IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Study of some ultrasonic parameters of Substituted Schiff base in different alcohols at 303K

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I ABSTRACT

Ultrasonic wave propagation in medium affects physical properties and hence can furnish information about molecular interaction of liquid –liquid mixture .Ultrasonic velocity is an important physical parameter which mainly depends on molecular interaction .Densities and ultrasonic velocities of binary mixtures have been measured at 303 K. The observed data was utilized to calculate some ultrasonic parameters such as adiabatic compressibility, acoustic impedance, relaxation time intermolecular free length .The results obtained were discussed in terms of molecular interaction between components in liquid mixture .

Keywords:

Ultrasonic velocity, binary mixture, Acoustic impedance

II INTRODUCTION

Sound generated above human hearing range (Generally above 20 kHz) is termed as ultrasound. Although ultrasound behaves in a similar way manner to audible sound ,it has smaller wavelength .It means the waves can be reflected off very small surfaces such as defects inside the material . This property of ultrasound useful for non-destructive testing of material. Ultrasonic velocity is an important physical parameter having structural dependence [1-5.] The change in ultrasonic speed and related parameters enlighten the structural changes associated with the liquid mixture having strongly interacting components as well as weakly interacting components [6]

Many techniques have been applied to study molecular interactions such as spectroscopic and non spectroscopic [7]. The physical and chemical properties of polymers in solutions were studied by number of researchers [8,9] and they correlated the linear and non linear variation of ultrasound velocity ,density ,viscosity and other acoustic parameters .

Density, viscosity and ultrasonic speed, data provide umpteen information about the molecular interaction between ions, dipoles, hydrogen bonding, Vander Waals forces as well as multipolar and dispersive forces [10]

In present study measurement on ultrasonic velocity ,density and viscosity and other ultrasonic parameters were carried out in following binary mixtures at different concentration of 3,4,5trihydroxy bezohydrazide chloro imine (THBCI) at 303 K in methanol, ethanol and 1-propanol.

III LITERATURE REVIEW

Ultrasonic waves can produce physico - chemical effect, chemical effects, thermal effects and biological effects. Therefore ultrasonic waves are extensively employed in industrial applications. Now it's possible with ultrasonic waves to explore structures within shape painlessly, safely and at relatively low cost. it's possible to get pictorial cross section of the body, tumours, cysts etc. with these waves. Ultrasonic waves are used as a method of investigation in physical research, as modes of their propagation can yield information on the properties of media and their structure. Ultrasonic waves are widely employed in the study of binary liquid mixtures, critical liquid mixtures, liquid polymers and electrolytic solutions. Ultrasonic velocity measurements are accustomed study the character of molecular interactions in various pure liquids [11-13] liquid mixtures [14-21] and in solutions [22-28] However, little work has been done for some solutions [29-32], especially Schiff bases [33-35].

Dewan et al [36] measured ultrasonic velocity for number of binary mixtures at 303 K over entire composition range. Using experimental data, various ultrasonic parameters and excess parameters are computed. Flory's theory, Jacobson's FLT, CFT, Jaunjies empirical relation and Nomoto relation are used for theoretical evaluation of ultrasonic velocity.

Ultrasonic speed measurements have widely accustomed study pure [37] binary [38] furthermore as ternary [39] liquid mixtures and solute of salts in binary solvent systems. Among theories, it's very interesting those which give a physical aspiring to the parameters in their expression, allowing the understanding of molecular interactions and their organization within the fluid [40]

The ultrasonic measurements provide useful information regarding the molecular interactions in pure liquids, liquid mixtures and ionic interactions in pure liquids, liquid mixtures and ionic interactions in solutions comprising of either single or mixed solutes[41-44] The study of the answer properties of liquid mixtures consisting of polar furthermore as non - polar components finds applications in industrial and technological processes[45]
S.Raj Gopalan et al studied acoustic behaviour of cellulose ester in cyclohexanon[46]

IV EXPERIMENTAL SECTION

Reagents

All the chemicals used in this study are of AR grade. Methanol, Ethanol and 1-Propanol were refluxed and distilled before use.

