ULTRASONIC AND MOLECULAR INTERACTION STUDIES ON CINNAMALDEHYDE WITH IODINE IN HEXANE TERNARY MIXTURES AT DIFFERENT TEMPERATURES

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ABSTRACT

Ultrasonic velocity and density of cinnamaldehyde with iodine in hexane ternary solution has been measured at different temperatures in different concentration. Ultrasonic velocity has been measured using single frequency interferometer at 2 MHz (Model F-81). By using the Ultrasonic velocity(u), density (ρ) and coefficient of viscosity (η), the other acoustical parameters adiabatic compressibility (β), the free length (L_f), interaction parameter (α), Free volume (V_f) are calculated. The addition of hexane with a mixture leads to a compact structure due to presence of dipolar type interaction. This contributes to the decrease in free volume values and the internal pressure shows an increasing trend. The results have been discussed in terms of solute-solute and solute-solvent interactions between the component and the compatibility of these methods in predicting the interactions in these mixtures has also been discussed.

Key Words: ciinnamaldehyde-iodine-hexane-Ultrasonic velocity-molecular interactions.

I. INTRODUCTION

Ultrasonic velocity measurement have been successfully employed to detect and assess weak and strong molecular interactions, present in binary[1,2] and ternary liquid mixtures. Ultrasonic studies have found wide applications owing to their ability to characterize the physico-chemical behaviour of solutions. The studies on volumetric, ultrasonic and viscometric properties of liquid mixtures and their dependence on composition and temperature are of importance in many fields of applied research and find applications in many important chemical, textile, Leather, Industrial and Biological process[3,4]. The excess properties have been claimed to be an aid in the characterization of the molecular interactions that are present in solutions and liquid mixtures. This is achieved through elevation of ideal quantities. In recent years, considerable efforts have been given for the elevation of ideal and excess thermodynamic quantities of binary and ternary liquid mixtures. The study of molecular interaction in the liquid mixtures is of considerable in the elucidation of the structural properties of the molecules.

Since, acoustic parameters provide a better insight into molecular environment to liquid mixtures, it seemed important to study molecular interactions which motivated the authors to carry out the present investigation in the ternary liquid mixtures of cinnamaldehyde with iodine in hexane using ultrasonic technique. The nature and degree of molecular interactions in different solutions depend upon the nature of the medium, the structure of the solute molecule and also the extent of solvation taking place in solution.

II. MATERIALS AND METHODS

Iodine (AR-Ranbaxy fine chemicals limited) is used as such. The solvent has taken as accurately weighted amount of sample was dissolved in suitable solvent to obtain solution in the concentration range $1\times10^{-3}\,M - 1\times10^{-2}\,M$. The ultrasonic velocity (U) have been measured in ultrasonic interferometer (Model F81) supplied by Mittal enterprises, New Delhi operating at a frequency of 2 MHz with an accuracy of $\pm$ 0.1%. The Viscosities (η) of pure compounds and their mixtures were determined using Oswald's Viscometer calibrated with double distilled water[5]. The densities (ρ) of pure compounds and their solutions were measured accurately using 10 ml specific gravity bottles in an electronic balance precisely and the accuracy in weighing is $\pm$ 0.1 mg[6].

The temperatures were controlled by circulating water around the liquid cell from a thermostatically controlled water bath (accuracy $\pm 0.1°C$). The temperature of the cell was measured using a thermocouple (at the crystal) and was found to be

accurate, to $\pm 0.25°C$. Using the measured data of U, ρ, η and the acoustical parameters such as adiabatic compressibility (β), free length (L_f), absorption co-efficient (α/f^2), Free Volume (V_f) and internal Pressure (π_i) have been calculated.

$$\beta = 1/(U^2 \rho)\ Kg^{-1}\ ms^2 \quad ...(1)$$

$$\alpha/f^2 = 8\pi^2 \eta/3\rho\ U^3\ Nps^2\ m^{-1} \quad ...(2)$$

$$L_f = K\sqrt{U_\rho}\ Å \quad ...(3)$$

$$V_f = (M_{eff}\ U/K\eta)^{3/2} \quad ...(4)$$

Where, $K-$ is the temperature dependent constant. M_{eff} - is the effective molecular weight which is expressed as ($M_{eff} = \Sigma\ x_i\ m_i$ in which m_i and x_i are the molecular weight and the mole fraction of the individual constituents respectively).

