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ORIGINAL ARTICLE

Thermo-Acoustic Molecular Interaction Studies in Binary Liquid Mixtures of Methyl Amine and Ortho Xylene using Ultrasonic Technique at 298K

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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 methyl 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 (βs) and intermolecular free length (Lf) are evaluated at the temperature 298K. The present paper represents the nonlinear variation of ultrasonic velocity and thermo-acoustical parameters lead to dipole-induced dipole interaction between methyl 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.

Key word: *ultrasonic velocity, acoustical parameters, molecular interaction, methyl amine, o-xylene.*

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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 decreases 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, 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 methyl amine +o-xylene at 298K. From the measured data, thermo-acoustical parameters have been computed and the results are analysed in the light of molecular interaction.

MATERIALS AND METHODS

Methyl 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 ±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:

$$Bs = 1/v2\rho \quad \text{....(1)}$$

Intermolecular free length (Lf) has been determined as:

$$Lf = KT(\beta s)1/2 \quad \text{....(2)}$$

Where KT is a Jacobson's constant.

Table 1: Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) of pure liquids at 298K

Liquid	Ultrasonic Velocity	Density	Viscosity
Methyl amine	1062	0.9282	0.6348
Ortho Xylene	1344	0.8865	0.7784

Table 2: Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) for the binary liquid mixture of methyl amine and o-xylene at 298K

Mole Fraction of Methyl Amine (X1)	Ultrasonic Velocity (v) ms-1	Density (ρ) Gml-1	Viscosity (η) Cp
0.0000	1344	0.8865	0.7784
0.0315	1316	0.8907	0.7663
0.0628	1288	0.8947	0.7589
0.1115	1260	0.8991	0.7518
0.1633	1232	0.9033	0.7442
0.2264	1204	0.9075	0.7349
0.3051	1176	0.9117	0.7242
0.4058	1148	0.9159	0.7109
0.5394	1120	0.9202	0.6933
0.7249	1092	0.9243	0.6692
1.0000	1062	0.9282	0.6348

Table 3: Experimental values of isentropic compressibility (βs) and intermolecular free length (Lf) for the binary liquid mixture of methyl amine and o-xylene at 298K

Mole Fraction of methyl amine X1	Isentropic Compressibility (β) Cm2dyne-1x1012	Intermolecular Free length (Lf) A0
0.0000	62.45	0.4939
0.0315	64.83	0.5032
0.0628	67.36	0.5130
0.1115	70.06	0.5231
0.1633	72.94	0.5338
0.2264	76.02	0.5449
0.3051	79.31	0.5566
0.4058	82.85	0.5689
0.5394	86.64	0.5818
0.7249	90.73	0.5953
1.0000	95.52	0.6108

Fig. 1-5 shows variation of ultrasonic velocity (v), density (ρ), viscosity (η), isentropic compressibility (βs) and intermolecular free length (Lf) with respect to mole fraction at temperature 298K.