Preparation of binary mixtures

The binary mixtures of different concentration were prepared for measurements. The binary liquid mixtures were preserved in well stoppered conical flasks. After mixing the liquids thoroughly, the flasks were left undisturbed to attain thermal equilibrium.

Measurement of Ultrasonic Velocity

The ultrasonic velocity was measured using Mittal Enterprise Interferometer (New Delhi) Model No F-81, operating at 2 MHz, respectively. Density was determined by the specific gravity method.

Viscosity was measured by Ostwald's viscometer method.

The ρ, η and U measurements were accurate to □0.1 kgm-3 , 0.01 mPas and □0.15%, respectively.

The molecular interactions are determined by measuring different parameters such as Adiabatic compressibility (β), free length (Lf), Acoustic impedance (Z) and Relaxation time (τ). These Parameters were measured by the standard procedures available in the literatures. The ultrasonic velocity of THBCL in methanol ,ethanol and 1 –propanol is given in Table no .1-3.

The acoustic parameters were calculated for various compositions of Methanol, Ethanol, 1- Propanol with THBCl (substituted Schiff base) from ultrasonic velocities and the results are given in Table no. 4-6. This data is discussed in the light of molecular interaction between the components. The increase in Ultrasonic velocity may be attributed to the cohesion brought by ionic hydration. The increase in density with molar concentration suggests a solvent solute interaction [47] Also increase in density may be interpreted to the structure maker of solvent due to hydrogen bonding [48,49] The change in viscosity related to structural changes .[50]

Ultrasonic velocity ,density and viscosity of pure solvents at 303 K

Solvents	Ultrasonic velocity(m/s)		Density (kg/m³)		Viscosity (N/m².s)	
	Literature	Reported	Literature	Reported	Literature	Reported
Methanol	1103	1100	791	790	0.543	0.542
Ethanol	1144	1139	765	760	1.41	1.38
1-Propanol	1195	1200	786	788	1.77	1.67

Table 1: Ultrasonic Velocity (U), Density (ρ) and Viscosity (η) values for the binary mixture of Methanol – THBCl 303K

Concentration (M)of THBCl	Ultrasonic velocity(m/s)	Density (kg/m³)	Viscosity(N/m².s)

0.01	1201	952	0.9769
0.02	1243	955	0.772
0.03	1248	959	0.9785
0.04	1256	963	0.979
0.05	1258	968	0.9820
0.1	1279	972	0.9835

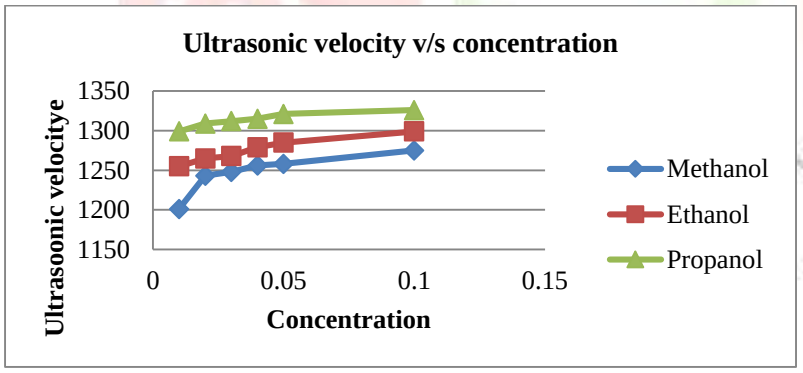
Table 2: Ultrasonic Velocity (U), Density (ρ) and Viscosity (η) values for the binary mixture of Ethanol –THBCl at 303K

Concentration (M)of THBCl	Ultrasonic velocity(m/s)	Density (kg/m^3)	Viscosity($N/m^2.s$)
0.01	1255	956	0.9501
0.02	1265	963	0.9508
0.03	1268	967	0.9518
0.04	1279	969	0.9519
0.05	1285	970	0.952
0.1	1299	971	0.9533