The following equation (5) was used to compute internal pressure (π_i).

$$\pi_i = bRT(K\eta/U)^{1/2}(\rho^{2/3}\ M_{eff}^{7/6}) \quad ...(5)$$

Where $b-$ is the cubic packing factor which is assumed to be two for all liquids and solutions, $K-$ the temperature constant whose value is 4.28×10^9, $R-$ is the gas constant.

III. RESULTS AND DISCUSSION

In the present investigation, ultrasonic velocity measurement is used to assess molecular interaction between cinnamaldehyde with iodine in hexane. The values of ultrasonic velocity (U), density (ρ) of pure components of iodine, cinnamaldehyde and hexane are given in Table. 1. The values of U, ρ and η of mixtures and other computed acoustical parameters are given in Table 2. Plot of ultrasonic velocity versus concentration are shown in fig. 1. It is evident from the values that, the ultrasonic velocity decreases with increase in concentration. It suggests that increase in salvation with concentration. It is obvious that the ultrasonic velocity of mixture is always higher than that of cinnamaldehyde or iodine and it increases with increase in the concentration of donor or acceptor[7,8]. This suggests that there is strong molecular interaction between the components. Density is a measure of solvent-solvent and ion-solvent interactions. Increase in density with concentration indicates the increase in solvent-solvent and solute-solute interactions; where as decreases in density indicates the lesser magnitude of solute-solvent and solvent- solvent interactions[9,10]. Increase in density with concentration is due to shrinkage in the volume which in turn is due to presence of solute molecules. In other words, the increase in density may be interpreted to the structure-maker (or) the solvent due to added solute. Similarly, the decrease in density with concentration indicates the structure-breaker of the solvent. It may also be true that solvent-solvent interactions bring about a bonding, probably hydrogen bonding between them[11,12]. Usually, the values of density and viscosity of any system vary with increase in concentration of solutions. The changes in structure of solvent or solutions are formed as a result of hydrogen bond formation or dissociation or hydrophobic (structure-breaking) or hydrophilic (structure-forming) character. That is hydrogen bond forming or dissociation properties can thus be correlated with change in density and viscosity[13].

Viscosity is an important parameter in understanding the structure as well as molecular interactions occurring in the solutions[13]. Viscosity variation is attributed to the structural changes. The structural changes influence the viscosity to a certain

Table 1. The Density, Melting/Boiling point and Ultrasonic velocity (U) of pure components

Component	Density	Melting/Boiling Point	Velocity (ms^{-1})
Iodine	4.93 $g.cm^{-3}$ at 20°C	114°C/118°C	1447.00
Cinnamaldehyde	1.05 g/ml	– 7.5 C/ 248 - 251 C	1544.26
Hexane	0.6548 g/mL	– 95°C/69°C	1075.00

Table 2. Experimental values of ultrasonic velocity, density, viscosity, compressibility, free length, Molar volume and Available volume of Cinnamaldehyde with iodine in hexane at 293 K

CONC. (M)	Velocity (u) ms^{-1}	Density (ρ) kgm^{-3}	Viscosity $\eta \times 10^{-3}$ Nsm^{-2}	Compressibility $(k) \times 10^{-10}$ $kg^{-1}ms^2$	Free length $(L_f)^{-11}m$	Molar Volume $V_m \times 10^{-4}$ $(m^3\ mol^{-1})$	Available Volume $V_a \times 10^{-5}$ $(m^3\ mol^{-1})$
0.001	1103.6	668.8	0.5820	12.28	7.008	1.28900	3.999
0.002	1101.4	668.1	0.5379	12.34	7.025	1.29077	4.022
0.003	1097.4	668.6	0.5753	12.42	7.048	1.29022	4.053
0.004	1103.3	667.3	0.5140	12.31	7.017	1.29164	4.010
0.005	1101.2	670.9	0.5052	12.29	7.012	1.28663	4.011
0.006	1097.5	669.8	0.5090	12.39	7.041	1.28916	4.049
0.007	1100.8	674.8	0.5383	12.23	6.994	1.28003	3.994
0.008	1101.4	671.6	0.5222	12.27	7.007	1.28654	4.009
0.009	1099.6	669.9	0.5259	12.35	7.027	1.29022	4.035
0.010	1096.8	672.5	0.5161	12.36	7.032	1.28565	4.043

Table 3. Computed values of I.J.P, internal pressure, free volume, relaxation time, impedance and interaction parameter of Cinnamaldehyde with iodine in hexane at 293 K.

