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Comparative Study of Molecular Interactions in Binary Liquid Mixtures of 4-Methyl-2-Pentanone with Aniline, *N*, *N*-Dimethyl Aniline and Chlorobenzene at 308 K

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Abstract

The ultrasonic velocity (u), density (ρ) and viscosity (η) have been restrained for binary mixtures of 4-methyl-2-pentanone with butan-2-one, cyclohexanone and furfuraldehyde at temperature T=308K at changed mole fractions. The experimental data have been used to calculate the acoustical and thermo-dynamical parameters like adiabatic compressibility (β_{ad}), free length (L_f), free volume (V_f), internal pressure (π_i), acoustical impedance, Gibb's free energy and their excess volumes in particular, it is seen that the response of these parameters to frequency is less prominent in to comparison to that of the binary mixtures containing 4-methyl-2-pentanone with butan-2-one, cyclohexanone and furfuraldehyde. Molecular interface studies with ultrasonic method in the binary liquid mixtures of 4-methyl-2-pentanone+butan-2-one, 4-methyl-2-pentanone+cyclohexanone and 4-methyl-2-pentanone+furfuraldehyde have been conceded out at 308 K. Using the dignified values of ultrasonic velocity, density and viscosity, acoustical parameters and their additional values are estimated. The necessity of glut properties of mixture compositions were associated and discuss in terms of the intermolecular free length and other elements moving the salvation and self-association effect. From the belongings of these glut parameters the nature and strength of the interfaces in these binary systems are discussed.

Keywords: binary mixtures, density, viscosity, hydrogen bonding, molecular interactions

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INTRODUCTION

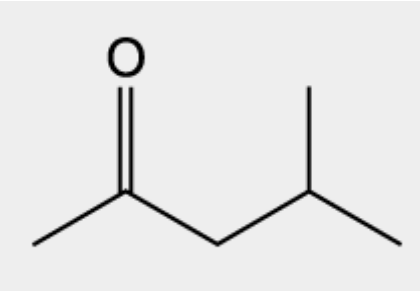
In the current year, the performance became ultrasonic powerful tool for the study of the molecular behavior of the liquid mixture. A dynamic and thermal property of pure liquids and liquid mixtures study has found various applications in the chemical, textile, pharmaceutical and many other industries. Physical in predicting and chemical properties of the liquid mixture, and no measurements of the speed of the ultrasonic waves in pure fluids and mixtures of liquid to be important.[1–4] Acoustic and thermal parameters help to understand the various types of association, such as molecular packing and/or movement and different types of interactions between molecules and their strengths that are affected by the size in pure components/mixtures.[5] The study of the nature of the interactions in systems involving 4-methyl-2-pentanone, acetophenone, cyclohexanone by many researchers. However, no reports of any work in the bilateral mixtures containing 4-methyl-2-pentanone with acetophenone, cyclohexanone and buta-2-one. Fluid used in this study is important because of the different industrial applications. It is used for different purposes in the industry. 4-methyl-2-pentanone is a clear, colorless

liquid ketone. The principal end users of MIBK include industrial solvent, coatings, extraction, and chemical intermediate. And daily life without 4-methyl-2-pentanone, they cannot be manufactured.

4-methyl-2-pentanone is very flammable with a high vapor pressure. Exposure to 4-methyl-2-pentanone is possible in both industrial and consumer applications. Occupational exposure limits have been established to control the allowable amount of exposure in workplace settings. Although infrequent and for short duration, consumer exposure depends upon the conditions under which 4-methyl-2-pentanone is used. 4-methyl-2-pentanone does not cause adverse health/environmental effects at levels typically found in the workplace and/or environment.

Other names: MIBK isopropyl acetone, 2-hexanonone isobutyl methyl ketene, 4-methylpentan-2-one, and 4-methyl-2-pentanone MIK.

It is said here that the nature of the interactions in the binary liquid mixture highly of 4-methyl-2-pentanone with acetophenone, cyclohexanone and buta-2-one of speed, density and viscosity measurements of ultrasonic 308K. From these values adiabatic compressibility, and the length of the free, free size, internal pressure, acoustic resistance and enthalpy been calculated. In order to shed light on the interaction between molecules presence of the, it is necessary to study the excess parameters.[6]



Deviation physical properties of the liquid mixture of ideal behavior is a measure of the interaction between the particles, which may be due to either adhesive or cohesive forces.the sign and magnitude of these deviations depend on the strength of the interaction between unlike molecules in mixtures.The experimental values of U, ρ, η were used to compute adiabatic compressibility β, free length $L_{f,}$ free volume $V_{f,}$ internal pressure π, acoustic impedance Z and enthalpy H and their additional functions. Excess values mark plays an important role in assessing compactness molecular dueto rearrangement and over the molecular interactions in binary liquid mixture.

