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Advances in Applied Science Research, 2013, 4(3):130-139

ISSN: 0976-8610
CODEN (USA): AASRFC

Study of molecular interaction in binary liquid mixture of dimethyl acetamide and acetone using ultrasonic probe

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ABSTRACT

The Ultrasonic velocity (U) and density (ρ) for binary mixture of dimethyl acetamide (DAMC) and acetone at frequencies $2MH_Z$, 4MHz, $6MH_Z$ and $8MH_Z$ have been measured at a constant temperature 308K.These data are used to evaluate the ultrasonic parameters such as adiabatic compressibility (K_s), intermolecular free length (L_f) acoustic Impedance (Z), molar volume (V_m), Rao's constant(R), Wada's constant(B), available volume (V_a), Lennard Jones potential repulsive term exponent(n), relative association(R_A),interaction parameter (χ) for the liquid mixture.The excess values of some parameters are also computed and interpreted to elucidate the molecular interaction in the liquid mixture.

Key words: Binary mixture, Rao's constant, Wada's constant, available volume, interaction parameter.

INTRODUCTION

The ultrasonic velocity of a liquid is related to the binding forces between atoms or molecules. Ultrasonic velocities have been adequately employed in understanding the nature of molecular interaction in pure liquids, binary and ternary mixture [1-5].The investigation regarding the study of molecular interaction in binary liquid mixture with dimethyl acetamide (DMAC) and acetone as the components is of particular interest, since DMAC is a dipolar aprotic solvent with high boiling point and good thermal and chemical stability. It Is used in industry and medicine. It is also used as solvent for the production of acrylic fibres, elasthane fibres, polymide resins and various pharmaceuticals. It is an excellent proton donor as well as proton acceptor and hence it is strongly associated through intermolecular hydrogen bond. It is highly soluble in a variety of polar and non-polar solvents and readily suitable to explore solute solvent interactions. Acetone is also an important solvent used in industry and pharmaceuticals.

Owing to these considerations, an attempt has been made to explain the molecular interaction in binary liquid mixture of dimethyl acetamide (DMAC) and acetone at different frequencies at constant temperature 308K.Departure from linearity in the velocity versus concentration in liquid mixture of DMAC is taken as an indication of the existence of interaction between different liquid molecules [6-21]. The physiochemical properties of liquid mixture can be studied by the non-linear variation of ultrasonic velocity and other ultrasonic parameters with structural changes occurring in a liquid and the liquid mixture.

MATERIALS AND METHODS

The liquid mixtures of various concentrations in mole fraction were prepared by taking chemicals of analytical grade (E Merck) which were used as such without further purification. Liquid mixtures of different mole fractions were prepared on concentration scale with a precision 0.0001g using an electronic digital balance. Densities of liquid mixtures were determined by a specific gravity bottle of 10ml capacity. The ultrasonic velocity was measured by a single crystal interferometer(M-82S) with a high degree of accuracy operating at different frequencies(1MHz to

8MHz).An electronically operated constant temperature water bath is used to circulate water through the double walled measuring cell made up of steel containing the experimental liquid mixture at the desired temperature.

THEORY

The ultrasonic parameters such as adiabatic compressibility (K_s), intermolecular free length (L_f), acoustic Impedance (Z), molar volume (V_m) and available volume (V_a) have been calculated using the experimental data from the following relations.

$$K_s = (U^2\rho)^{-1} \quad (1)$$

$$L_f = k\,(K_S)^{-1/2} \quad (2)$$

$$Z = \rho U \quad (3)$$

$$V_m = M/\rho \quad (4)$$

$$V_a = (M/\rho)\,[1-(U/U_\infty)] \quad (5)$$

Where k is a temperature dependent constant, M is the molecular mass of the liquid mixture and U_∞=1600 m/s.

The excess values of the above ultrasonic parameters have been calculated from the following relations.

$$A^E = A_{exp} - (X_1A_1 + X_2A_2) \quad (6)$$

Where X_1 and X_2 are mole fractions of DMAC and acetone respectively and A is any ultrasonic parameter.

Molar sound velocity(R), molar compressibility (B), Lennard Jones potential repulsive term exponent (n), relative association (R_A) and interaction parameter (χ) have been calculated from the following relations.

$$R = (M/\rho)\,U^{1/3} \quad (7)$$

$$B = (M/\rho)\,(K_s)^{-1/7} \quad (8)$$

$$n = (6\,V_m / V_a) - 13 \quad (9)$$

$$R_A = (\rho/\rho_0)\,(U_0/U) \quad (10)$$

$$\chi = (U/U_{ideal})^2 - 1 \quad (11)$$

Where ρ_0 and U_0 are density and ultrasonic velocity of DMAC respectively.

The ideal mixing velocity U_{ideal} is given by

$$U_{ideal} = X_1U_1+X_2U_2 \quad (12)$$

RESULTS AND DISCUSSION

The experimental values of density and ultrasonic velocity at 308K for pure liquids and binary liquid mixture were used to calculate various acoustical parameters and the relevant data are presented in Tables 1 to 9 and displayed graphically in Figures 1 to 18 for frequencies 2MHz, 4MHz, 6MHz and 8MHz.