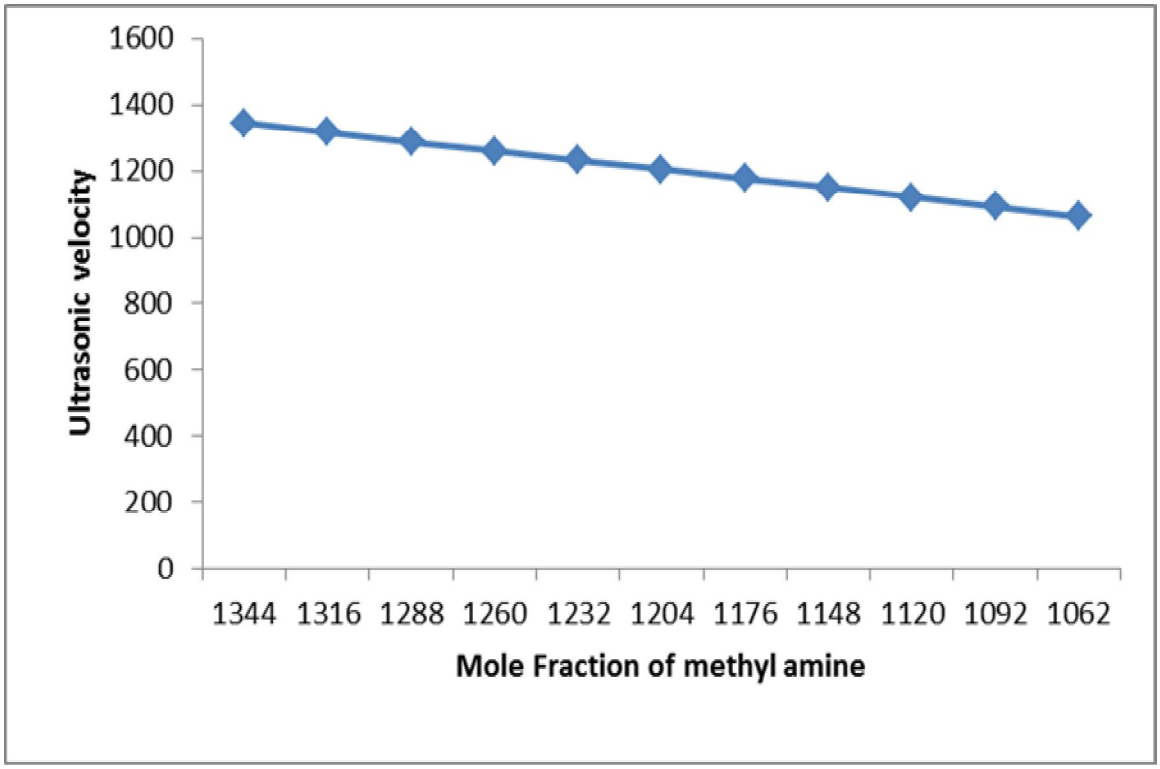

Fig. 1: Variation of ultrasonic velocity with mole fraction

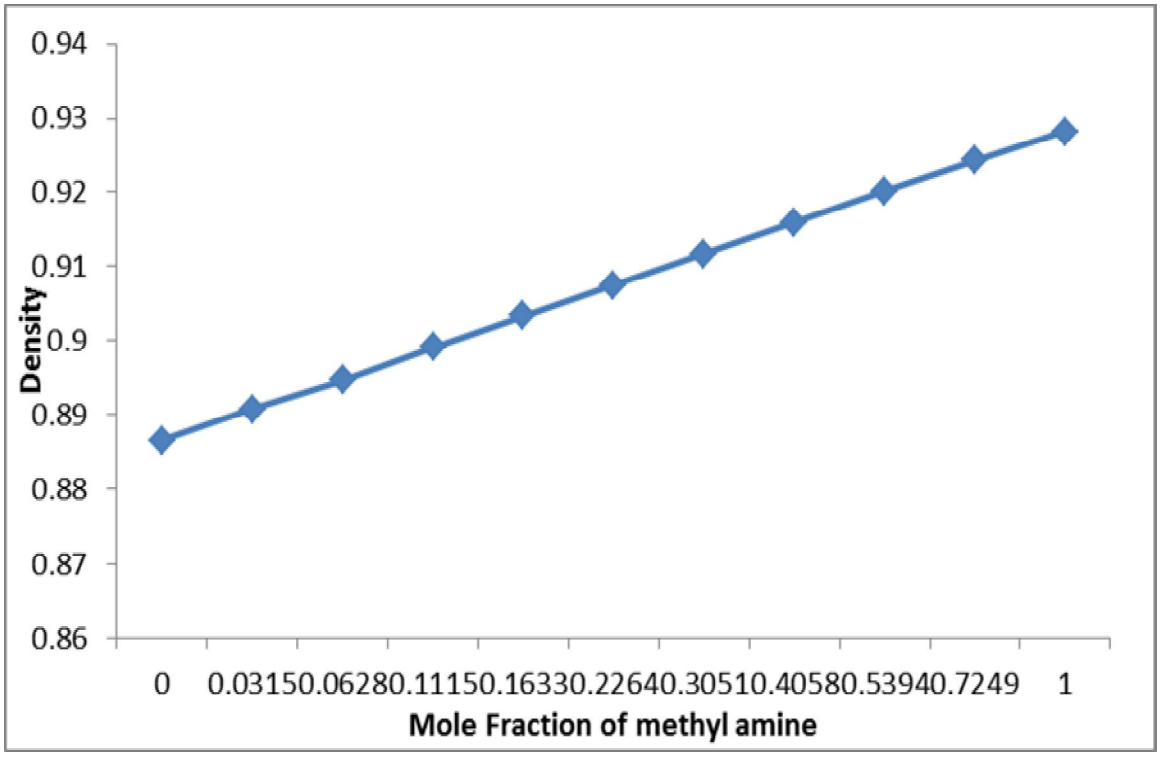

Fig. 2: Variation of density with mole fraction

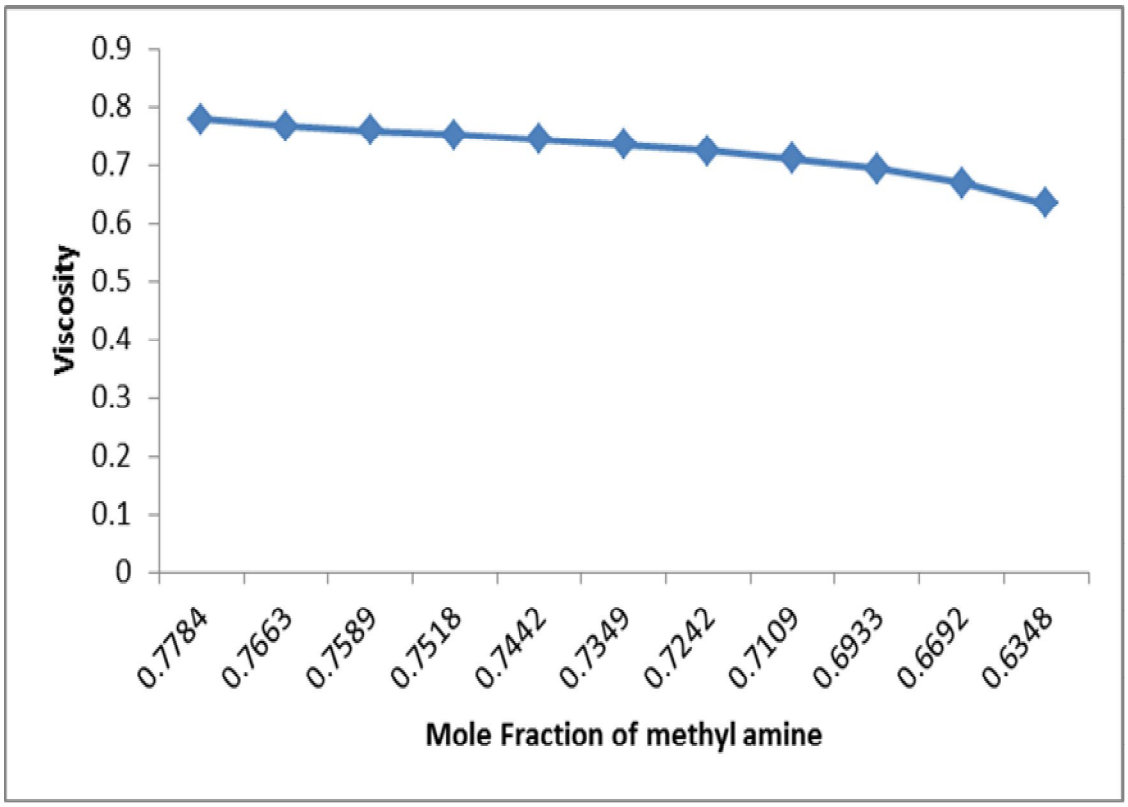

Fig. 3: Variation of viscosity with mole fraction

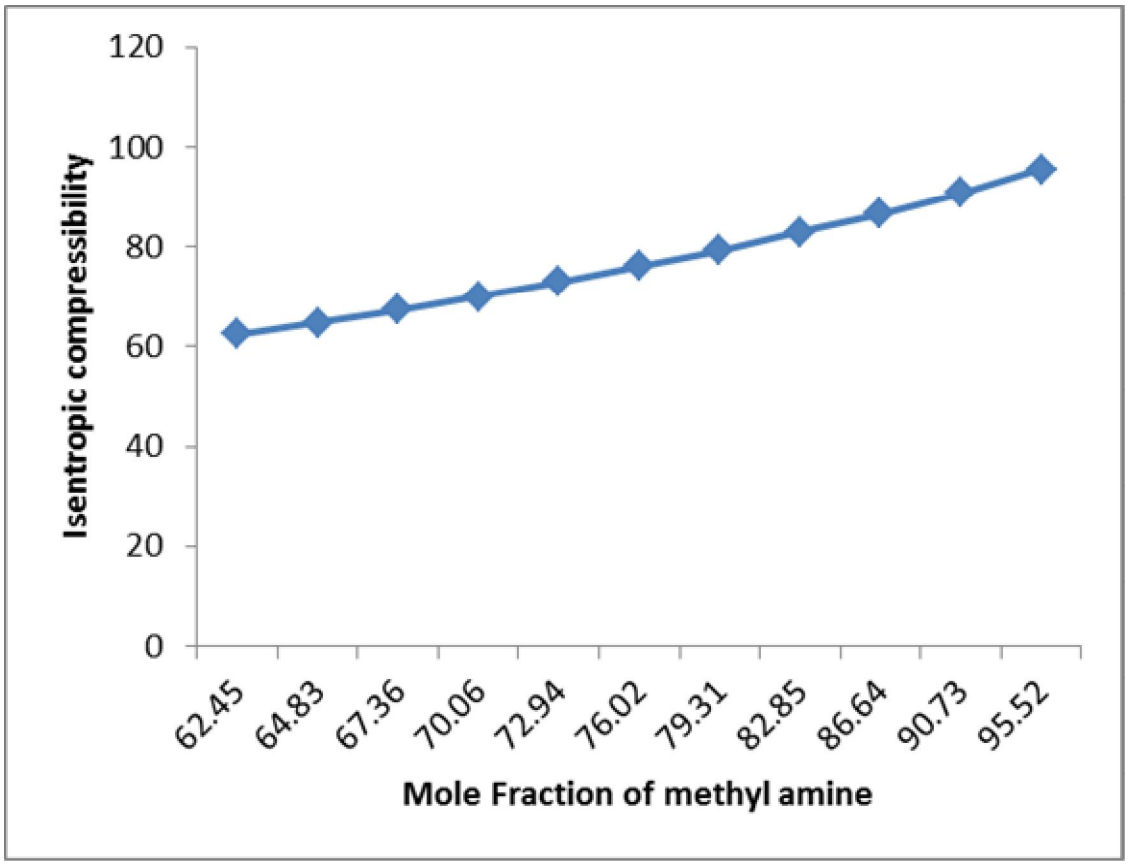

Fig. 4: Variation of isentropic compressibility with mole fraction.

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 298K are presented in Table 1. Experimental values of ultrasonic velocity, density and viscosity for binary mixture at 298K are given in Table 2. The thermodynamic parameters such as isentropic compressibility (βs) and intermolecular free length (Lf) are listed in Table 3. The variation of ultrasonic velocity, density and viscosity at 298K are shown in Fig. 1, 2 and 3 respectively. While other thermodynamic parameters such as isentropic compressibility (βs) and intermolecular free length (Lf) at 298K are shown in Fig. 4 and 5 respectively.

From Table 2 it is observed that, the density (ρ) increases with increase in mole fraction for methyl amine and o-xylene system while viscosity (η) decreases with increase in mole fraction 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 o-xylene is non-polar molecule does not possess dipole moment, when it interacts with methyl amine which is polar molecule possess dipole moment then o-xylene possess induced dipole moment. This induced dipole-dipole interaction between benzene and methyl amine molecules.

CONCLUSION

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

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