Table 3: Ultrasonic Velocity (U), Density (ρ) and Viscosity (η) values for the binary mixture of 1-Propanol –THBCl at 303 K

Concentration (M)of THBCl	Ultrasonic velocity(m/s)	Density (kg/m^3)	Viscosity($N/m^2.s$)
0.01	1299	958	0.9478
0.02	1309	960	0.9487
0.03	1312	961	0.9789
0.04	1315	963	0.9791
0.05	1321	967	0.9796
0.1	1326	968	0.9799

Figure 1 : Variation of ultrasonic velocity



Density (ρ)

Due to increase in presence of ions or particles , the density is increased in all three systems as concentration increases . It is also observed that density for 1-Propanol- THBCl is greater than that for other two systems. Density increases with increase in chain length of alcohol (Table 1-3).

Table 4 : Acoustical parameters for THBCl in Methanol

Conc. (M)	βx 10^{-10} $Kg^{-1}ms^2$	Zx10^6 $Kgm^{-2}s^{-1}$	RA	Lf x $10^3 A^0$	ζx10^{-10} s	R $m^3/mol\ (m/s)^{1/3}$
0.01	4.371	1.1433	0.2968	115.4	8.1098	3.411
0.02	4.313	1.187	0.3062	111.4	8.0987	3.4395
0.03	4.254	1.196	0.3061	110.7	8.0234	3.4263
0.04	4.207	1.2923	0.3249	100.2	8.0001	3.4987
0.05	4.133	1.3339	0.3349	99.82	7.9998	3.557
0.1	4.11	1.4103	0.3512	94.61	7.99	3.557

Table 5 : Acoustical parameters for THBCl in Ethanol

Conc.(M)	βx 10^{-10} $Kg^{-1}ms^2$	Z x 10^6 $Kgm^{-2}s^{-1}$	RA	Lf x$10^3 A^0$	ζx10^{-10}s	R $m^3/mol\ (m/s)^{1/3}$
0.01	6.6696	1.1947	0.02766	110.27	8.8922	3.2607
0.02	6.5434	1.200	0.2786	109.22	8.724	3.2696
0.03	6.4922	1.2336	0.279	108.79	8.6562	3.2714
0.04	6.3744	1.2147	0.2799	107.8	8.4992	3.2775
0.05	6.3084	1.2336	0.3004	107.24	8.4112	3.2782
0.1	6.1667	1.243	0.3012	106.3	8.222	3.2798

Table 6 : Acoustical parameters for THBCl in 1- propanol

Conc. (M)	β x $10^{-10}Kg^{-1}ms^2$	Z x10^6 $Kgm^{-2}s^{-1}$	RA	Lf x $10^{3\ A^0}$	ζx10^{-10}s	R $m^3/mol\ (m/s)^{1/3}$
0.01	7.282	1.2094	0.2712	108.34	9.7098	3.1099
0.02	6.772	1.2134	0.2721	108.12	9.0362	3.1101
0.03	6.695	1.314	0.2739	108.11	8.9266	3.1123
0.04	5.7659	13254	0.2754	108.09	7.6878	3.1136
0.05	5.4403	1.3345	0.2765	107.89	7.2537	3.1156
0.1	4.8865	1.3389	0.281	107.65	6.5133	3.1163