Table-1 shows that density ρ and ultrasonic velocity U increase with the increase in mole fraction of DMAC (Fig-1 and Fig-2). The increase in ultrasonic velocity with the increase in concentration of DMAC at a particular frequency may be due to the structural changes occurring in the binary mixture resulting in the increase in intermolecular forces. The variations of adiabatic compressibility Ks, intermolecular free length L_f , molar volume V_m and acoustic impedance Z with the increase in mole fraction of DMAC are presented in Tables-2 and 3 and shown graphically in figures-3 to 6. The decrease in adiabatic compressibility and intermolecular free length while opposite trend in acoustic impedance and molar volume with the increase in concentration of DMAC reveal the presence of specific interactions between the components in the binary liquid mixture [22].

These are in agreement with the Eyring Kincaid model for sound propagation [23].According to which the ultrasonic velocity must increase if the intermolecular free length decreases in the liquid mixture and vice versa. Therefore, intermolecular free length is one of the predominating factors for deciding the nature of variation in ultrasonic parameters in the liquid mixture. The decrease in intermolecular free length leads to decrease in adiabatic compressibility as the concentration of DMAC increases in the binary liquid mixture. The decrease in intermolecular free length also results in increase in ultrasonic velocity,density and acoustic impedance.

Table-1-Values of density and ultrasonic velocity at 308K

Mole Fraction		ρ Kgm^{-3}	U ms^{-1}			
X_1	X_2		2MHz	4MHz	6MHz	8MHz
0	1	764	1140	1128	1116	1104
0.081	0.918	776	1162	1150	1137	1126
0.164	0.835	789	1184	1172	1158	1148
0.299	0.7	811	1240	1228	1212	1200
0.395	0.604	826	1258	1248	1236	1224
0.494	0.505	842	1293	1284	1272	1256
0.598	0.401	859	1333	1320	1308	1296
0.705	0.294	876	1358	1344	1335	1324
0.819	0.18	895	1406	1392	1368	1360
1	0	925	1488	1472	1464	1440

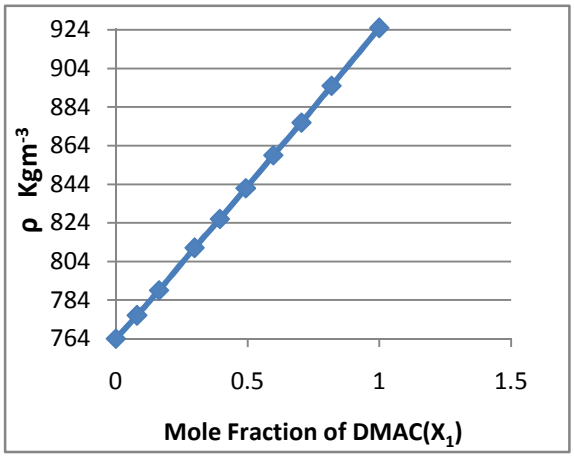

Fig-1: Variation of ρ Versus X_1

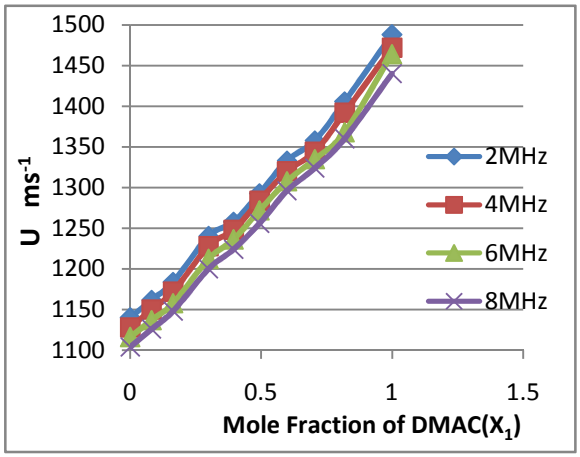

Fig-2: Variation of U Versus X_1

Table-2-Values of adiabatic compressibility and free length at 308K

Mole Fraction		$K_s \times 10^{-10}$ m^2N^{-1}				$L_f \times 10^{-10}$ m			
X_1	X_2	2MHz	4MHz	6MHz	8MHz	2MHz	4MHz	6MHz	8MHz
1	1	10.0715	10.2869	10.5094	10.7391	0.6353	0.6421	0.649	0.656
0.081	0.918	9.5439	9.7441	9.9682	10.1639	0.6184	0.6249	0.632	0.6382
0.164	0.835	9.041	9.2271	9.4516	9.6169	0.6019	0.6081	0.6154	0.6208
0.299	0.7	8.0192	8.1767	8.394	8.5628	0.5669	0.5724	0.58	0.5858
0.395	0.604	7.6499	7.773	7.9247	8.0805	0.5537	0.5581	0.5635	0.569
0.494	0.505	7.1038	7.2037	7.3402	7.5285	0.5335	0.5373	0.5423	0.5493
0.598	0.401	6.5515	6.6812	6.8044	6.931	0.5124	0.5174	0.5222	0.527
0.705	0.294	6.19	6.3197	6.4052	6.512	0.498	0.5032	0.5066	0.5108
0.819	0.18	5.652	5.7663	5.9704	6.0408	0.4759	0.4807	0.4891	0.492
1	0	4.8826	4.9893	5.044	5.2135	0.4423	0.4468	0.4496	0.4571

Table-3 and Fig-7 show that available volume decreases with the increase in mole fraction of DMAC. Available volume is a direct measure of compactness and strength of bonding between the molecules of the liquid mixture [24].The decrease in V_a is due to net packing of molecules inside the shell which may be formed by complexation between unlike molecules through hydrogen bonding in the binary liquid mixture.

