THERMO-ACOUSTIC MOLECULAR INTERACTION STUDIES IN BINARY LIQUID MIXTURES OF PROPYL AMINE AND TOLUENE USING ULTRASONIC TECHNIQUE AT 311K.

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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 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 311K. 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.

Keyword: ultrasonic velocity, acoustical parameters, molecular interaction, propyl amine, toluene.

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 (Largemann and Dumbar *(1992))* .

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 (Verma et al (2018)).

In the present study ultrasonic velocity, density and viscosity were measured experimentally for binary system namely propyl amine + toluene at 311K. From the measured data , thermo-acoustical parameters have been computed and the results are analyzed in the light of molecular interaction.

MATERIALS AND METHODS

Propyl amine and toluene 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:

$$Bs = 1/v2\rho \qquad (1)$$

Intermolecular free length (Lf) has been determined as:

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

Where KT is a Jacobson's constant.

Table-1: Experimental values of ultrasonic velocity (v),density (ρ) and viscosity (η) of pure liquids at 311K.

Liquid	Ultrasonic Velocity	Density	Viscosity
Propyl amine	1098	0.6640	0.1310
Toluene	1220	0.8232	0.3050

Table-2: : Experimental values of ultrasonic velocity (v),density (ρ) and viscosity (η) for the binary liquid mixture of propyl amine and toluene at 311K.

Mole Fraction of propyl amine (X_1)	Ultrasonic Velocity (v) ms-1	Density (ρ) Gml-1	Viscosity (η) Cp
0.0000	1220	0.8232	0.3050
0.1535	1206	0.7987	0.2791
0.2973	1190	0.7767	0.2552
0.4323	1174	0.7558	0.2330
0.5593	1160	0.7327	0.2111
0.6790	1144	0.7161	0.1899
0.7920	1130	0.6974	0.1688
0.8988	1115	0.6793	0.1493
1.0000	1098	0.6640	0.1310

Table-3: Experimental values of isentropic compressibility (βs) and intermolecular free length (L_f) for the binary liquid mixture of propyl amine and toluene at 311K.

Mole Fraction Of propyl amine X_1	Isentropic Compressibility(β) Cm2dyne-1x1012	Intermolecular Free length (Lf) A0
0.0000	81.61	0.5972
0.1535	86.08	0.5928
0.2973	90.91	0.6092
0.4323	95.99	0.6260
0.5593	101.42	0.6435
0.6790	106.70	0.6600
0.7920	112.29	0.6771
0.8988	118.41	0.6953
1.0000	124.91	0.7141

Graphs: 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 311K.

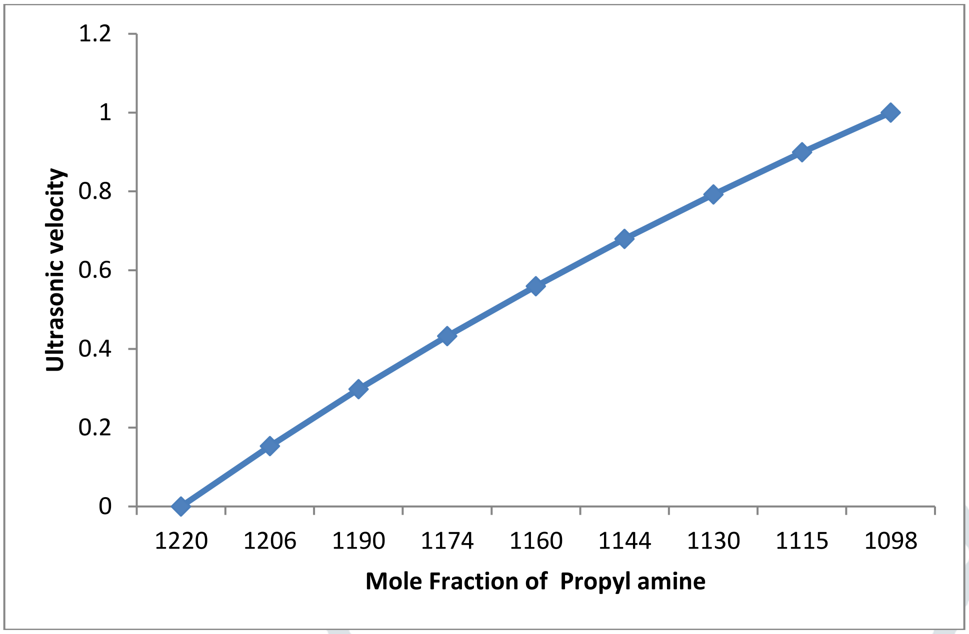

Fig.1: Variation of Ultrasonic velocity with mole fraction.