EXPERIMENTAL DETAILS

Analytical grade chemicals were obtained from SRL chemicals used. They and purified by standard procedure[7] were examined.

The purity of the samples from the density and viscosity measurements.[8] To prepare mixtures in the required ratios, mode of action of continuous variation was used and the mixtures were maintined in well-stoppard conical flasks. After mixing the liquids completely, bottles were left undisturbed to allow to achieve thermal equilibrium.

Ultrasonic pulse echo overlap Singlecrystal (Mittal, India: Model: F-80X) was used to measure velocities.it ultrasound consists of ahigh-frequency generator and made measurements cell.the measure the velocities of ultrasonic on a fixed frequency of 2 MHz. The equipment has been calibrated by measuring the speed in gasoline nitrate and ccl4. The results are in good agreement with literature values.[9–15] And the speed of ultrasound has the accuracy of the temperature of ±0.1 and was controlled by circulating water around the liquid cell control thermostatistically constant temperature water bath (accuracy ± 0.1 K).

Been using bottle specific gravity of the fluid density measurements of pure andliquid mixtures. Weights was measured with an electronic balance (shimadzuAU 220) capable of measuring up to an average of 4–5 0.1 mg. An measurements taken for each sample. Ostwald viscosity was used measure of viscosity in the desired temperature, which was calibrated using a mixture of water and nitrobenzene. After have achieved bath temperature, and the flow of time may flow measurements were made with measured. The hour electronic timer with 0.01 s accuracy. Viscosity is determined using the relationship.

$$\eta_2 = \eta_1 \left(\frac{t_2}{t_1}\right)\left(\frac{\rho_2}{\rho_1}\right)$$

EXPERIMENTAL TECHNIQUES

Adiabatic Compressibility (β)

The adiabatic compressibility is defined as the fractional decrease of volume per unit increase of pressure, when no heat flows in/out. These changes are related to the compressibility of the medium in a thermodynamic relation expressed as:

$$\beta = \frac{1}{v}[\partial v/\partial p] \qquad \text{Eq. (1)}$$

It can also be calculated from the speed of sound (U) and density of the medium (ρ), using the equation of Newton Laplace as

$$\beta = \frac{1}{u^2 \rho} \qquad \text{Eq. (2)}$$

Intermolecular Free Length

The adiabatic compressibility of a liquid can be expressed in terms of the intermolecular free length which is the distance between the surfaces of neighboring molecules and is given by the relation:

$$L_f = K T \beta^{1/2} \qquad \text{Eq. (3)}$$

where K_T is the temperature dependent constant.

Free Volume (V_f)

Free volume is one of the important in explaining differences in physical and chemical properties of liquids and liquid mixtures factors. Free space and real estate affiliate to have close contact with the molecular structure and they may show interesting features about the interactions that may occur when two or more of the fluid mixing together. And influenced these molecular interactions between the molecules resemble unlike the structural arrangements along with the shape and size of the particles. Liquid can be handled as if it were composed of individual molecules each moving in Vodafone size in average due to the possibility of its neighbors. That is, not was packed in liquid molecules quite closely and there are some free spaces between the molecules of the movement and the size of Vodafone called 9. Eyring size free and Kincaid 10 definition of free size, with an effective size can be a particular molecule of the liquid can move and obedience to perfect the volume of gas laws free in terms of the speed of ultrasound (U) and the viscosity of the fluid (η) as

$$V_f = \left[\frac{M_{eff}\, U}{K\eta}\right]^{3/2} \qquad \text{Eq. (4)}$$

Internal Pressure (π_i)

Measurement of internal pressure is important for the study of thermodynamic properties of liquids. Internal pressure, a cohesive force, is the resultant of force of attraction and/or repulsion between the molecules.[11,12] Cohesion creates a pressure within the liquid in the range of 103–104 atmospheres. Internal pressure also gives an idea about the solubility characteristics. Dissolved solutes exist under the internal pressure of the medium and their interactions with the solvent that arise through hydrogen bonding, charge transfer, Columbic (or) Vander Waal's interaction. The term a/v^2 in van der

Waal's equation being the measure of attractive force of the molecule is called the cohesive or internal pressure.