Table-3-Values of molar volume, acoustic impedance and available volume at 308K

Mole Fraction		V_m	$Z\times10^5$ Kgm^{2}s^{-1}				V_a m^{3}mol^{-3}			
X_1	X_3	m^3 mol^{-1}	2MHz	4MHz	6MHz	8MHz	2MHz	4MHz	6MHz	8MHz
0	1	0.076	8.7096	8.6179	8.5262	8.4345	0.0218	0.0224	0.0229	0.0235
0.081	0.918	0.0778	9.0171	8.924	8.8231	8.7377	0.0215	0.0221	0.0228	0.0233
0.164	0.835	0.0795	9.3417	9.247	9.1366	9.0577	0.0206	0.0212	0.0219	0.0224
0.299	0.7	0.0822	10.0564	9.959	9.8293	9.732	0.0184	0.0191	0.0199	0.0205
0.395	0.604	0.0841	10.391	10.3084	10.2093	10.1102	0.0179	0.0185	0.0191	0.0197
0.494	0.505	0.0859	10.887	10.8112	10.7102	10.5755	0.0164	0.0169	0.0176	0.0184
0.598	0.401	0.0877	11.4504	11.3388	11.2357	11.1326	0.0146	0.0153	0.016	0.0166
0.705	0.294	0.0896	11.896	11.7734	11.6946	11.5982	0.0135	0.0143	0.0148	0.0154
0.819	0.18	0.0914	12.5837	12.4584	12.2436	12.172	0.011	0.0118	0.0132	0.0137
1	0	0.0941	13.764	13.616	13.542	13.32	0.0065	0.0075	0.0079	0.0094