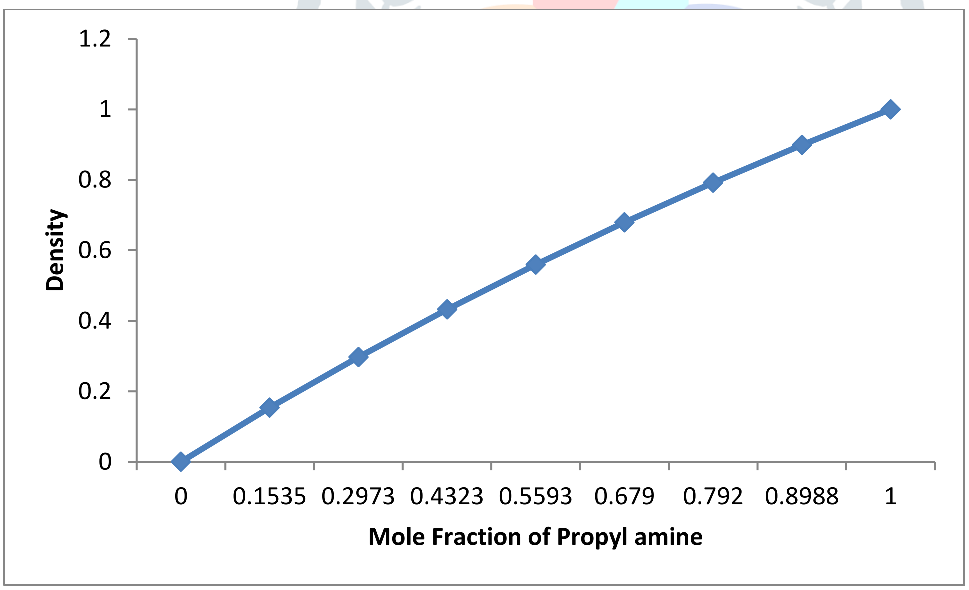

Fig.2: Variation of density with mole fraction.

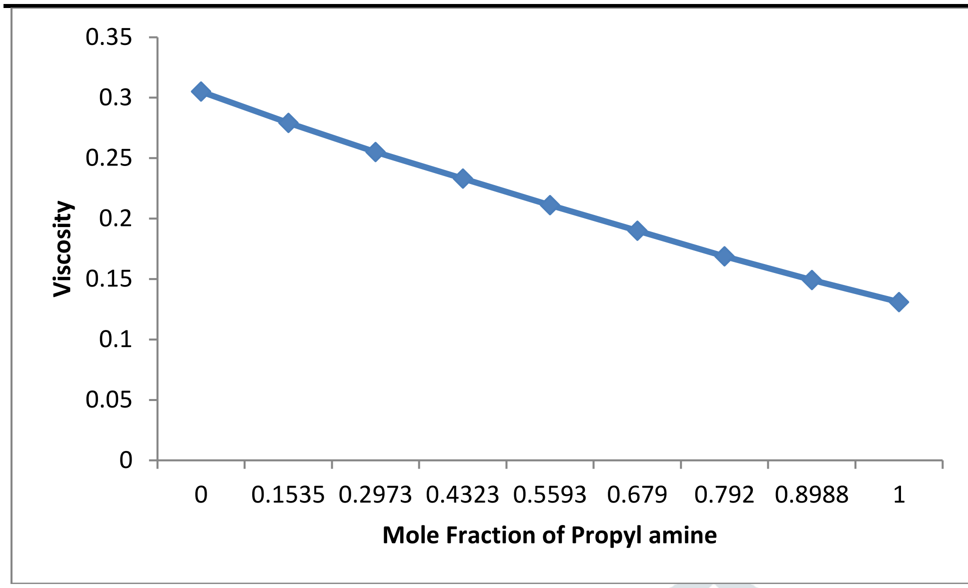

Fig.3:Variation of viscosity with mole fraction.

