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ORIGINAL ARTICLE

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

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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 propylamine 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 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 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.

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) using the equation as:

$$Bs = 1/v^2\rho \quad \text{..... 1}$$

Intermolecular free length (L_f) has been determined as:

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

Where KT is a Jacobson's constant.

Table1: Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) of pure liquids at 301K

Liquid	Ultrasonic Velocity (v) ms^{-1}	Density (ρ) gml^{-1}	Viscosity (η) cp
Propyl amine	1160	0.8096	0.3780
Benzene	1294	0.8690	0.5610

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

Mole Fraction of methyl amine (X1)	Ultrasonic Velocity (v) ms^{-1}	Density (ρ) gml^{-1}	Viscosity (η) cp
0.0000	1294	0.8690	0.5610
0.1316	1276	0.8448	0.5381
0.2613	1258	0.8215	0.5152
0.3890	1241	0.7988	0.4924
0.5148	1224	0.7765	0.4697
0.6388	1208	0.7556	0.4469
0.7610	1192	0.7359	0.4240
0.8813	1176	0.7170	0.4011
1.0000	1160	0.8096	0.3780

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

Mole Fraction of Propyl amine X1	Isentropic Compressibility(βs) $Cm^2dyne\text{-}1x10^{12}$	Intermolecular Free length (L_f) A^0
0.0000	68.72	0.5205
0.1316	72.70	0.5372
0.2613	76.91	0.5537
0.3890	81.28	0.5700
0.5148	85.95	0.5861
0.6388	90.69	0.6018
0.7610	95.63	0.6174
0.8813	100.84	0.6322
1.0000	106.47	0.6429

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.