CONC. (M)	L.J.P (J mol^{-1})	Internal pressure (π_i) 10^8 atm	Free volume $V_{fx} 10^{-7}$ $(m^3\ mole^{-1})$	Relaxation time (τ) 10^{-13} S	Impedance $(Z) \times 10^5$ Rayl	Interaction parameter χi
0.001	6.339	3.089	2.360	9.5267	7.381	0.0526
0.002	6.254	2.970	2.650	8.8493	7.358	0.0482
0.003	6.101	3.077	2.384	9.5266	7.337	0.0405
0.004	6.328	2.900	2.842	8.4371	7.362	0.0521
0.005	6.246	2.883	2.915	8.2796	7.388	0.0474
0.006	6.104	2.895	2.869	8.4121	7.351	0.0402
0.007	6.231	2.986	2.651	8.7775	7.428	0.0463
0.008	6.254	2.930	2.778	8.5462	7.397	0.0472
0.009	6.185	2.936	2.744	8.6569	7.366	0.0437
0.010	6.078	2.919	2.813	8.5060	7.376	0.0382

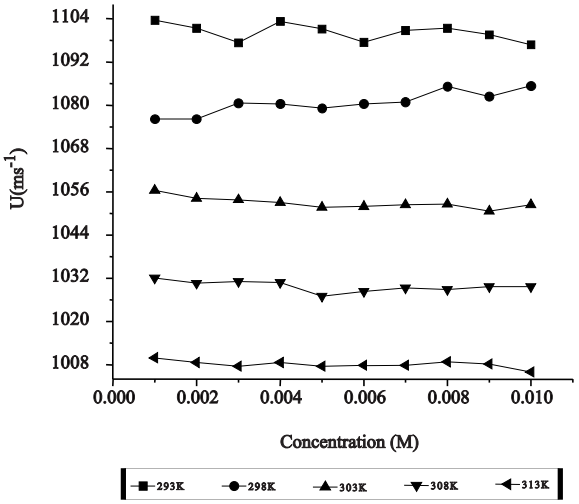

Fig. 1 Plot of Ultrasonic velocity versus equi Molar concentration of Cinnamaldehyde and Iodine in hexane solution at 303 K

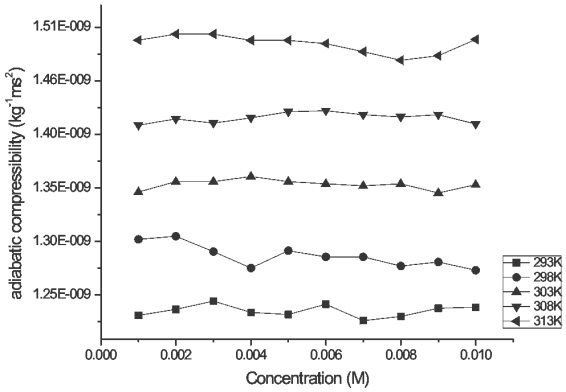

Fig. 2 Plot of adiabatic compressibility versus equi Molar concentration of Cinnamaldehyde and Iodine in hexane solution at 303 K

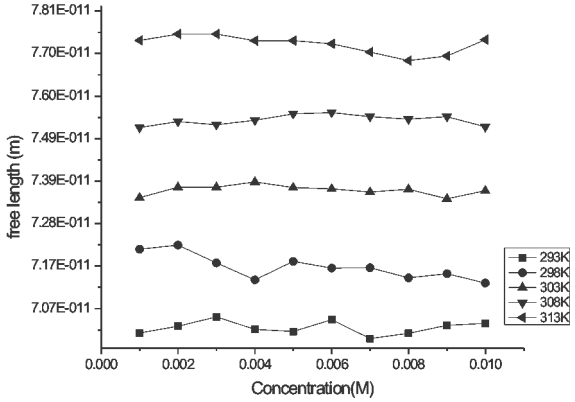

Fig. 3 Plot of free length versus equi Molar concentration of Cinnamaldehyde and Iodine in hexane solution at 303 K