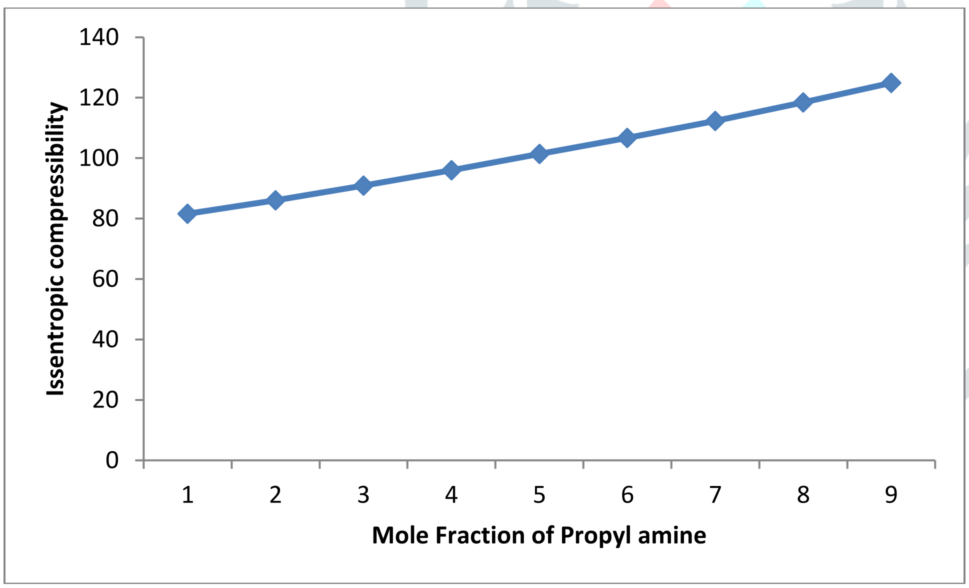

Fig.4: Variation of isentropic compressibility with mole fraction.

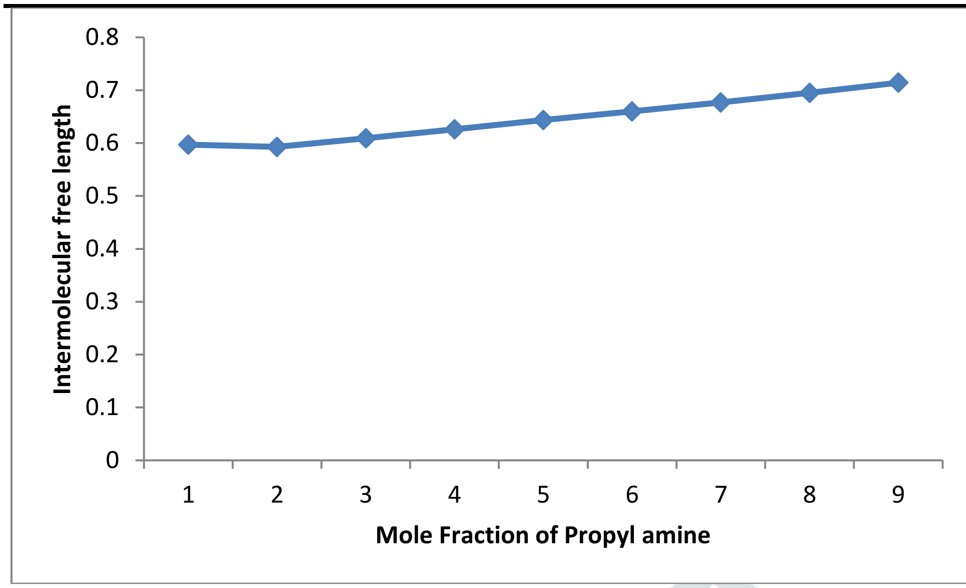

Fig.5: Variation of intermolecular free length with mole fraction.

RESULTS AND DISCUSSION

The experimentally measured values of ultrasonic velocity, density and viscosity for pure liquids at 311K are presented in Table-1. Experimental values of ultrasonic velocity , density and viscosity for binary mixture at 311K 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 311K 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 311K are shown in Fig. 4 and 5 respectively.

From Table-2 it is observed that , the density (ρ) and viscosity (η) increases with increase in mole fraction for propyl amine and toluene system and ultrasonic velocity (v) decreases with increasing mole fraction. 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 toluene is non-polar molecule does not possess dipole moment, when it interacts with propyl amine which is polar molecule possess dipole moment then toluene 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 concentration at 311K, it has been found that there exists a dipole-induced dipole interaction between propyl amine and toluene.

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