velocity with mole fraction

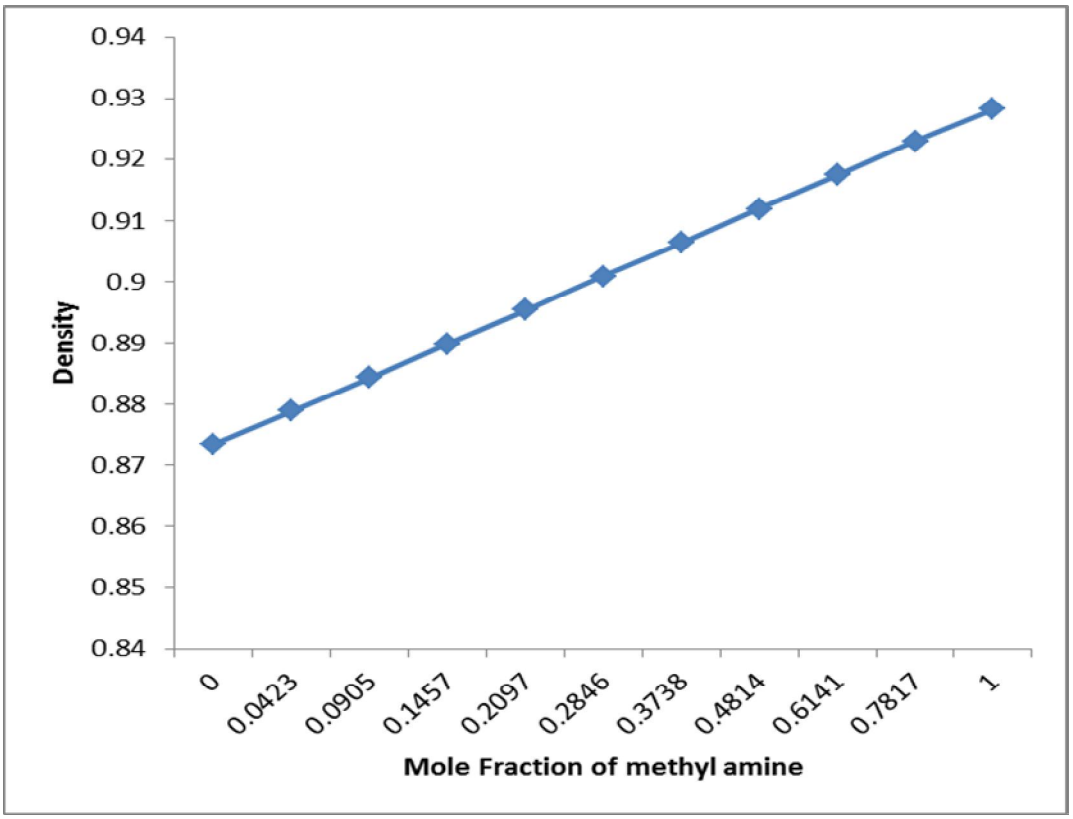

Fig. 2: Variation of density with mole fraction.