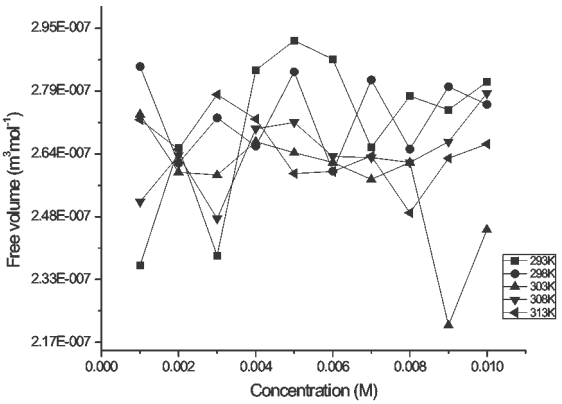

Fig. 4 Plot of free volume versus equi Molar concentration of Cinnamaldehyde and Iodine in hexane solution at 303 K

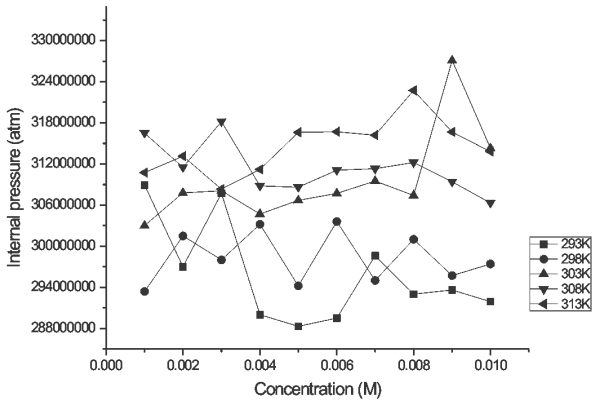

Fig. 5 Plot of adiabatic compressibility versus equi Molar concentration of Cinnamaldehyde and Iodine in hexane solution at 303 K

extent as compared to density and compressibility. From the Table. 2, it is observed that the values of η increases with increase in solute concentration in all the systems. This increasing trend indicates the existence of molecular interaction occurring in this system. Fig. 2 shows the plot of adiabatic compressibility versus concentration. B values are used to ascertain the molecular interaction in solution[14]. Compressibility decreases with increase in concentration. Adiabatic compressibility, intermolecular free length and free volume are continuously decreases with increasing mole fraction whereas internal pressure is in increasing trend. The minimum compressibility indicates the enhancement of bond strength and maximum compressibility indicates the poor bond strength of the molecule. A reduction in adiabatic

Table 4. Experimental values of ultrasonic velocity, density, viscosity, compressibility, free length, Molar volume and Available volume of Cinnamaldehyde with iodine in hexane at 298 K.

CONC. (M)	Velocity (u) ms^{-1}	Density (ρ) kgm^{-3}	Viscosity (η) $\times 10^{-3}$ Nsm^{-2}	Compressibility (k) $\times 10^{-10}$ $kg^{-1}ms^2$	Free length $(L_f)^{-11}m$	Molar Volume $V_m \times 10^{-4}$ $(m^3\ mol^{-1})$	Available Volume $V_a \times 10^{-5}$ $(m^3\ mol^{-1})$
0.001	1076.2	663.3	.5004	13.02	7.216	1.29968	4.255
0.002	1076.2	661.5	.5307	13.05	7.226	1.30365	4.268
0.003	1080.6	664.1	.5183	12.90	7.182	1.29896	4.217
0.004	1080.4	672.2	.5268	12.74	7.140	1.28215	4.164
0.005	1079.2	665.1	.5040	12.91	7.186	1.29785	4.225
0.006	1080.4	666.7	.5362	12.85	7.169	1.29515	4.206
0.007	1080.9	666.0	.5075	12.85	7.170	1.29694	4.208
0.008	1085.2	665.4	.5314	12.76	7.145	1.29853	4.178
0.009	1082.4	667.0	.5106	12.80	7.155	1.29583	4.192
0.010	1085.4	667.5	.5176	12.72	7.132	1.29528	4.166

Table 5. Computed values of I.J.P, internal pressure, free volume, relaxation time, impedance and interaction parameter of Cinnamaldehyde with iodine in hexane at 298K.