The internal pressure is the single factor which varies due to all type of solvent-solute, solute-solute and solvent–solvent interactions. A general method of measuring the internal pressure is based on the Maxwell's equation of thermodynamics,[13] given as follows:

$$\mathbf{P = T}\left[\frac{\partial P}{\partial T}\right]_V - \left[\frac{\partial E}{\partial V}\right]_T \qquad \text{Eq. (5)}$$

Based on statistical thermodynamics and based on the concept of free volume, internal pressure can be determined as follows:

$$\mathbf{V_f} = \frac{1}{V^2}\left[\frac{bRT}{P+\left(\frac{\partial E}{\partial v}\right)_T}\right]^3 \qquad \text{Eq. (6)}$$

As $\left(\frac{\partial E}{\partial v}\right)_T$ is the internal pressure and neglecting P which is insignificantly small toπ_i

$$\mathbf{V_f} = \frac{1}{V^2}\left[\frac{bRT}{\pi_i}\right]^3 \qquad \text{Eq. (7)}$$

Combining the Equations (6) and (7), the final equation for the evaluation of internal pressure is:

$$\boldsymbol{\pi_i} = \mathbf{bRT}\left(\frac{K\eta}{U}\right)^{\frac{1}{2}}\left(\frac{\rho^{\frac{2}{3}}}{M_{eff}^{\frac{7}{6}}}\right) \qquad \text{Eq. (8)}$$

where K is constant, T the absolute temperature, η the viscosity (NS/m^2), U the ultrasonic velocity (m/s), ρ is the density (kg/m^3) of the liquid.

Relaxation Time (τ)

Relaxation time is the time taken by excitation energy to convert into translational energy, depending on the temperature and impurities. Dispersion of the ultrasonic velocity in binary mixture reveals information about the characteristic time of the relaxation process that causes dispersion. The relaxation time (τ) can be calculated from the relation:

$$\boldsymbol{\tau = \frac{4}{3}\beta\,\eta} \qquad \text{Eq. (9)}$$

Acoustic Impedance (Z)

The specific acoustic impedance is given by

$$\mathbf{Z = U*\rho} \qquad \text{Eq. (10)}$$

where U and ρ are velocity and density of the liquid, respectively.

Gibb's Free Energy (ΔG*)

The relaxation time for a given transition is related to the activation free energy. The variation of **ΔG** with temperature can be expressed in the form of Eyring salt process theory.[14]

$$\frac{1}{\tau} = \frac{KT}{h}\,exp\left(\frac{-\Delta G^*}{KT}\right) \qquad \text{Eq. (11)}$$

The above equation can be rearranged as:

$$\Delta G^* = KT\,log\left(\frac{h}{KT\tau}\right) \qquad \text{Eq. (12)}$$

where K is Boltzmann constant and h is Plank's constant.

The excess values are calculated using the formula

$$A_{EXCESS} = A_{EXP} - A_{IDEAL} \qquad \text{Eq. (13)}$$

where **Aid= ∑ AiXi ,** where Ai is any acoustical parameter and Xi is the mole fraction of liquid component.

System 1: 4-Methyl-2-Pentanone+Chlorobenzene (Tables 1 and 2).

Table 1. *Mole Fraction of First Component (X_1), Mole Fraction of Second Component (X_2), Density (ρ), Viscosity (η), Ultrasonic Velocity (U), Acoustic Impedance (Z), Leonard's Jones Potential (LJP) and Molecular Interaction Parameter (u_p) Values at Different Mole Fraction of Chlorobenzene+IBMK at 308 K.*