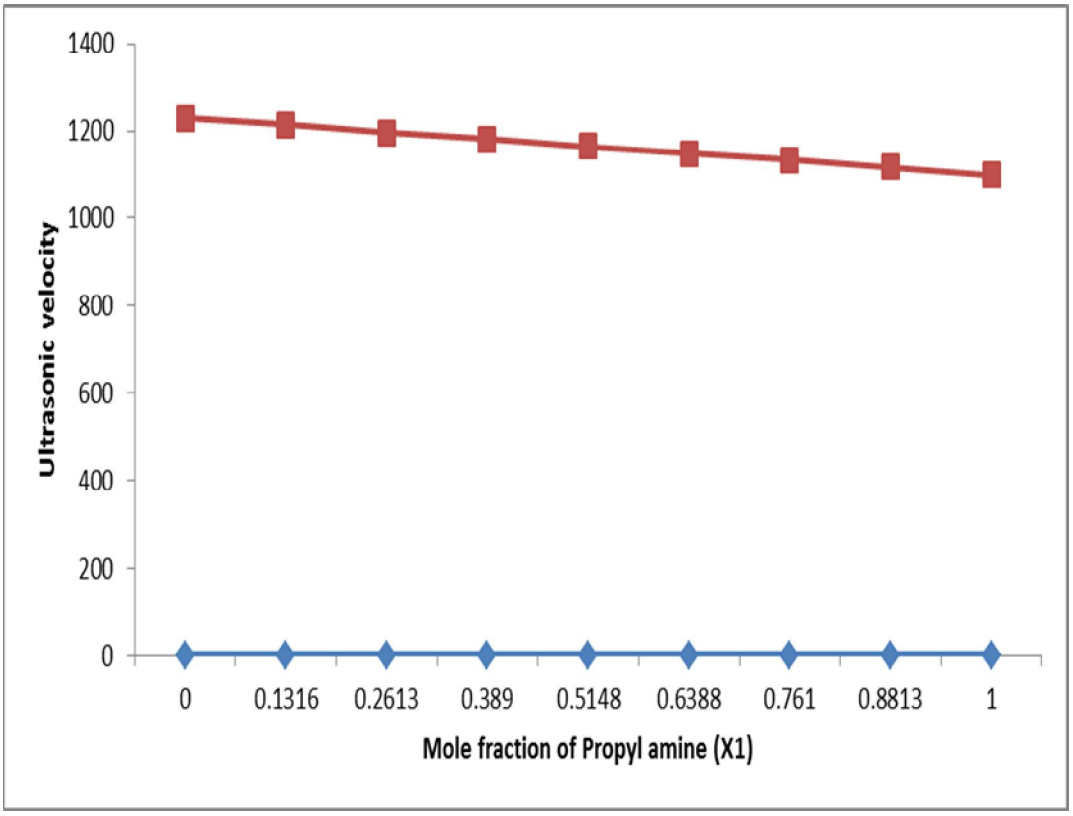

Fig. 1: Variation of Ultrasonic velocity with mole fractions

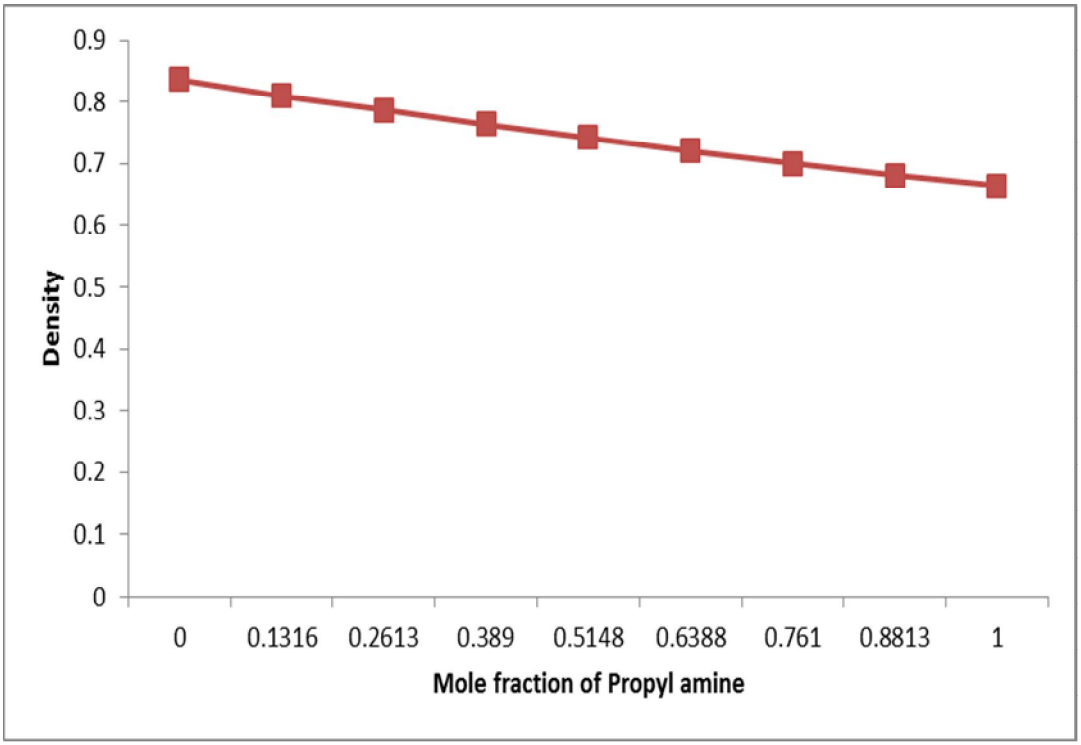