CONC. (M)	L.J.P $(Jmol^{-1})$	Internal pressure (π_i) 10^8 atm	Free volume V_{fx} 10^{-7} $(m^3\ mole^{-1})$	Relaxation time (τ) 10^{-13} S	Impedance (Z) $\times 10^5$ Rayl	Interaction parameter χi
0.001	6.339	3.089	2.360	9.5267	7.381	0.0526
0.002	6.254	2.970	2.650	8.8493	7.358	0.0482
0.003	6.101	3.077	2.384	9.5266	7.337	0.0405
0.004	6.328	2.900	2.842	8.4371	7.362	0.0521
0.005	6.246	2.883	2.915	8.2796	7.388	0.0474
0.006	6.104	2.895	2.869	8.4121	7.351	0.0402
0.007	6.231	2.986	2.651	8.7775	7.428	0.0463
0.008	6.254	2.930	2.778	8.5462	7.397	0.0472
0.009	6.185	2.936	2.744	8.6569	7.366	0.0437
0.010	6.078	2.919	2.813	8.5060	7.376	0.0382

Table 6. Experimental values of ultrasonic velocity, density, viscosity, compressibility, free length, Molar volume and Available volume of Cinnamaldehyde with iodine in hexane at 303K.

CONC. (M)	Velocity (u) ms^{-1}	Density (ρ) kgm^{-3}	Viscosity (η) $\times 10^{-3}$ Nsm^{-2}	Compressibility (k) $\times 10^{-10}$ $kg^{-1}ms^2$	Free length $(L_f)^{-11}m$	Molar Volume $V_m x10^{-4}$ $(m^3\ mol^{-1})$	Available Volume $V_a x10^{-5}$ $(m^3\ mol^{-1})$
0.001	1056.4	664.5	.5053	13.48	7.344	1.29734	4.408
0.002	1054.2	662.6	.5227	13.58	7.370	1.30148	4.440
0.003	1053.8	663.1	.5237	13.58	7.370	1.30092	4.441
0.004	1053.0	661.9	.5120	13.63	7.383	1.30218	4.452
0.005	1051.7	665.9	.5157	13.58	7.369	1.29629	4.442
0.006	1051.9	666.3	.5191	13.56	7.366	1.29593	4.439
0.007	1052.4	667.0	.5251	13.54	7.358	1.29499	4.432
0.008	1052.6	665.6	.5198	13.56	7.365	1.29814	4.441
0.009	1050.6	672.5	.5800	13.47	7.341	1.28524	4.413
0.010	1052.4	666.5	.5433	13.55	7.361	1.29722	4.440

Table 7. Computed values of I.J.P, internal pressure, free volume , relaxation time, impedance and interaction parameter of Cinnamaldehyde with iodine in hexane at 303K.

CONC. (M)	L.J.P $(Jmol^{-1})$	Internal pressure (π_i) 10^8 atm	Free volume $V_{fx}\ 10^{-7}$ $(m^3\ mole^{-1})$	Relaxation time (τ) 10^{-13} S	Impedance (Z) $\times 10^5$ Rayl	Interaction parameter χi
0.001	4.660	3.030	2.733	9.0852	7.020	– 0.0355
0.002	4.589	3.078	2.590	9.4644	6.985	– 0.0397
0.003	4.576	3.081	2.583	9.4826	6.988	– 0.0406
0.004	4.549	3.047	2.665	9.3023	6.970	– 0.0417
0.005	4.509	3.067	2.638	9.3356	7.003	– 0.0447
0.006	4.515	3.077	2.614	9.3880	7.009	– 0.0445
0.007	4.531	3.095	2.572	9.4775	7.020	– 0.0437
0.008	4.537	3.074	2.614	9.3980	7.006	– 0.0435
0.009	4.474	3.271	2.212	10.418	7.065	– 0.0473
0.010	4.531	3.143	2.448	9.8133	7.014	– 0.0442

Table 8. Experimental values of ultrasonic velocity, density, viscosity, compressibility, free length, Molar volume and Available volume of Cinnamaldehyde with iodine in hexane at 308 K.