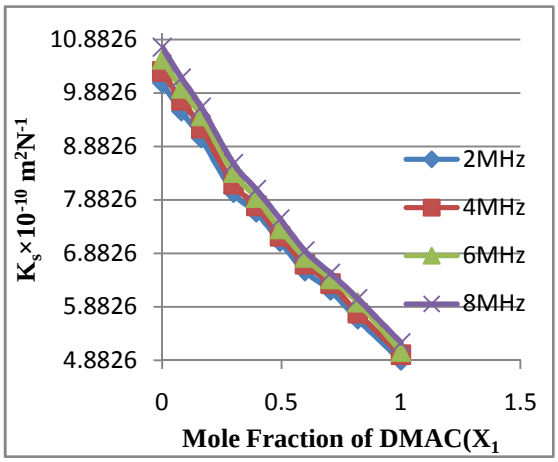

Fig-3: Variation of K_s Versus X_1

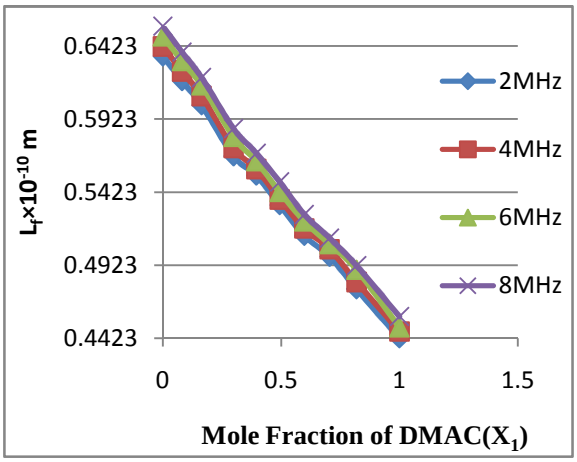

Fig-4:Variation of L_f Versus X_1

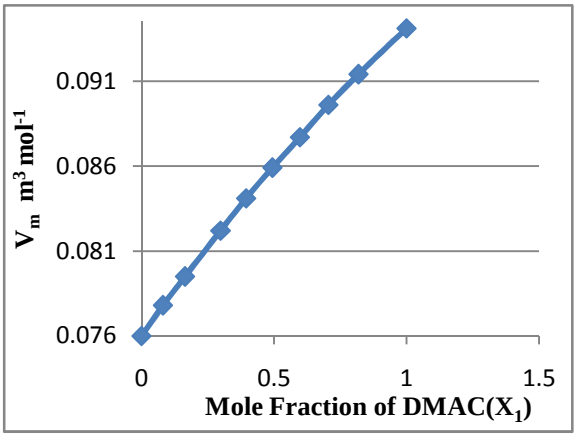

Fig-5: Variation of V_m Versus X_1

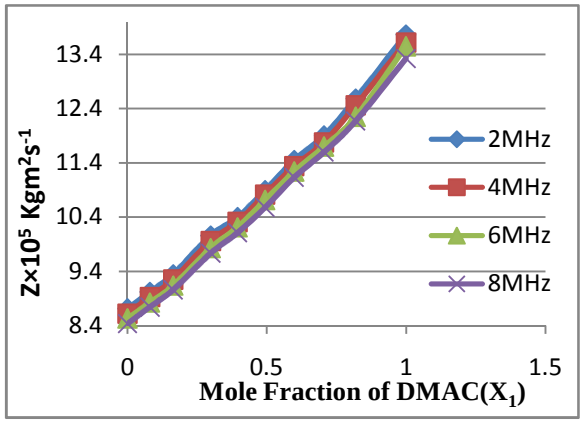

Fig-6:Variation of Z Versus X_1

The ultrasonic velocity decreases at a particular concentration of DMAC with the increase in frequency from 2MHz, to 8MHz. This decrease in ultrasonic velocity is perhaps due to the decrease in molecular interaction in the binary liquid mixture with the increase in frequency. Consequently, adiabatic compressibility, intermolecular free length and available volume increase and the acoustic impedance decreases with the increase in frequency for a particular mole fraction of DMAC.

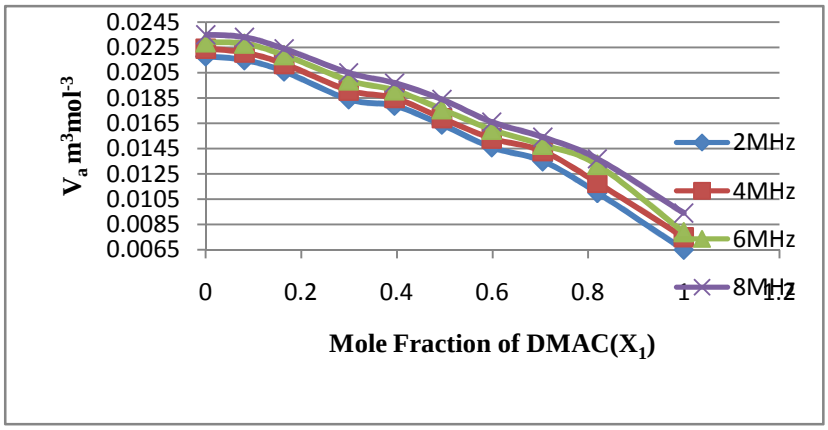

Fig-7: Variation of V_a Versus X_1

In order to know the nature of interactions between the component molecules of the ternary liquid mixture, it is better to discuss the same in terms of the excess parameters rather than their actual values. It is found that the dispersive forces are responsible for weak interaction between unlike molecules. This leads to positive excess values of adiabatic compressibility, intermolecular free length, molar volume, available volume and negative excess values of velocity and acoustic impedance. The attractive forces are responsible for strong interaction between unlike molecules. This leads to negative excess values of adiabatic compressibility, intermolecular free length, molar volume and available volume and positive excess values of velocity and acoustic impedance. Non ideal liquid mixture show considerable deviation from linearity from their physical properties with respect to mole fraction and these have been interpreted as the presence of both strong and weak interactions.

Table-4 and Figure-8 show that the values of excess velocity U^E are negative for the entire range of concentration of DMAC for all frequencies. The negative values of U^E indicate the presence dispersive forces between unlike molecules in the binary liquid mixture.

The values of K_s^E are negative (Table-5 and Figure-9) for the whole range of mole fraction of DMAC for all frequencies. The negative value of K_s^E is associated with a structure forming tendency but the positive value is associated with a structure breaking tendency due to hetero-molecular interaction between the component molecules of liquid mixture [25]. In the present investigation the negative values of K_s^E predict the existence of strong molecular interactions in the binary liquid mixture.

Table-4-Excess values of velocity at 308K

Mole Fraction		U^E ms^{-1}			
X1	X2	2MHz	4MHz	6MHz	8MHz
0	1	0	0	0	0
0.081	0.918	-5.048	-4.736	-6.072	-4.112
0.164	0.835	-11.932	-11.932	-13.956	-10
0.299	0.7	-2.912	-1.728	-9.036	-3.36
0.395	0.604	-18.326	-14.752	-16.344	-11.616
0.494	0.505	-16.772	-12.808	-14.796	-12.88
0.598	0.401	-13.964	-12.584	-14.988	-7.824
0.705	0.294	-26.2	-25.398	-25.224	-15.776
0.819	0.18	-17.872	-16.606	-31.896	-18.08
1	0	0	0	0	0

Table-6 and Figure-10 show that the values of L_f^E are negative for the whole range of composition of DMAC for frequencies 2MHz, 4MHz, 6MHz and 8MHz. The positive values of excess free length are attributed to the dispersive forces and the negative excess values of L_f^E are due to charge transfer and formation of hydrogen bond. In the present study the negative excess values of free length L_f^E predict the existence of strong molecular interactions in the binary liquid mixture due to charge transfer and formation of hydrogen bond.

The values of excess molar volume V_m^E are positive for the entire range of composition of DMAC (Table-6 and Figure-11). The values of excess molar volume are influenced by (i) the loss of dipolar association and the difference in size and shape (ii) dipole-dipole and dipole-induced dipole interactions or charge transfer complexation between the unlike molecules. The former effect leads to expansion of volume and the latter effect leads to

contraction of volume. In the present investigation the positive values of V_m^E are favourable for the former effect which accounts for the loss of dipolar association and the difference in size and shape in the binary liquid mixture.