Fig. 2.Variation of adiabatic compressibility

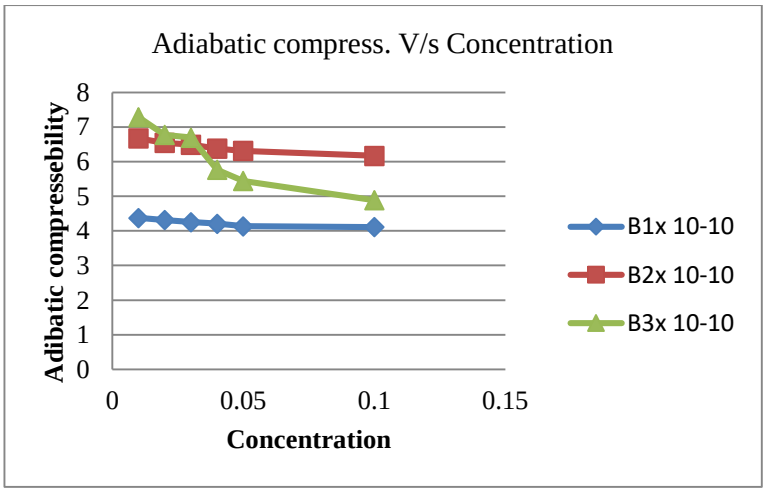


Fig.3 Variation of Acoustic impedance

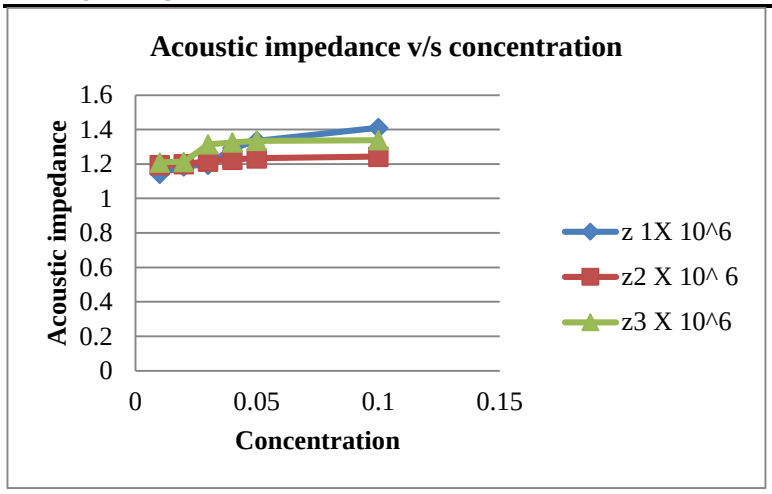


Fig.4 Variation of relative association

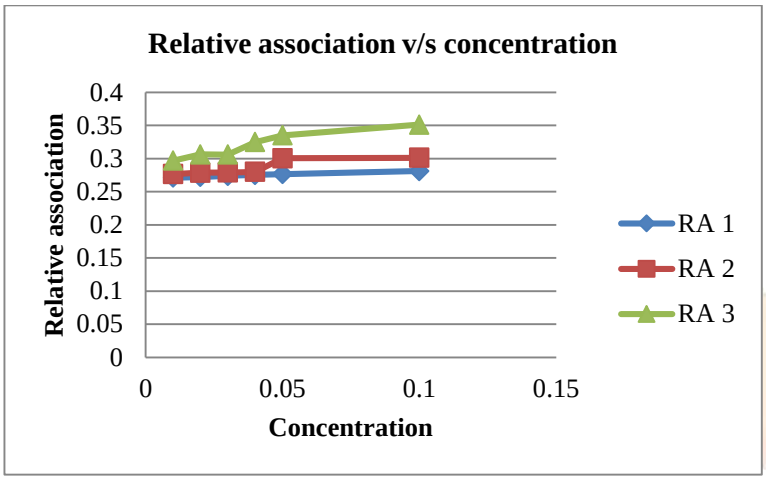


Fig.5 Variation of intermolecular free length

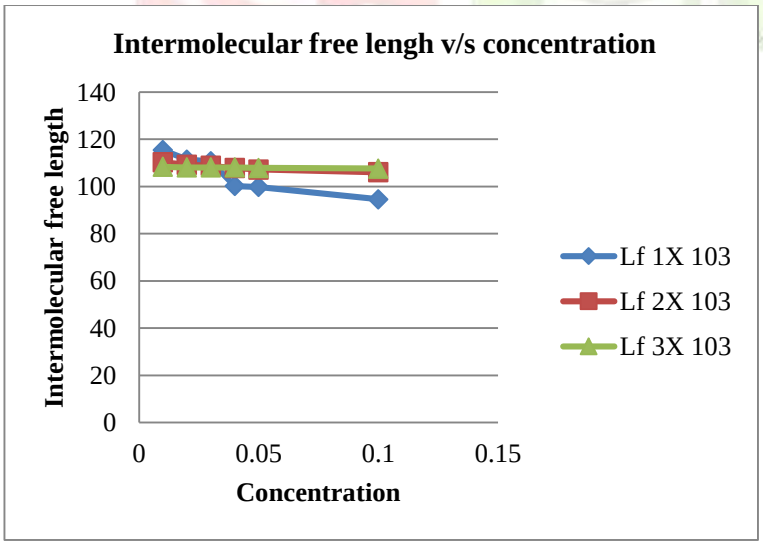


Fig. 6 Variation of relaxation time

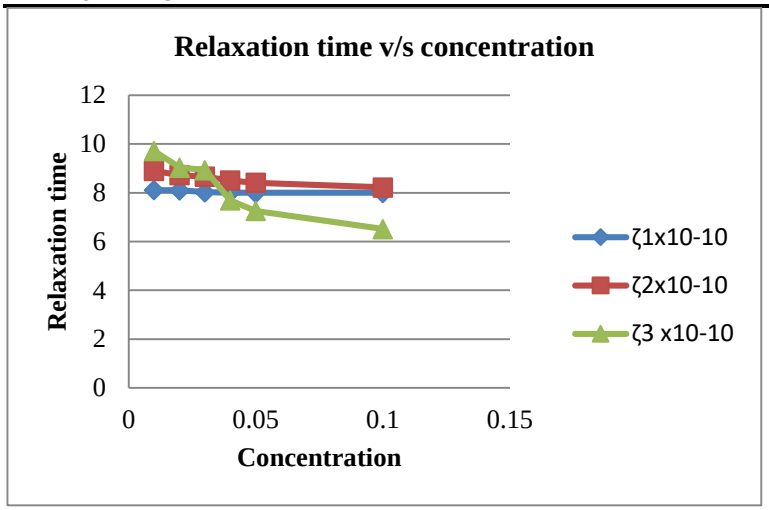