CONC. (M)	Velocity (u) ms^{-1}	Density (ρ) kgm^{-3}	Viscosity (η) $\times 10^{-3}$ Nsm^{-2}	Compressibility (k) $\times 10^{-10}$ $kg^{-1}\ ms^2$	Free length $(L_f)^{-11}$ m	Molar Volume $V_m \times 10^{-4}$ $(m^3\ mol^{-1})$	Available Volume V_a $\times 10^{-5}$ $(m^3\ mol^{-1})$
0.001	1032.1	664.3	.5215	14.13	7.518	1.29773	4.606
0.002	1030.6	663.7	.5057	14.19	7.533	1.29932	4.624
0.003	1031.1	664.5	.5272	14.15	7.525	1.29818	4.616
0.004	1030.8	662.8	.4973	14.20	7.536	1.30041	4.626
0.005	1027.0	665.0	.4942	14.26	7.552	1.29805	4.649
0.006	1028.3	662.7	.5055	14.27	7.555	1.30297	4.656
0.007	1029.3	663.3	.5065	14.23	7.545	1.30222	4.645
0.008	1028.9	664.8	.5081	14.21	7.539	1.29970	4.639
0.009	1029.7	662.7	.5021	14.23	7.545	1.30424	4.649
0.010	1029.7	667.2	.4878	14.14	7.520	1.29586	4.619

Table 9. Computed values of I.J.P, internal pressure, free volume , relaxation time, impedance and interaction parameter of Cinnamaldehyde with iodine in hexane at 308 K.

CONC. (M)	L.J.P $(Jmol^{-1})$	Internal pressure (π_i) 10^8 atm	Free volume V_{fx} 10^{-7} $(m^3\ mole^{-1})$	Relaxation time (τ) 10^{-13} S	Impedance (Z) $\times 10^5$ Rayl	Interaction parameter χi
0.001	3.904	3.165	2.517	9.8262	6.856	– 0.0794
0.002	3.860	3.115	2.631	9.5649	6.840	– 0.0822
0.003	3.875	3.182	2.475	9.9499	6.852	– 0.0815
0.004	3.866	3.088	2.697	9.4151	6.832	– 0.0816
0.005	3.753	3.086	2.713	9.3954	6.829	– 0.0891
0.006	3.792	3.111	2.629	9.6184	6.815	– 0.0869
0.007	3.821	3.113	2.626	9.6100	6.827	– 0.0852
0.008	3.810	3.122	2.614	9.6261	6.840	– 0.0861
0.009	3.833	3.094	2.665	9.5281	6.824	– 0.0848
0.010	3.833	3.063	2.785	9.1940	6.870	– 0.0849

Table 10. Experimental values of ultrasonic velocity, density, viscosity, compressibility, free length, Molar volume and Available volume of Cinnamaldehyde with iodine in hexane at 313 K.

CONC. (M)	Velocity (u) ms^{-1}	Density (ρ) kgm^{-3}	Viscosity (η) $\times$ 10^{-3} Nsm^{-2}	Compressibility $k \times 10^{-10}$ $kg^{-1} ms^2$	Free length $(L_f)^{-11}$ m	Molar Volume $V_m \times 10^{-4}$ $(m^3\ mol^{-1})$	Available Volume $V_a \times 10^{-5}$ $(m^3\ mol^{-1})$
0.001	1009.9	655.9	0.4845	14.95	7.734	1.31435	4.849
0.002	1008.6	654.7	0.4930	15.01	7.750	1.31719	4.869
0.003	1007.6	656.0	0.4766	15.01	7.750	1.31500	4.869
0.004	1008.6	657.4	0.4837	14.95	7.734	1.31109	4.846
0.005	1007.6	658.7	0.5006	14.95	7.734	1.31046	4.852
0.006	1007.8	659.8	0.5002	14.92	7.726	1.30870	4.844
0.007	1007.8	663.3	0.4955	14.84	7.705	1.30222	4.820
0.008	1008.8	665.7	0.5146	14.76	7.684	1.29795	4.796
0.009	1008.2	664.5	0.4967	14.81	7.695	1.30071	4.811
0.010	1006.0	660.4	0.4914	14.94	7.732	1.30920	4.856

Table 11. Computed values of I.J.P, internal pressure, free volume, relaxation time, impedance and interaction parameter of Cinnamaldehyde with iodine in hexane at 313 K.