Table-5-Excess values of adiabatic compressibility and free length at 308K

Mole Fraction		$K_s^E \times 10^{-10}$ m^2N^{-1}				$L_f^E \times 10^{-10}$ m			
X_1	X_2	2MHz	4MHz	6MHz	8MHz	2MHz	4MHz	6MHz	8MHz
0	1	0	0	0	0	0	0	0	0
0.081	0.918	-0.0972	-0.1033	-0.0879	-0.1167	-0.0006	-0.0006	-0.0001	-0.001
0.164	0.835	-0.1694	-0.1803	-0.1509	-0.2052	-0.001	-0.0012	-0.0002	-0.0018
0.299	0.7	-0.4906	-0.5159	-0.4706	-0.5133	-0.01	-0.0105	-0.0087	-0.01
0.395	0.604	-0.3619	-0.4109	-0.4152	-0.4652	-0.0047	-0.0061	-0.0059	-0.0077
0.494	0.505	-0.3943	-0.4558	-0.4587	-0.4701	-0.0057	-0.0076	-0.0075	-0.0077
0.598	0.401	-0.4068	-0.4274	-0.4261	-0.4929	-0.0067	-0.0071	-0.0068	-0.0093
0.705	0.294	-0.2132	-0.222	-0.2405	-0.3207	-0.0005	-0.0004	-0.0011	-0.0042
0.819	0.18	-0.1596	-0.1715	-0.0522	-0.162	-0.0006	-0.0007	-0.0033	-0.0003
1	0	0	0	0	0	0	0	0	0

Table-6-Excess Values of molar volume and acoustic impedance and available volume at 308K

Mole Fraction		V_m^E	$Z^E \times 10^5$ Kgm^2s^{-1}				V_a^E m^3mol^{-3}			
X_1	X_3	m^3 mol^{-1}	2MHz	4MHz	6MHz	8MHz	2MHz	4MHz	6MHz	8MHz
0	1	0	0	0	0	0	0	0	0	0
0.081	0.918	0.0004	-0.0931	-0.0901	-0.1	-0.084	0.0009	0.0009	0.0011	0.0009
0.164	0.835	0.0006	-0.1881	-0.1819	-0.2035	-0.1695	0.0013	0.0012	0.0014	0.0012
0.299	0.7	0.0008	-0.1557	-0.1447	-0.192	-0.1547	0.0011	0.0011	0.0015	0.0012
0.395	0.604	0.001	-0.3063	-0.2751	-0.2895	-0.2456	0.0021	0.002	0.0021	0.0017
0.494	0.505	0.001	-0.3107	-0.2671	-0.2852	-0.2639	0.0021	0.0018	0.0021	0.0018
0.598	0.401	0.0009	-0.2729	-0.2592	-0.2814	-0.2149	0.0019	0.0018	0.002	0.0015
0.705	0.294	0.0009	-0.3893	-0.3594	-0.3592	-0.2721	0.0025	0.0024	0.0024	0.0018
0.819	0.18	0.0007	-0.2657	-0.2443	-0.3815	-0.2552	0.0017	0.0016	0.0026	0.0017
1	0	0	0	0	0	0	0	0	0	0

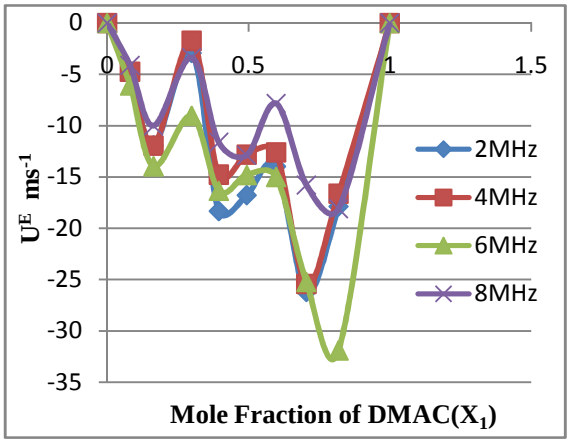

Fig-8: Variation of V_m Versus X_1

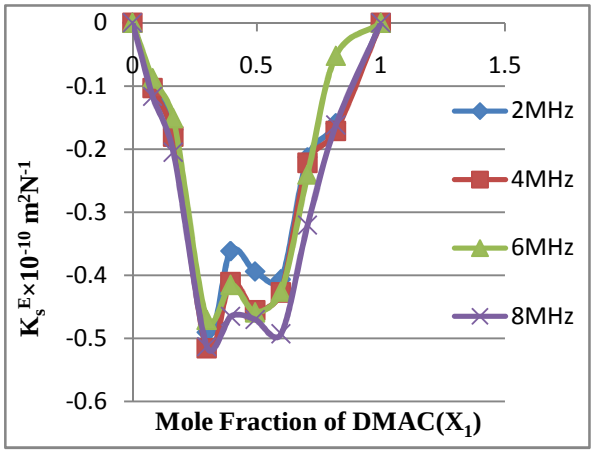

Fig-9: Variation of K_s^E Versus X_1

The values of Z^E are negative for the entire composition range of DMAC (Table-6 and Fig-12) for frequencies 2MHz, 4MHz, 6MHz and 8MHz.The negative values of Z^E indicate the presence of dispersive forces between unlike molecules in the binary liquid mixture.

