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RESEARCH ARTICLE

Thermo-Acoustic Molecular Interaction Studies in Binary Liquid Mixtures of Methyl Amine and Benzene Using Ultrasonic Technique at 303K

K.Y. Singh[1*] and R.C. Verma[2]
[*1]Department of Physics, B.S.A. College, Mathura, India
[2]Deptt.of Chemistry, Janta College, Bakewar (U.P.) India
*Corresponding Author's Email: drkysingh @gmail.com

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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 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 (Lf) are evaluated at the temperature 303K. The present paper represents the nonlinear variation of ultrasonic velocity and thermo-acoustical parameters lead to dipole-induced dipole interaction between methyl 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 words: *ultrasonic velocity, acoustical parameters, molecular interaction, methyl amine, benzene*

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 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 and Benzene at 303K. 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 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) using the equation as:

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

Intermolecular free length (Lf) has been determined as:

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

Where KT is a Jacobson's constant.

Table 1: Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) of pure liquids at 303K

Liquid	Ultrasonic Velocity	Density	Viscosity
Methyl amine	1050	0.9108	0.6105
Benzene	1275	0.8682	0.5976

Table 2: Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) for the binary liquid mixture of methyl amine and benzene at 303K.

Mole Fraction of methyl amine (X1)	Ultrasonic Velocity (v) ms-1	Density (ρ) Gml-1	Viscosity (η) Cp
0.0000	1275	0.8682	0.5976
0.0423	1253	0.8725	0.5976
0.0905	1231	0.8768	0.5952
0.1457	1209	0.8811	0.5945
0.2097	1187	0.8854	0.5940
0.2846	1165	0.8897	0.5952
0.3738	1143	0.8940	0.5977
0.4814	1121	0.8983	0.6014
0.6141	1099	0.9026	0.5903
0.7817	1077	0.9069	0.6054
1.0000	1050	0.9108	0.6105

Table 3: Experimental values of isentropic compressibility (βs) and intermolecular free length (Lf) for the binary liquid mixture of methyl amine and benzene at 303K.

Mole Fraction of methyl amine X1	Isentropic Compressibility (β) Cm2dyne-1x1012	Intermolecular Free length (Lf) A0
0.0000	70.85	0.5311
0.0423	73.00	0.5391
0.0905	75.26	0.5474
0.1457	77.65	0.5560
0.2097	80.16	0.5649
0.2846	82.81	0.5742
0.3738	85.62	0.5839
0.4814	88.59	0.5939
0.6141	91.70	0.6043
0.7817	95.06	0.6152
1.0000	99.59	0.6297

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 303K 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 303K are shown in Fig. 1, 2 and 3 respectively. While other thermodynamic parameters such as isentropic compressibility (βs) and intermolecular free length (Lf) at 303K are shown in Fig. 4 and 5 respectively. Fig. 1-5 shos variation of ultrasonic velocity (v), density (ρ), viscosity (η), isentropic compressibility (βs) and intermolecular free length (Lf) with respect to mole fraction at temperature 303K.