Mole fraction		P (kg/m^3)	$\eta*10^{-3}$ (NpM^{-2})	U (m/s)	$Z*10^{-3}$ ($kgm^{-2}s^{-1}$)	LJP	χ_u*10^{-3} (m/s)
X_1	X_2						
0.0000	1.0000	763.7	5.428	508.40	38.824	8.7944	0.0000
0.0506	0.9494	801.3	6.011	592.40	47.467	9.5276	52.900
0.1037	0.8963	805.5	6.106	628.80	50.651	9.8847	15.000
0.2019	0.7981	841.8	6.116	780.80	65.729	11.7188	77.300
0.3045	0.6955	844.4	6.202	868.80	73.365	13.1291	40.900
0.3991	0.6009	889	6.46	993.20	88.299	15.8207	61.000
0.5094	0.4906	913.7	6.926	1153.20	105.369	21.4861	93.800
0.6059	0.3941	944.2	7.158	1268.00	119.731	28.9157	95.300
0.7042	0.2958	979	7.191	1385.60	135.655	44.7761	97.100
0.8055	0.1945	1015.4	7.298	1442.00	146.426	60.7595	51.300
0.9016	0.0984	1047.4	7.527	1569.60	164.398	315.7895	64.500
1.0000	0.0000	1068.7	7.681	1580.00	168.859	480.0000	0.0000

Table 2. *Adiabatic Compressibility (β), Relaxation Time (τ), Free Volume (V_f), Internal Pressure (π_i), Cohesive Force (CE), Absorption Co-efficient (α/f^2), Free Length (L_f) and Activation Energy ($\Delta G^{\#}$) Values at Different Mole Fraction of 4-Methyl-2-Pentanone +Chlorobenzene at 308 K.*

β_s10^{-10} (T/Pa)	$\tau10^{-4}$ (s)	V_f (mL/mole)	π_i (atm)	$CE*10^{-2}$ (kJ/mole)	$\alpha/f^2 10^3$ ($NPm^{-1}s^2$)	L_f A^0	$\Delta G^{\#}10^{-20}$ (kJ/mole)
50.7	3.6664	0.1118	0.0000	0.0000	0.0000	2.17	0.0000
35.6	2.8502	0.1206	4181.7276	52.600	1.683	1.96	0.003
31.4	2.5562	0.1694	4074.2113	51.310	1.35	1.90	0.003
19.5	1.5891	0.1984	3716.3508	45.323	5.62	1.67	0.003
15.7	1.2974	0.2320	3504.3769	43.133	3.67	1.58	0.003
11.4	0.98208	0.2666	3416.6108	40.394	2.31	1.44	0.003
8.23	0.7600	0.2975	3293.6937	38.382	1.43	1.32	0.003
6.59	0.62861	0.3433	3221.5940	36.736	1.03	1.24	0.003
5.32	0.5101	0.3626	3123.0564	34.736	0.72	1.16	0.003
4.74	0.4608	0.3995	3118.0487	33.823	0.62	1.12	0.003
3.88	0.3890	0.3979	3059.9708	32.528	0.46	1.06	0.003
3.75	0.3838	0.1118	3083.0352	32.471	0.46	1.04	0.003

System 2: 4-Methyl-2-Pentanone + Aniline (Tables 3 and 4).

Table 3. *Mole Fraction of First Component (X_1), Mole Fraction of Second Component (X_2), Density (ρ), Viscosity (η), Ultrasonic Velocity (U), Acoustic Impedance (Z), Leonard's Jones Potential (LJP) and Molecular Interaction Parameter (χ_u) Values at Different Mole Fraction of 4-Methyl-2-Pentanone + Aniline at 308 K.*

Mole fraction		ρ (kg/m^3)	$\eta*10^{-5}$ (Npm^{-2})	U (m/s)	$Z*10^{-3}$ ($kgm^{-2}s^{-1}$)	LJP	χ_u*10^{-3} (m/s)
X_1	X_2						
0.0000	1.0000	101.41	1.5777	1380.00	1399	43.64	0.0000
0.0506	0.9494	100.16	1.4937	1373.00	1375	42.29	0.0007
0.1037	0.8963	98.72	1.4368	1364.00	1347	40.68	0.0007
0.2019	0.7981	97.31	1.3814	1352.00	1316	38.71	0.0007
0.3045	0.6955	94.21	1.2353	1324.00	1247	34.78	0.0007
0.3991	0.6009	92.73	1.1620	1305.00	1210	32.54	0.0007
0.5094	0.4906	89.91	1.0346	1275.00	1146	29.54	0.0008
0.6059	0.3941	88.42	0.9783	1262.00	1116	28.40	0.0008
0.7042	0.2958	85.35	0.9001	1241.00	1059	26.74	0.0008
0.8055	0.1945	82.56	0.7966	1226.00	1012	25.67	0.0008
0.9016	0.0984	81.56	0.4523	1210.00	987	24.62	0.0008
1.0000	0.0000	79.4	0.3947	1204.00	956	24.24	0.0000