The values of excess available volume V_a^E (Table-7 and Fig-13) are positive for the whole concentration range of DMAC for frequencies 2MHz, 4MHz, 6MHz and 8MHz. which indicate the presence of dispersive forces in the binary liquid mixture [26].

The values of excess adiabatic compressibility and excess free length are more negative at about equimolar region of DMAC which indicate that the dipole-induced dipole interaction is predominant in this region. At lower and higher concentration regions of DMAC there exists dipole-dipole interaction among unlike molecules in the binary liquid mixture.

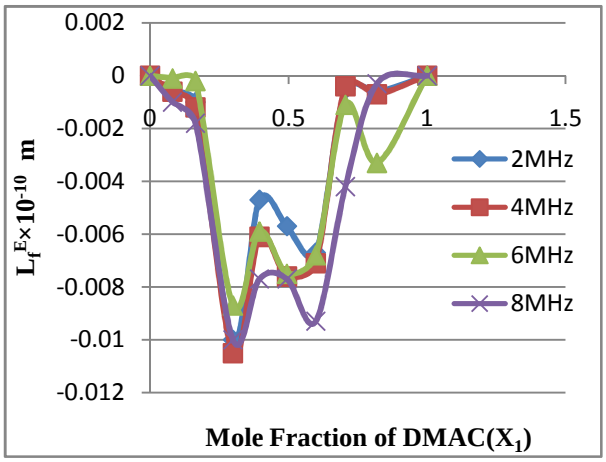

Fig-10: Variation of L_f^E Versus X_1

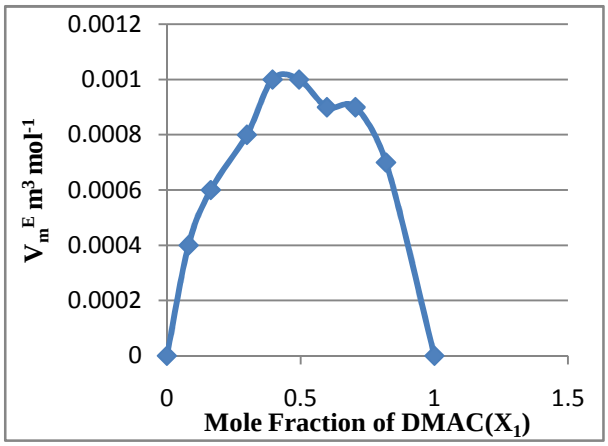

Fig-11:Variation of V_m^E Versus X_1

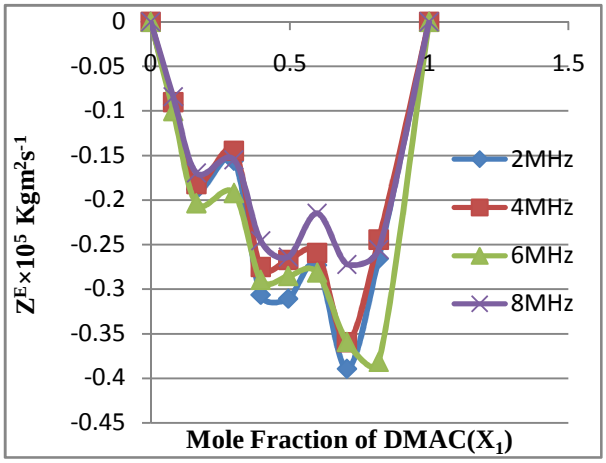

Fig-12: Variation of Z^E Versus X_1

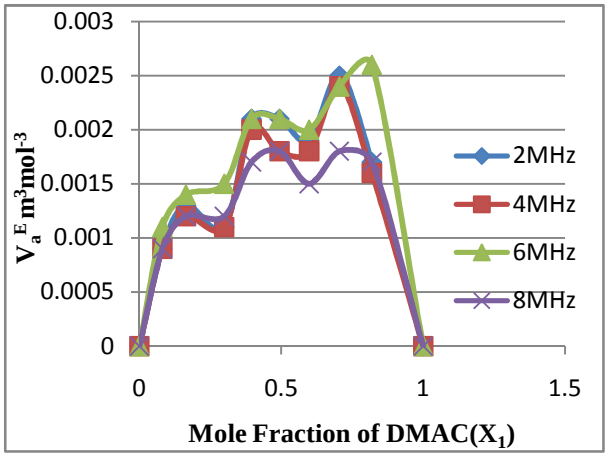

Fig-13:Variation of V_a^E Versus X_1

Tables-4,5 and 6 show that the excess values of velocity, adiabatic compressibility, free length, acoustic impedance and available volume are changed with the increase in frequency due to the decrease in ultrasonic velocity in the binary liquid mixture.