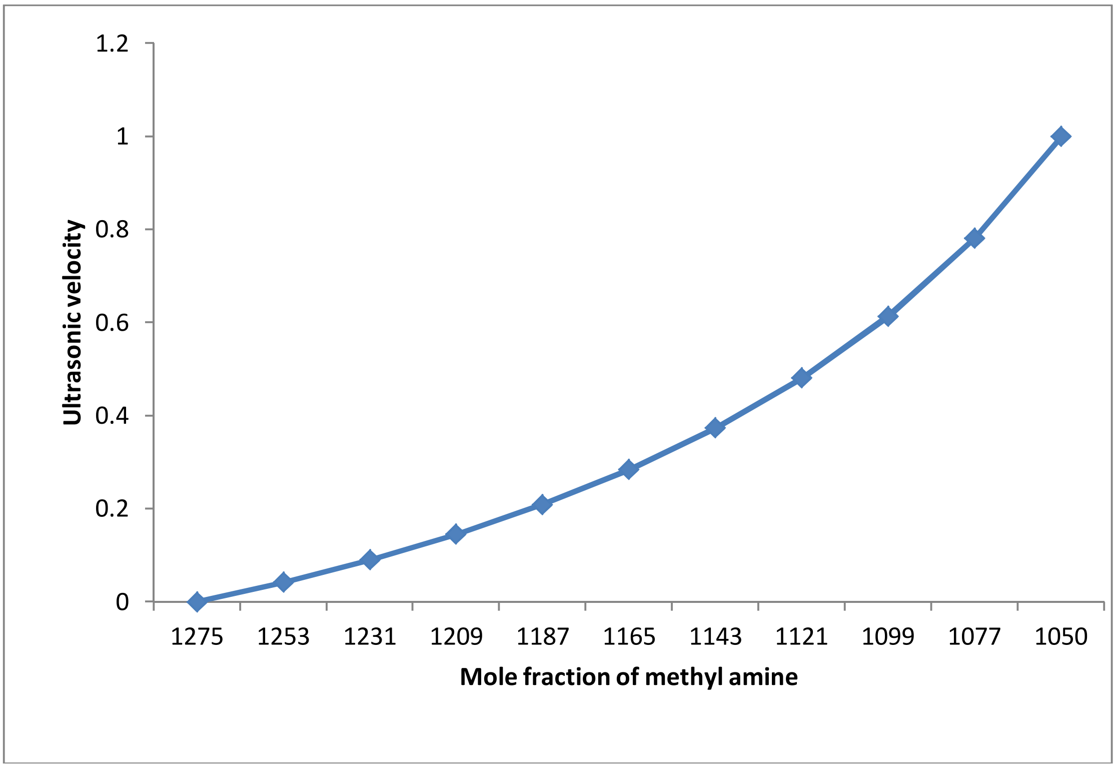

Fig.1: Variation of Ultrasonic velocity with mole fraction

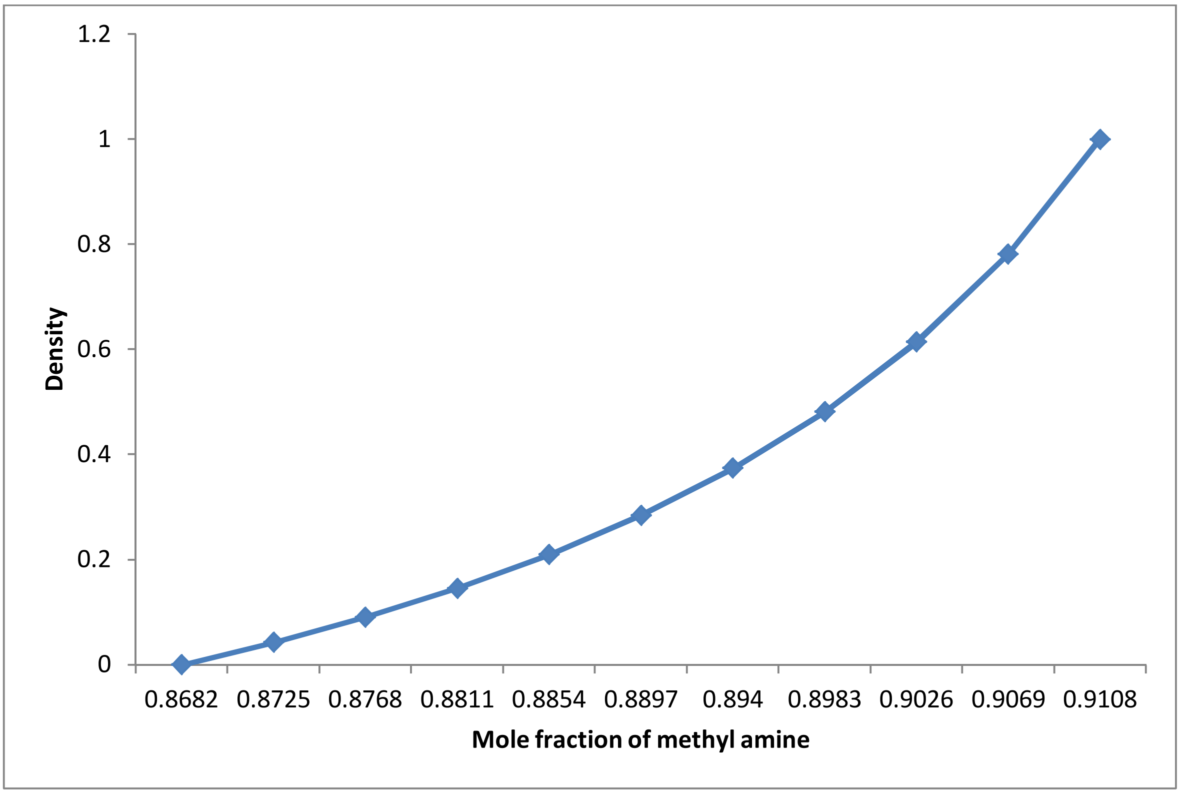

Fig.2: Variation of density with mole fraction.