Fig. 2: Variation of density with mole fraction

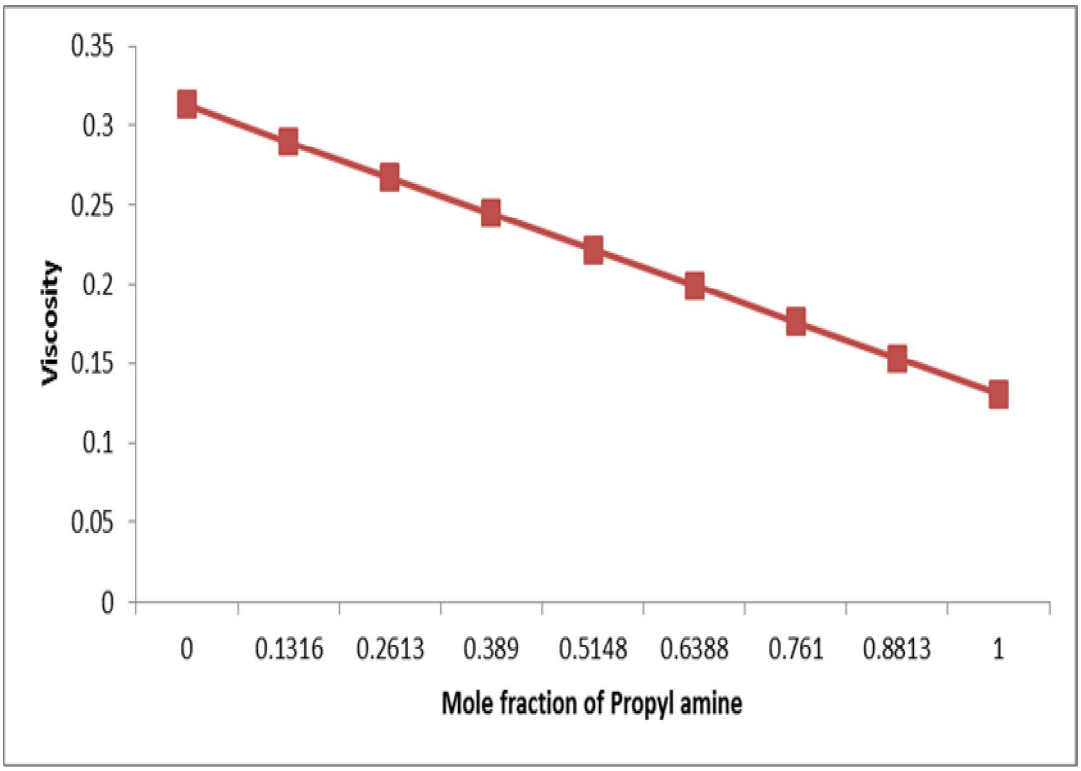

Fig. 3: Variation of viscosity with mole fraction.