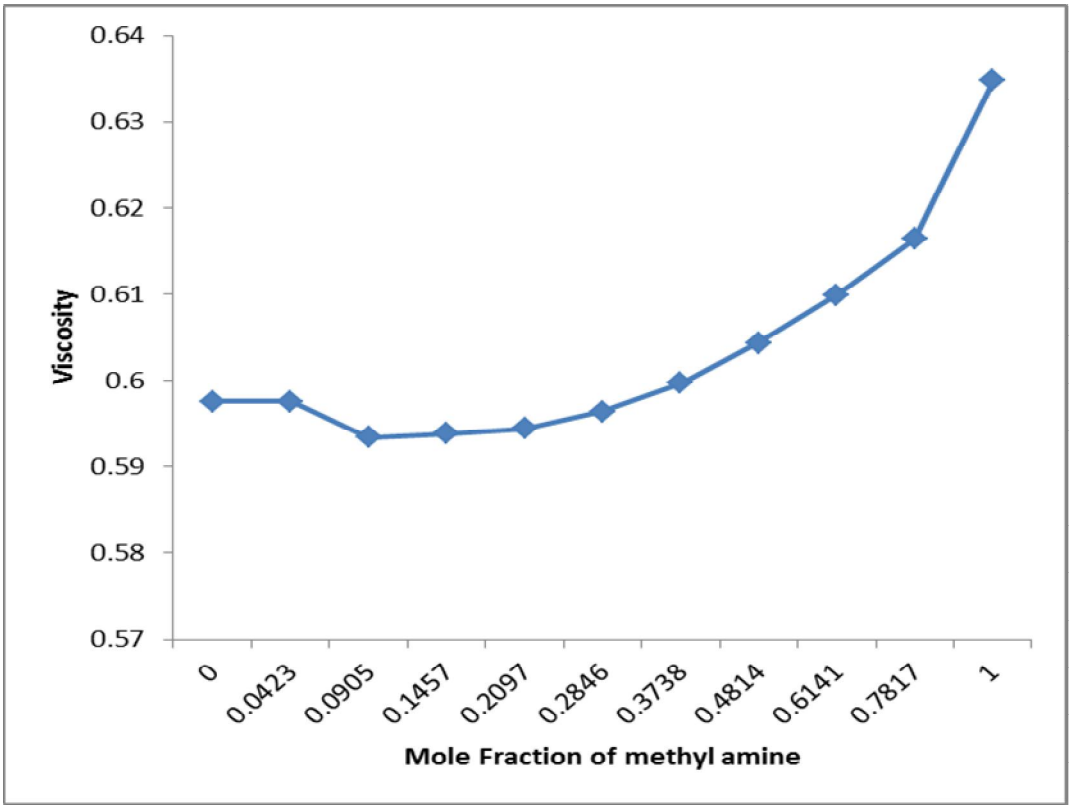

Fig. 3: Variation of viscosity with mole fraction.

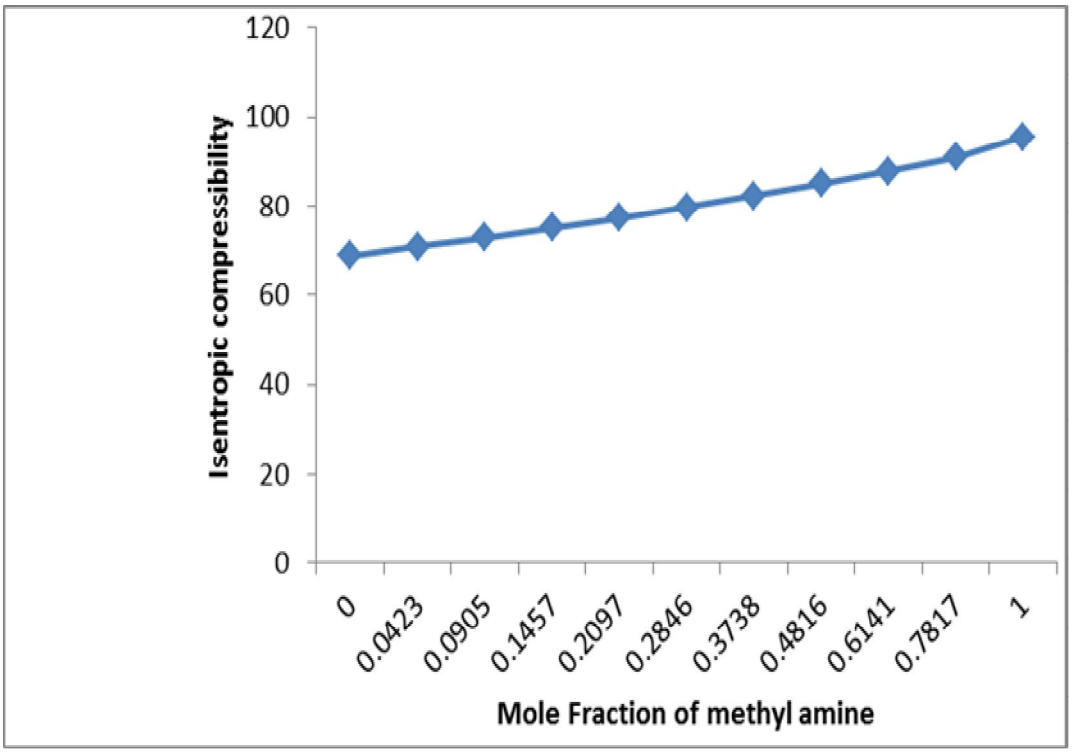

Fig. 4: Variation of isentropic compressibility with mole fraction.