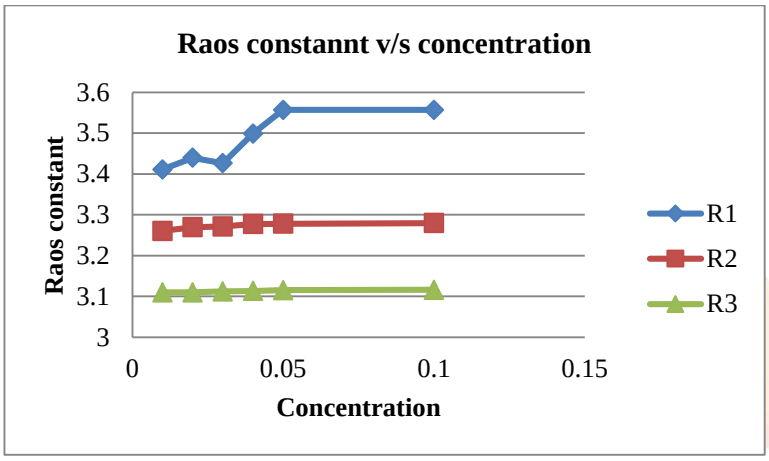


Fig. 7 Variation of Raos constant



Adiabatic compressibility (β)

The adiabatic compressibility values for various concentration of THBCl in different alcohol have been calculated from the measured ultrasonic velocities (Table 4 - 6). The plots of adiabatic compressibility against concentration of THBCl for the three systems are given in fig.2.

