JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

THERMO-ACOUSTIC MOLECULAR INTERACTION STUDIES IN BINARY LIQUID MIXTURES OF ACETONE AND BENZALDEHYDE USING ULTRASONIC TECHNIQUE AT 30^0C.

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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 acetone and benzaldehyde 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 30^0C. The present paper represents the nonlinear variation of ultrasonic velocity and thermo-acoustical parameters lead to dipole-induced dipole interaction between acetone and benzaldehyde 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, benzaldehyde, acetone.

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 (Kannappan 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 (Bhandarkar, 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 2018,2022)

In the present study ultrasonic velocity, density and viscosity were measured experimentally for binary system namely acetone and benzaldehyde at 30^0C. From the measured data, thermo-acoustical parameters have been computed and the results are analyzed in the light of molecular interaction.

MATERIALS AND METHODS

Acetone and benzaldehyde 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:

$$Bs = 1/v^2\rho \qquad (1)$$

Intermolecular free length (L_f) has been determined as:

$$L_f = KT(\beta s)^{1/2} \qquad (2)$$

Where KT is a Jacobson's constant.

Table-1: Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) of pure liquids at 30^0C.

Liquid	Ultrasonic Velocity (v) ms^{-1}	Density (ρ) gml^{-1}	Viscosity (η) cp
Acetone	1160	0.7774	0.3153
Benzaldehyde	1420	1.0357	1.2165

Table-2: Experimental values of ultrasonic velocity (v), density (ρ) and viscosity (η) for the binary liquid mixture of acetone and benzaldehyde at 30^0C.

Mole fraction of benzene (X_1)	Ultrasound Velocity (v) m/s	Density (ρ) gm/ml	Viscosity (Ƞ) Cp
0.0000	1420	1.0357	1.2165
0.1318	1384	1.0141	1.1972
0.2551	1352	0.9878	1.1525
0.3700	1328	0.9615	1.1225
0.4723	1296	0.9352	0.9065
0.5783	1272	0.9089	0.8110
0.6729	1248	0.8826	0.7532
0.7619	1224	0.8560	0.6866
0.8804	1198	0.8247	0.5507
0.9215	1176	0.8095	0.4541
1.0000	1160	0.7774	0.3153

Table-3: Experimental values of isentropic compressibility (βs) and intermolecular free length (Lf) for the binary liquid mixture of acetone and benzaldehyde at 30^0C.

Mole Fraction of benzene (X_1)	Isentropic Compressibility(βs) $Cm^2dyne\text{-}1x10^{12}$	Intermolecular Free length (L_f) A^0
0.0000	47.88	0.4366
0.1094	51.48	0.4527
0.2169	55.38	0.4695
0.3219	58.97	0.4825
0.4249	63.66	0.5034
0.5394	68.00	0.5203
0.6245	72.75	0.5381
0.7210	77.78	0.5561
0.8188	84.49	0.5799
0.9090	89.32	0.5963
1.0000	95.60	0.6169

Graphs: Fig. 1-5 shows 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 30^0C.