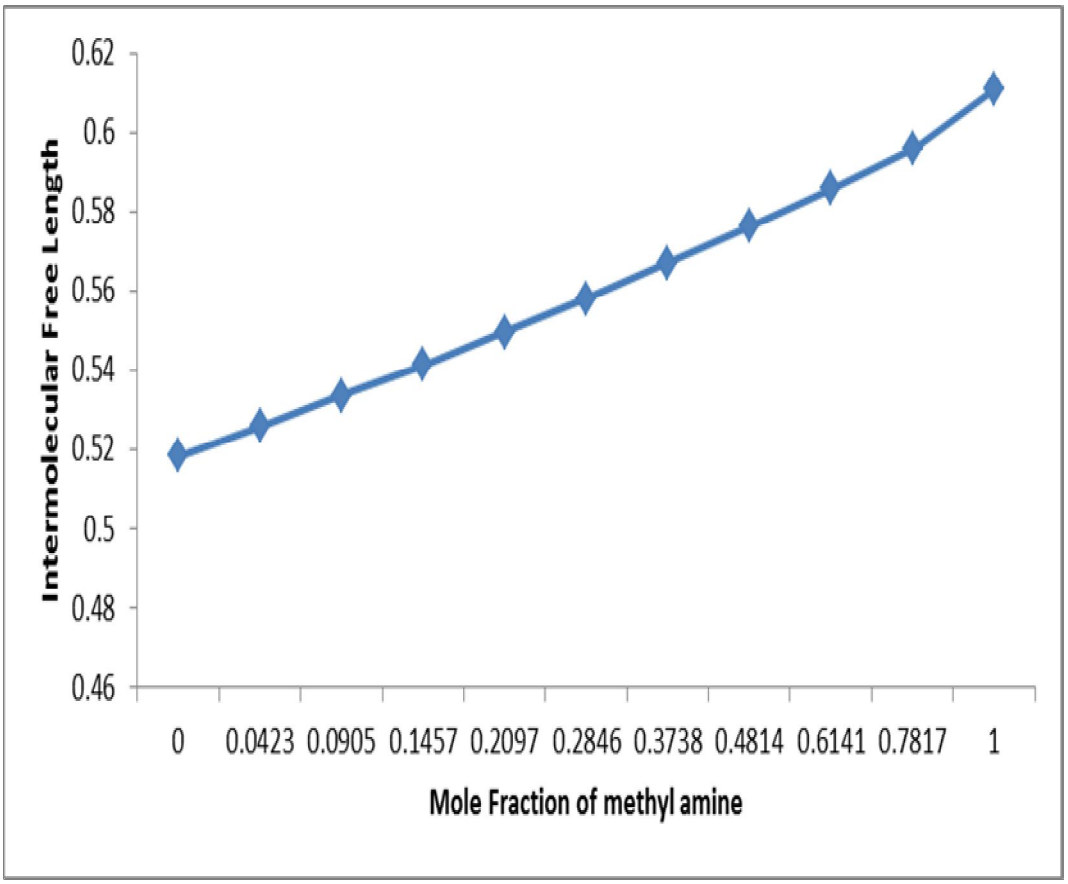

Fig. 5: Variation of intermolecular free length with mole fraction.

RESULTS AND DISCUSSION

The experimentally measured values of ultrasonic velocity, density and viscosity for pure liquids at 306K are presented in Table-1. Experimental values of ultrasonic velocity, density and viscosity for binary mixture at 306K 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 306K 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 306K are shown in Fig. 4 and 5 respectively.

From Table-2 it is observed that, the ultrasonic velocity (v), density (ρ) and viscosity (η) decreases with increase in mole fraction for propyl amine and benzene system. 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 benzene 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 benzene and methyl amine molecules.

CONCLUSION

From ultrasonic velocity, related acoustic parameters forPropyl amine with benzene for various concentration at 306K, it has been found that there exists a dipole-induced dipole interaction between propyl amine and benzene.

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