CONC. (M)	L.J.P $(Jmol^{-1})$	Internal pressure (πi) 10^8 atm	Free volume V_{fx} 10^{-7} $(m^3\ mole^{-1})$	Relaxation time (τ) 10^{-13} S	Impedance (Z) $\times$ 10^5 Rayl	Interaction parameter χi
0.001	3.263	3.107	2.720	9.6607	6.623	– 0.1180
0.002	3.233	3.131	2.647	9.8697	6.603	– 0.1201
0.003	3.205	3.083	2.782	9.5414	6.610	– 0.1220
0.004	3.233	3.112	2.721	9.6438	6.631	– 0.1198
0.005	3.205	3.166	2.586	9.9808	6.637	– 0.1224
0.006	3.211	3.167	2.592	9.9523	6.649	– 0.1222
0.007	3.211	3.162	2.630	9.8067	6.685	– 0.1224
0.008	3.238	3.227	2.490	10.128	6.716	– 0.1208
0.009	3.222	3.167	2.624	9.8049	6.699	– 0.1220
0.010	3.178	3.138	2.662	9.7916	6.648	– 0.1250

compressibility is an indication that component molecules are held close to each other[15,16].

Acoustic impedance is the reciprocal of compressibility. The value of impedance is suddenly decreases at a concentration indicate the interaction between ion-solvent molecules, which increases the intermolecular free length Thus, addition of solvent makes all components to be closer. This idea is supported by the decreasing trend of intermolecular free length. Free volume and internal pressure are behaving opposite to each other. Free volume shows a decreasing trend with increasing mole fraction of hexane. The addition of hexane with a mixture leads to a compact structure due to presence of dipolar type interaction[17]. This contributes to the decrease in free volume values and the internal pressure shows an increasing trend.

The intermolecular free length depends upon the adiabatic compressibility and shows a similar to that of compressibility and inverse to the velocity. The behavior of intermolecular free length is an inverse behavior of sound propagation. An increase in intermolecular free length produces a decrease in ultrasonic velocity[18]. Here, on increasing the concentration, the free length values are non-variably varied. But, the intermolecular free length is suddenly increased at a particular concentration with corresponding change in velocity[19]. It indicates the interaction between the solute and solvent molecules due to which the structural arrangement is considerably changed. The free length increases due to expansion, which indicates the looser packing of the molecules.

Free volume is one of the significant factors in explaining the free space and its dependent properties have close connection with molecular structure and it may show interesting features about interactions between liquid mixtures. This molecular interactions between like and dislike molecules are influenced by structural arrangements along with shape and size of the molecules[20]. That is, the molecules of a liquid are not quite closely packed and there are some free spaces between the molecules for movement and this volume is called the free volume. In this present investigation, author(s) are observed the non linear variation of free volume with concentration. It may be formed due the cohesive force between the solute and solvent mixtures. It may be interpreted that by taking into account the eletronegativity of chlorine atom which acts as an electron acceptor. This is due the group of $-CH_3$ donating through induction.

Intermolecular forces give a liquid its cohesion. The attractive force mainly comprises of hydrogen bonding, dipole-dipole interaction, multi polar, and dispersion interactions[21]. Repulsive forces acting over very small intermolecular distances play a minor role in the cohesion process under normal circumstances. Cohesion creates a pressure within the liquid. Dissolved solutes experience some of this pressure, and the amount of internal pressure increases whenever they interact with solvent through hydrogen bonding, charge transfer, Coulomb or van der Waals interaction. Thus a solute is subjected to a “Structural pressure” from the solvent and a “Chemical pressure” from the interaction with the solvent, and hence the solution exists under a higher internal pressure than the pure solvent. The variation of internal pressure is also support in this present investigation.

Acoustical relaxation time depends upon viscosity and compressibility. Relaxation time of a system can be used to characterize the intermolecular interactions. The values are calculated for above ternary system at different temperature in different concentrations. Relaxation process leads to absorption of the waves, which is related to structural changes in the liquids. The relaxation time shows a non-linear variation[22]. It shows a dips at a particular concentration of chinnamaldihyde with iodine. The variation of relaxation time reaches minimum and then increases with concentration. The increases of relaxation time with concentration studies support solute-solvent interactions. The variation of interaction parameters is also support for this solute-solvent interaction.

IV. CONCLUSION

From density, viscosity, ultrasonic velocity and other related acoustical parameters of ternary liquid mixtures of cinnamaldehyde with iodine in hexane ternary solution has been measured at different temperatures in different concentration. It is very obvious that there exists a strong molecular association between the component molecules at a particular concentration in the ternary mixtures. The dipole-dipole interactions are formed in the mixtures through hydrogen bonding. The donor-acceptor complexation is also observed between the cinnamaldehyde and iodine.

Further study may give more details about the complex formation.

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