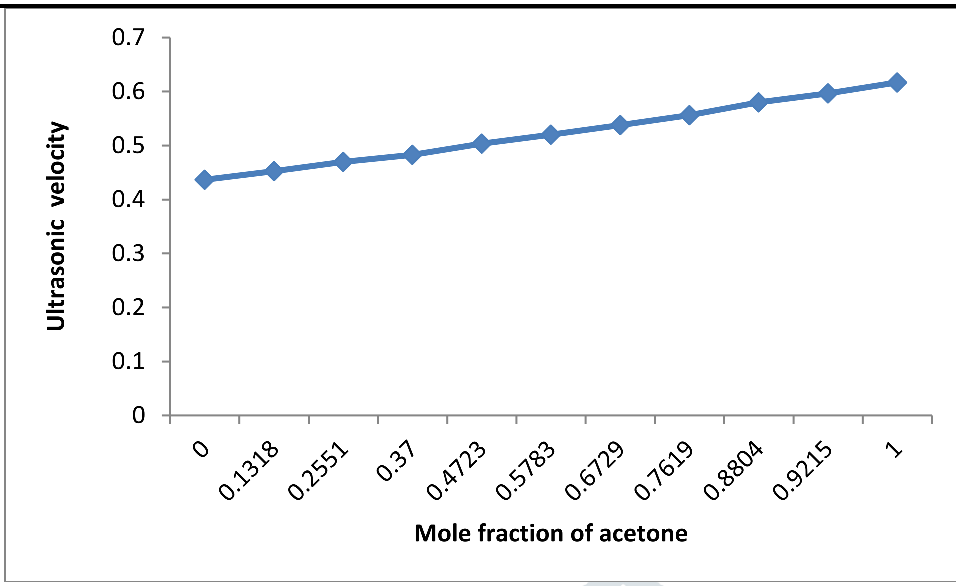

Fig.1: Variation of Ultrasonic velocity with mole fractions

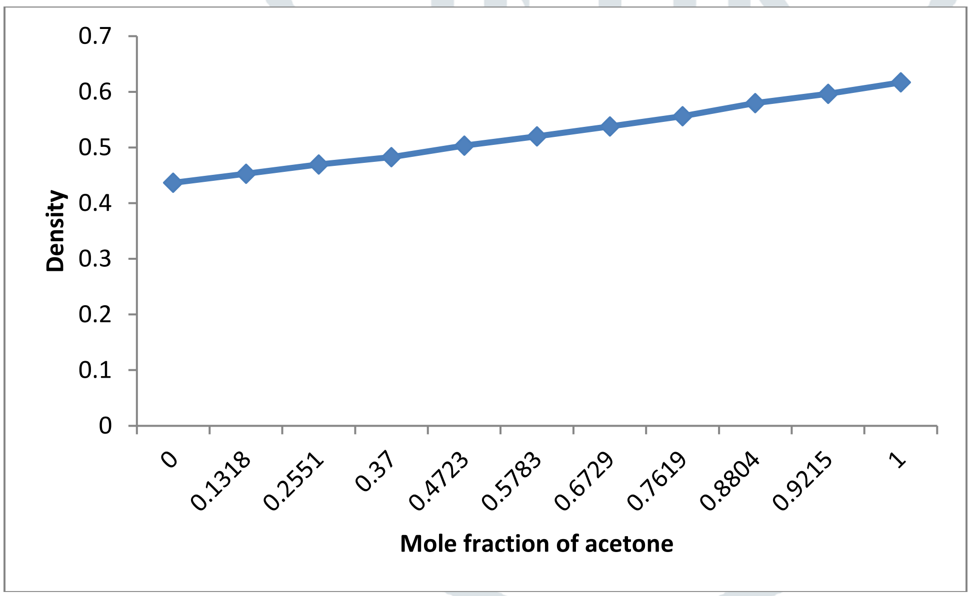

Fig.2: Variation of density with mole fraction.

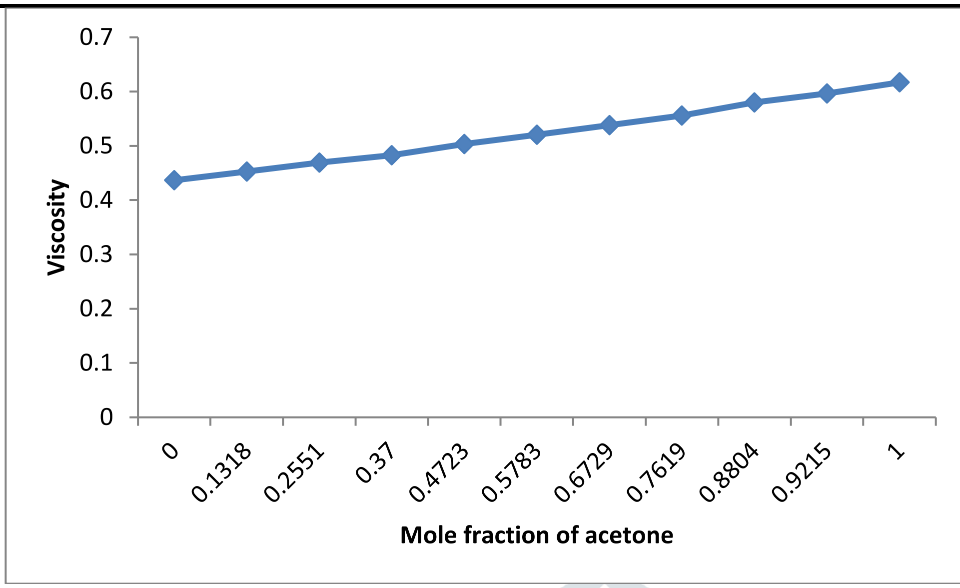

Fig.3: Variation of viscosity with mole fraction.