Table-7-Values of Rao's constant and Wada's constant

Mole Fraction		R				B			
X_1	X_2	2MHz	4MHz	6MHz	8MHz	2MHz	4MHz	6MHz	8MHz
0	1	0.8	0.7909	0.7881	0.7852	1.5059	1.4615	1.4571	1.4526
0.081	0.918	0.8177	0.8141	0.8118	0.8092	1.5317	1.5272	1.5222	1.518
0.164	0.835	0.8408	0.8379	0.8346	0.8322	1.5573	1.5528	1.5475	1.5436
0.299	0.7	0.8828	0.88	0.8761	0.8732	1.638	1.6335	1.6274	1.6227
0.395	0.604	0.9076	0.9052	0.9023	0.8994	1.6872	1.6834	1.665	1.6741
0.494	0.505	0.9355	0.9334	0.9305	0.9265	1.7416	1.7382	1.7335	1.7273
0.598	0.401	0.9649	0.9618	0.9588	0.9559	1.7988	1.7938	1.7891	1.7844
0.705	0.294	0.9919	0.9885	0.9863	0.9836	1.8527	1.8472	1.8437	1.8394
0.819	0.18	1.0236	1.0202	1.0143	1.0124	1.9146	1.8844	1.8997	1.8965
1	0	1.074	1.0701	1.0682	1.0623	2.0128	2.0066	2.003	1.9941

Table-7, Fig-14 and Fig-15 show that the values of Rao's Constant R and Wada's Constant B increase linearly with the increase in mole fraction of DMAC. The linear increase in Rao's Constant and Wada's Constant indicates the presence of specific interactions in the binary liquid mixture without complex formation. The values of R and B decrease with the increase in frequency at a particular concentration of DMAC. This decrease in R and B also supports the reduction in molecular interaction with the increase in frequency in the binary liquid mixture.

Table-8-Values of available volume and Lennard Jones potential repulsive exponent at 308K

Mole Fraction		n			
X1	X2	2MHz	4MHz	6MHz	8MHz
0	1	7.9174	7.3571	6.2196	6.4042
0.081	0.918	8.9906	8.3936	7.7368	7.2918
0.164	0.835	10.1553	9.5	8.7808	8.2946
0.299	0.7	13.8043	12.8219	11.7839	11.0585
0.395	0.604	15.1899	14.2756	13.4188	12.6142
0.494	0.505	18.4268	17.497	16.284	15.0108
0.598	0.401	22.3013	21.3921	19.8875	18.6987
0.705	0.294	26.8222	24.5944	23.3243	21.909
0.819	0.18	36.8545	33.4745	28.5454	27.0291
1	0	73.8615	62.28	58.4683	47.0638

Table-9-Values of relative association and interaction parameter at 308K

Mole Fraction		R_A				χ			
X1	X2	2MHz	4MHz	6MHz	8MHz	2MHz	4MHz	6MHz	8MHz
0	1	0.9026	0.9025	0.9041	0.9024	0	0	0	0
0.081	0.918	0.9109	0.9108	0.9126	0.9105	-0.0086	-0.0081	-0.0105	-0.0072
0.164	0.835	0.9204	0.9202	0.9223	0.9198	-0.0198	-0.0189	-0.0236	-0.0171
0.299	0.7	0.9316	0.9313	0.9337	0.9316	-0.0046	-0.0028	-0.0147	-0.0055
0.395	0.604	0.9437	0.9434	0.9448	0.9426	-0.0285	-0.0232	-0.0259	-0.0187
0.494	0.505	0.9539	0.9526	0.9539	0.9527	-0.0254	-0.0196	-0.0228	-0.0201
0.598	0.401	0.9633	0.963	0.9641	0.9618	-0.0206	-0.0187	-0.0225	-0.0119
0.705	0.294	0.9763	0.9761	0.9765	0.9739	-0.0374	-0.0367	-0.0367	-0.0234
0.819	0.18	0.986	0.9857	0.9896	0.9861	-0.0249	-0.0234	-0.045	-0.026
1	0	1	1	1	1	0	0	0	0

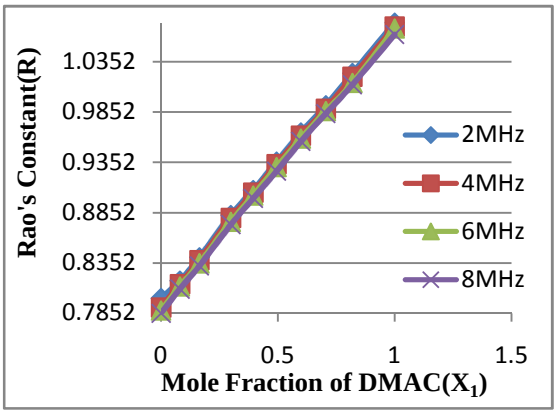

Fig-14: Variation of R Versus X_1

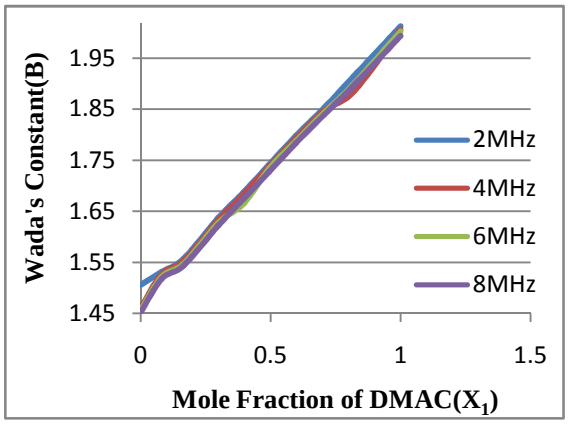

Fig-15:Variation of B Versus X_1

Lennard-Jones potential φ(r) is given by the relation [27].