Table 4. *Adiabatic Compressibility (β), Relaxation Time (τ), Free Volume (V_f), Internal Pressure (π_i), Cohesive Force (CE), Absorption Co-efficient (α/f^2), Free Length (L_f) and Activation Energy ($\Delta G^{\#}$) Values at Different Mole Fraction of 4-Methyl-2-Pentanone+Aniline At 308 K.*

$\beta_s 10^{-12}$ $(T\ Pa)^{-1}$	$\tau 10^{-7}$ (s)	$V_f * 10^{-3}$ (L/mole)	π_i (atm)	CE (kJ/mole)	$\alpha/f^2 10^3$ $(NPm^{-1}s^2)$	L_f A^0	$\Delta G^{\#} 10^{-20}$ (kJ/mole)
51.78	1.0892	0.0830	5695	52.3	5.1	1.14	0.003
52.96	1.0548	0.0900	5485	51.2	4.6	1.15	0.003
54.45	1.0430	0.0950	5322	50.6	4.3	1.17	0.003
56.22	1.0355	0.1000	5168	50.0	4.1	1.18	0.003
60.55	0.9973	0.1161	4783	48.3	3.4	1.21	0.003
63.32	0.9811	0.1254	4599	47.4	3.2	1.23	0.003
68.42	0.9438	0.1461	4257	45.6	2.7	1.26	0.003
71.01	0.9263	0.1576	4091	44.8	2.5	1.28	0.003
76.08	0.9130	0.1770	3817	43.8	2.1	1.32	0.003
80.58	0.8559	0.2121	3490	41.8	1.7	1.35	0.003
83.74	0.5050	0.4910	2605	31.8	.6	1.36	0.003
86.88	0.4572	0.6030	2380	30.0	.4	1.38	0.003

System 3: 4-Methyl-2-Pentanone + *N*, *N*-Dimethylaniline (Tables 5 and 6)

Table 5. *Mole Fraction of First Component (X_1), Mole Fraction of Second Component (X_2), Density (ρ), Viscosity (η), Ultrasonic Velocity (U), Acoustic Impedance (Z), Leonard's Jones Potential (LJP) and Molecular Interaction Parameter (χ_u) Values at Different Mole Fraction of 4Methyl-2-Pentanone_+ N,N-Dimethyl Aniline at 308 K.*

Mole fraction		ρ (kg/m^3)	$\eta * 10^{-3}$ (Npm^{-2})	U (m/s)	$Z * 10^{-3}$ $(kgm^{-2}s^{-1})$	LJP	$\chi_{u*} 10^{-3}$ (m/s)
X_1	X_2						
0.0000	1.0000	94.08	1.4368	1393.00	1311	46	0
0.0506	0.9494	93.38	1.2987	1383.00	1291	44	0.002
0.1037	0.8963	92.43	1.1515	1371.00	1267	42	0.003
0.2019	0.7981	91.56	1.0334	1362.00	1247	40	0.005
0.3045	0.6955	89.51	0.9106	1337.00	1197	37	0.006
0.3991	0.6009	88.54	0.8206	1336.00	1183	36	0.015
0.5094	0.4906	86.67	0.7176	1294.00	1122	31	0.001
0.6059	0.3941	85.52	0.6683	1271.00	1087	29	-0.006
0.7042	0.2958	85.35	0.5935	1247.00	1064	27	-0.005
0.8055	0.1945	83.51	0.5287	1227.00	1025	26	-0.003
0.9016	0.0984	81.76	0.4523	1210.00	989	25	-0.009
1.0000	0.0000	79.37	0.3945	1204.00	956	24	0

Table 6. *Adiabatic Compressibility (β), Relaxation Time (τ), Free Volume (V_f), Internal Pressure (π_i), Cohesive Force (CE), Absorption Co-efficient (α/f^2), Free Length (L_f) and Activation Energy ($\Delta G^{\#}$) Values at Different Mole Fraction of 4-Methyl-2-Pentanone + N, N-Diethyl Aniline at 308 K.*