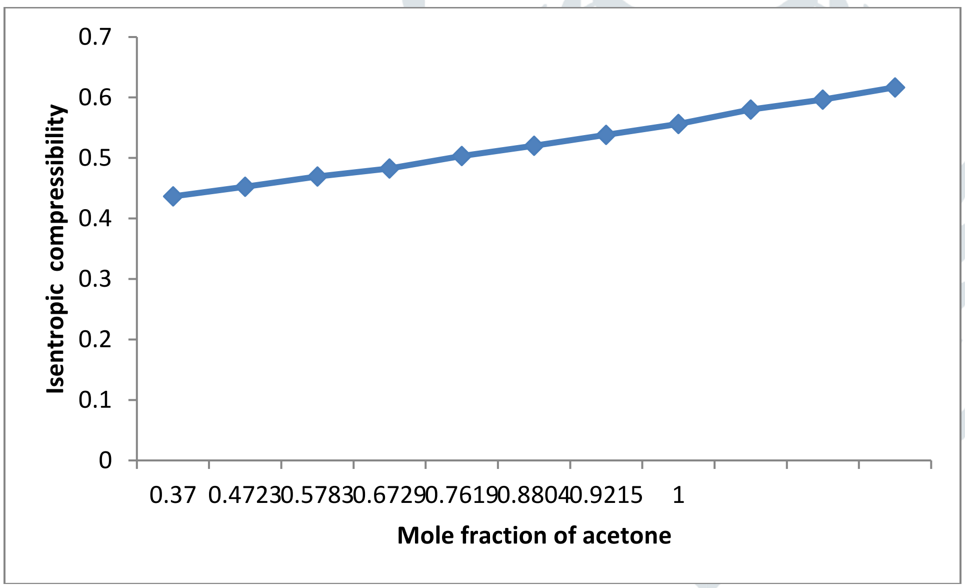

Fig.4: Variation of isentropic compressibility with mole fraction.

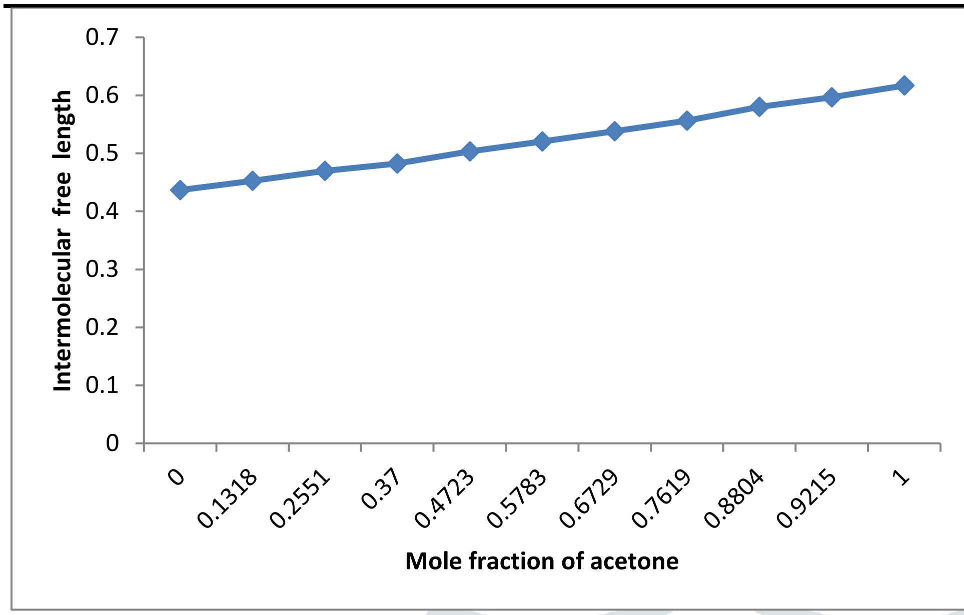

Fig.5: Variation of intermolecular free length with mole fraction.

RESULTS AND DISCUSSION

The experimentally measured values of ultrasonic velocity, density and viscosity for pure liquids at 35^0C are presented in Table-1. Experimental values of ultrasonic velocity, density and viscosity for binary mixture at 35^0C 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 35^0C 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 35^0C are shown in Fig. 4 and 5 respectively.

From Table-2 it is observed that, the ultrasonic velocity (v), density (ρ) and viscosity (η) decrease with increase in mole fraction for benzene and benzaldehyde system. The decrease in ultrasonic velocity is 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 benzaldehyde which is polar molecule possess dipole moment then benzene possess induced dipole moment. This induced dipole-dipole interaction between benzene and benzaldehyde molecules.

CONCLUSION

From ultrasonic velocity, related acoustic parameters for benzene with benzaldehyde for various concentration at 350C, it has been found that there exists a dipole-induced dipole interaction between benzene and benzaldehyde.

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