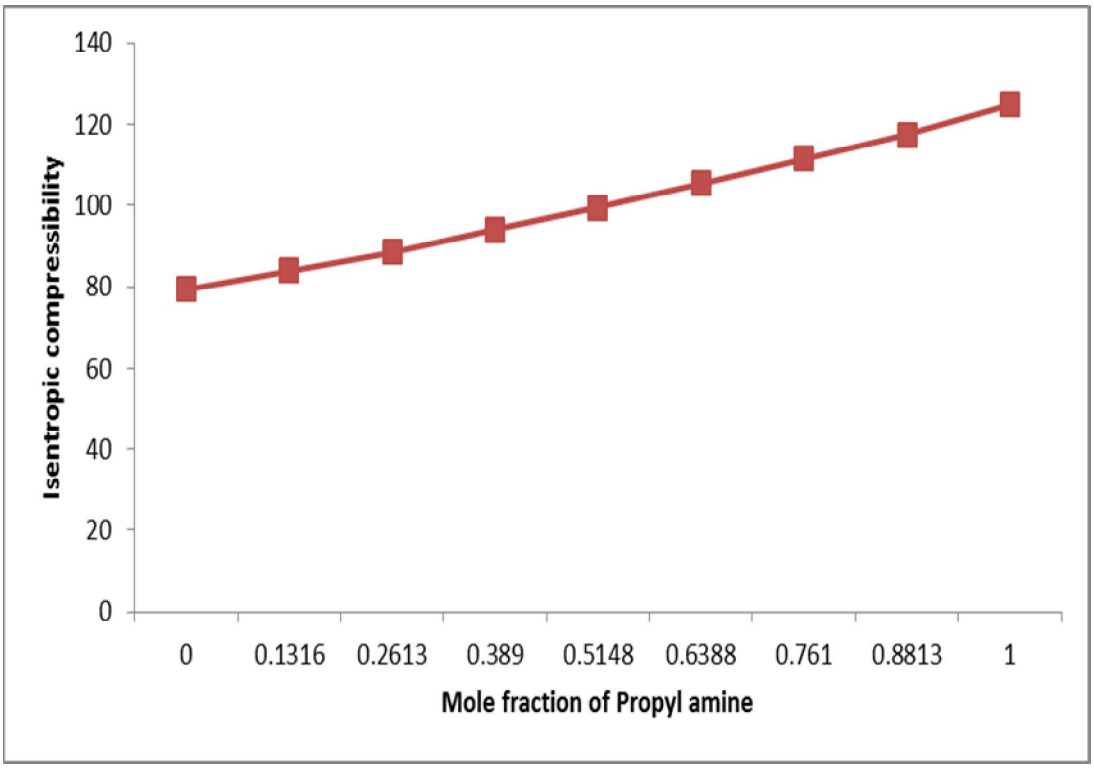

Fig. 4: Variation of isentropic compressibility with mole fraction.

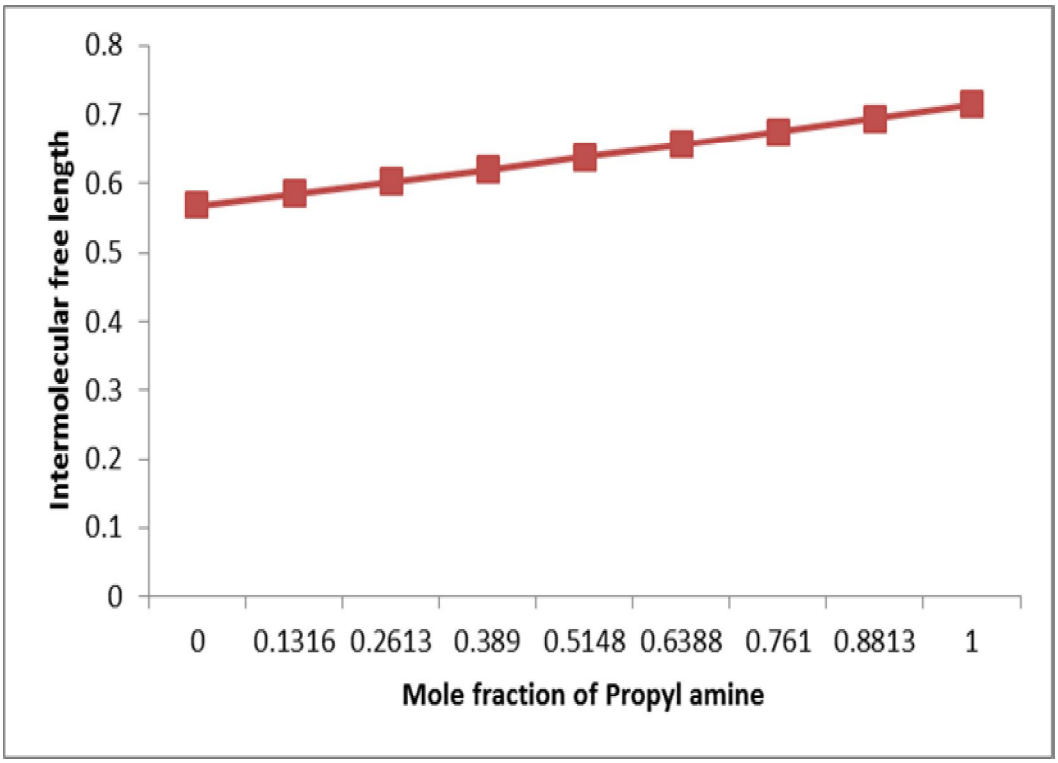

Fig. 5: Variation of intermolecular free length with mole fraction.

RESULTS AND DISCUSSION

The experimentally measured values of ultrasonic velocity, density and viscosity for pure liquids at 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.

From Table-2 it is observed that, the ultrasonic velocity (v), density (ρ) and viscosity (η) dencreases with increase in mole fraction for propyl amine and benzene system. 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 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 propyl amine with benzene for various concentrations at 301K, it has been found that there exists a dipole-induced dipole interaction between propyl amine and benzene.

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