Adiabatic compressibility decreases with increase in chain length of Alcohol (Table 4 - 6).

This indicates stronger Hydrogen bonding over wide range of concentration. According to Fort and Moore, Hydrogen bonding between unlike components makes a negative contribution to compressibility [50]. The compressibility data also shows that dipole induced dipole attraction are stronger in Methanol-THBCl binary mixture than in Ethanol-THBCl and in 1-Propanol – THBCl binary mixtures.

The softness information conjointly shows that dipole **induced** dipole attraction are stronger in Methanol-THBCl binary mixture than in Ethanol-THBCl and in 1-Propanol – THBCl binary mixtures.

Linear free length (Lf)

Intermolecular free length is related to ultrasonic velocity. Intermolecular free length is concept to explain the speed of sound in liquids and their mixtures .The free length is distance between surfaces of neighbouring molecules. In general when ultrasonic velocity increases the intermolecular free length decreases due to the increase in concentration[51]. Decrease in intermolecular free length indicates interaction between the solute and solvent molecules due to structural arrangement in neighbouring ions or constituent molecules get affected.

It may be noted that in all the three cases linear free length decreases with increase with increase in concentration of THBCl (Table 4 - 6). This shows that dipole induced dipole attraction increases with the concentration of THBCl

The linear free length for a given composition for Methanol – THBCl binary mixture is greater than that for similar compositions in other two systems. Linear free length decreases with increase in chain length of alcohol (Table 4-6). The plots of linear free length against mole fraction of THBCl for the three systems are given in fig.4

Acoustic impedance (Z)

The acoustic impedance increases with increase in concentration of THBCl in all the three systems studied.

Molecules or atoms of liquid are bound to one another elastically ,the excess pressure results in wave propagating through the liquids The increase in acoustic impedance with the concentration can be explained on the basis of lyophobic interaction between solute and solvent molecules [52,53] Which increases the intermolecular distance, making relatively wider gap between the molecules.

It is also observed that acoustic impedance for 1-Propanol- THBCI binary mixture is greater than that for the other two systems. The plots of acoustic impedance verses concentration of THBCl for the three systems are given in fig.4. Acoustic impedance increases with increase in chain length of alcohol (Table 4-6).

Relaxation time (τ)

As concentration increases the relaxation time decreases in all three systems

This shows that molecular interaction is strong at lower concentration of THBCl and relatively weak at higher concentration. The relaxation time is of order 10^{-10} due to structural relaxation process [54-55] in such a case it is suggested that molecules get rearranged due to co-operative process [56-63]

The plots of relaxation time versus concentration of THBCl for the three systems are given in fig.5. Relaxation time increases with increase in chain length of alcohol (Table 4 - 6).

Relative association (RA)

There are two factors which influence the relative association [64,65]

A . Breaking up of associate solvent molecules on addition of solute

B. The salvation of solute. There is linear variation of Relative association for all three systems. After evaluation of structures of all solvents it was observed that there is chain of methylene group which increases .Due to which there is increases in RA may be because of strong hydrogen bonding because of methylene group.

Raos Constant

The molar sound velocity (R) indicates the cube root of sound velocity through one molar volume of solution called Raos constant. It is also measure of interaction existing in the solution.

The increasing trend in Rao's constant with concentration indicates the availability of more no. of components in the given region thus leads to tight packing of medium.

V CONCLUSION

The various acoustic parameters such as adiabatic compressibility, free length, acoustic impedance, relaxation time, Raos Constant ,relative association have been evaluated from ultrasonic velocity, density and viscosity for the binary liquid mixture of Methanol – THBCI , Ethanol –THBCl and 1- Propanol – THBCl systems at 303K.

In the present investigation, it could be inferred that there are inter molecular interactions among the components of the binary mixtures. Molecular interaction increases with increase in the concentration of Imine in all the three systems. It is also observed that molecular interaction increases with increase in chain length of alcohol in the order 1- Propanol > Ethanol >Methanol.

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