$$\varphi(r) = -Ar^{-6} + Dr^{-n} \quad (13)$$

Where r and n are intermolecular distance and Lennard-Jones potential repulsive term exponent respectively. A and D are constants. The first term arises from attractive forces while the second term arises from repulsive forces. It is clear that larger the value of n small is the second term. Thus large value of n indicates the dominance of attractive forces over repulsive forces. The values of n increase with the increase in mole fraction of DMAC(Table-8 and Fig-16) for a fixed frequency. The increase in n indicates the increasing dominance of attractive forces over repulsive forces in the binary liquid mixture. Further, the values of n decrease with the increase in frequency for a particular concentration which indicates the increase in repulsive forces due to reduction in molecular interaction in the binary liquid mixture.

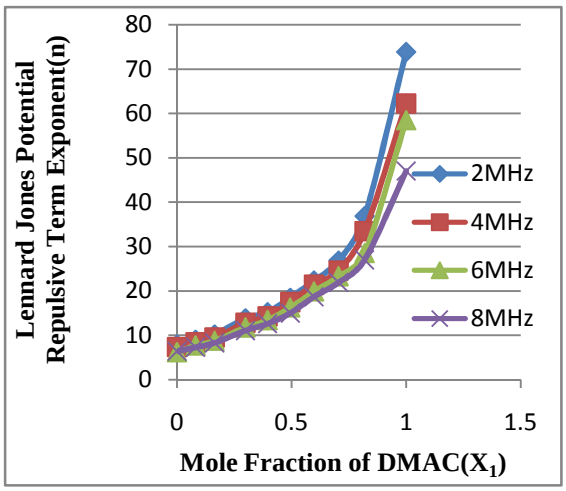

Fig-16: Variation of n Versus X_1

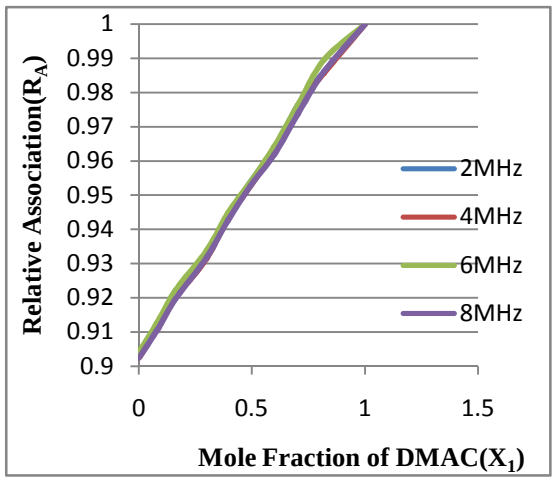

Fig-17:Variation of R_A Versus

The values of relative association R_A increase (Table-9 and Fig-17) with the increase in mole fraction of DMAC for a particular frequency and this increase in relative association indicates the presence of molecular interaction between unlike molecules in the liquid mixture. Such increase in relative association supports the idea that the liquid system is in a more compressed state and the component molecules are much closer to each other at higher concentration of DMAC and there may exist dipole-induced dipole interactions between component molecules in the binary liquid mixture[28]. Relative association remains almost constant for all frequencies at a particular concentration.

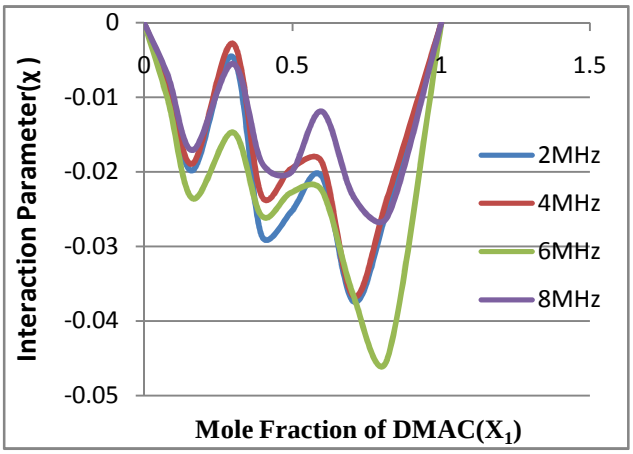

Fig-18: Variation of χ Versus X_1

Table-9 and Fig-18 show that the values of interaction parameter χ are negative for the entire range of mole fraction DMAC for all frequencies which indicate the existence of dispersive forces with weak dipole-induced dipole interactions in the binary liquid mixture. Further interaction parameter shows irregular trend with the increase in frequency.

CONCLUSION

From the experimental values of density, ultrasonic velocity, related acoustical parameters and some of their excess values for the binary liquid mixture it is found that there exists molecular interaction between components in the binary liquid mixture of DMAC and acetone. The negative excess values of adiabatic compressibility and intermolecular free length indicate a strong molecular interaction in the liquid mixture. The negative excess values of velocity and acoustic impedance and the positive excess values of molar volume and available volume predict the presence of dispersive forces between component molecules in the liquid mixture. Further, it is concluded that the molecular interaction decreases with the increase in frequency for a fixed concentration of DMAC in the binary mixture.

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