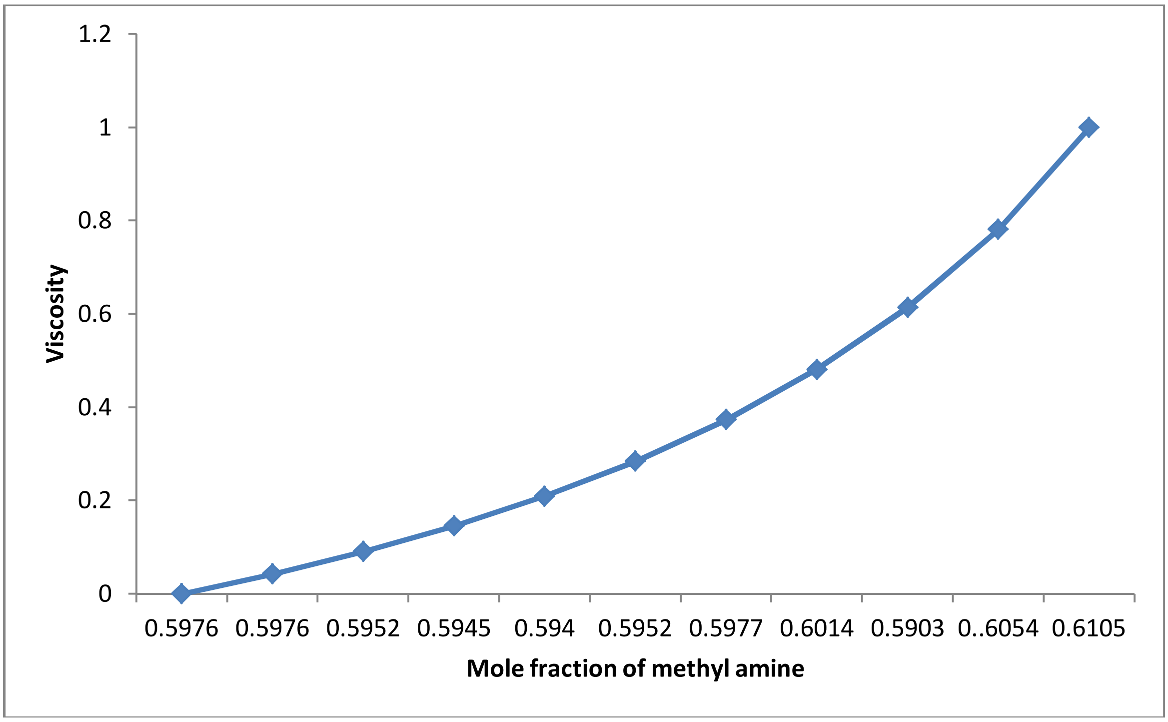

Fig. 3: Variation of viscosity with mole fraction

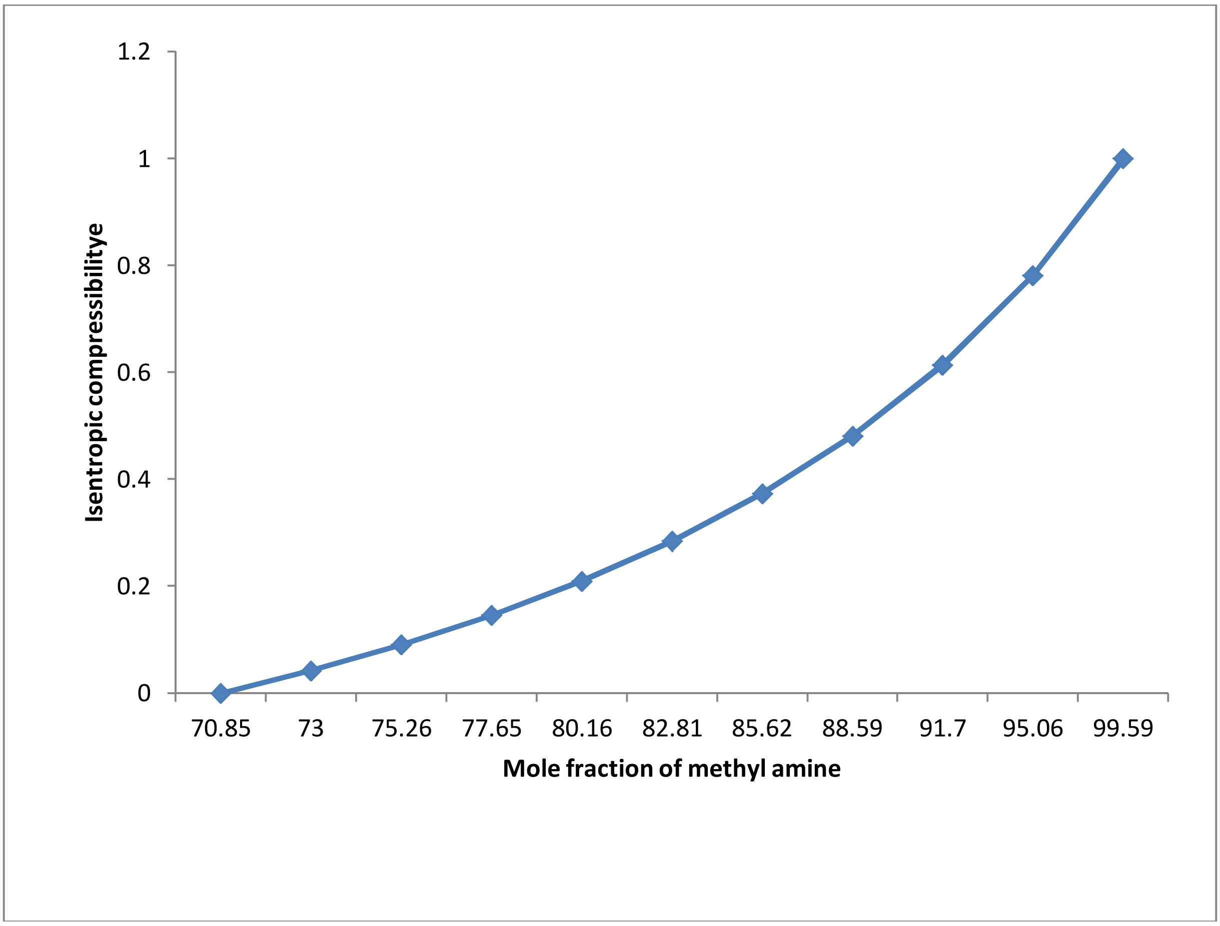

Fig. 4: Variation of isentropic compressibility with mole fraction.

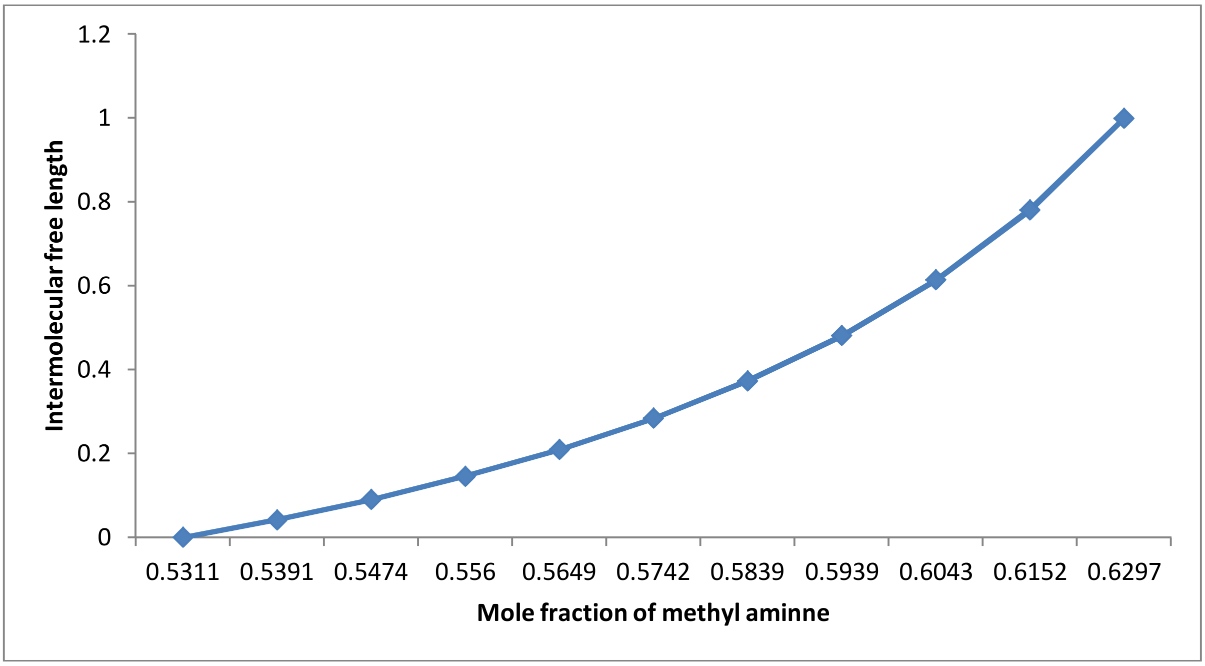

Fig. 5: Variation of intermolecular free length with mole fraction

From Table-2 it is observed that, the density (ρ) and viscosity (η) increases with increase in mole fraction for methyl amine and benzene 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 benzene is non-polar molecule does not possess dipole moment, when it interacts with methyl 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 for methyl amine with benzene for various concentrations at 303K, it has been found that there exists a dipole-induced dipole interaction between methyl amine and benzene.

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