$\beta_s 10^{-12}$ $(T.Pa)^{-1}$	$\tau * 10^{-6}$ (s)	$V_f * 10^{-3}$ (L/mole)	π_i (atm)	CE (kJ/mole)	$\alpha/f^{2*} 10^{3}$ $(NPm^{-1}s^2)$	L_f A^0	$\Delta G^{\#} 10^{-20}$ (kJ/mole)
54.78	1.049	0.1438	3785	48.7	2.158	1.18	0.003
55.99	0.969	0.1625	3645	46.7	1.863	1.19	0.003
57.56	0.884	0.1888	3471	44.4	1.553	1.20	0.003
58.88	0.811	0.2163	3321	42.4	1.313	1.21	0.003
62.50	0.759	0.2447	3193	40.7	1.157	1.24	0.003
63.28	0.692	0.2805	3054	38.9	0.967	1.24	0.003
68.91	0.659	0.3155	2942	37.3	0.882	1.28	0.003
72.98	0.645	0.3342	2888	36.6	0.847	1.30	0.003
75.35	0.596	0.3731	2830	35.0	0.766	1.31	0.003
79.54	0.561	0.4181	2727	33.7	0.680	1.34	0.003
83.54	0.504	0.5096	2535	31.6	0.535	1.36	0.003
86.91	0.457	0.6035	2379	30.0	0.430	1.38	0.003

Graph

Corresponding plots are given in Figures 1–6.

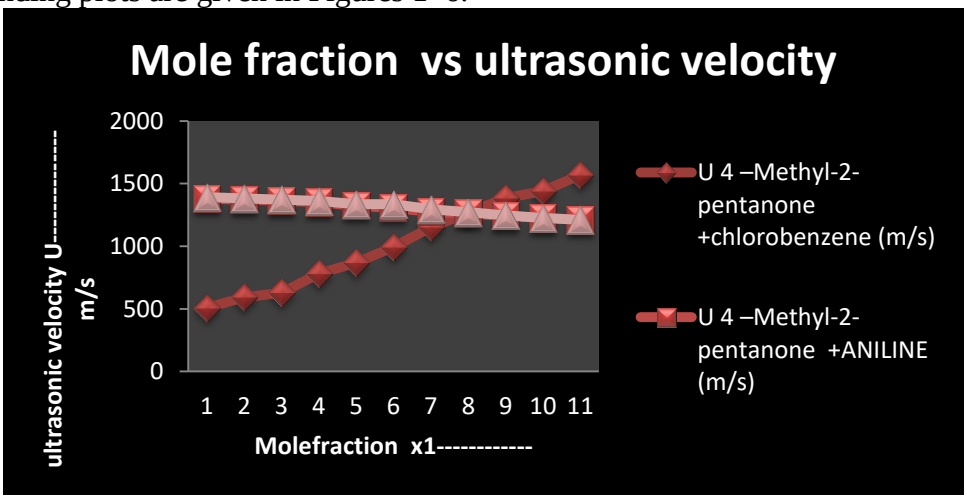


Fig. 1. *Mole Fraction Vs Ultrasonic Velocity.*

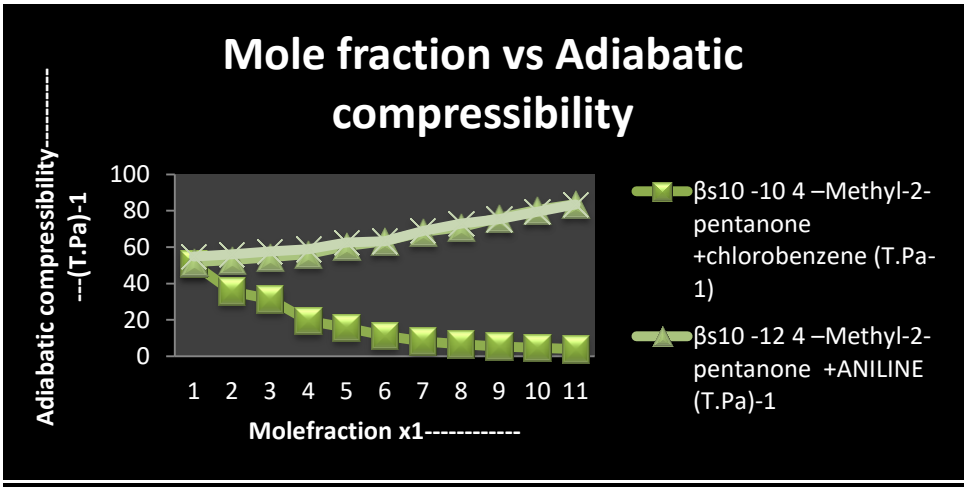


Fig. 2. *Mole Fraction Vs Adiabatic Compressibility.*

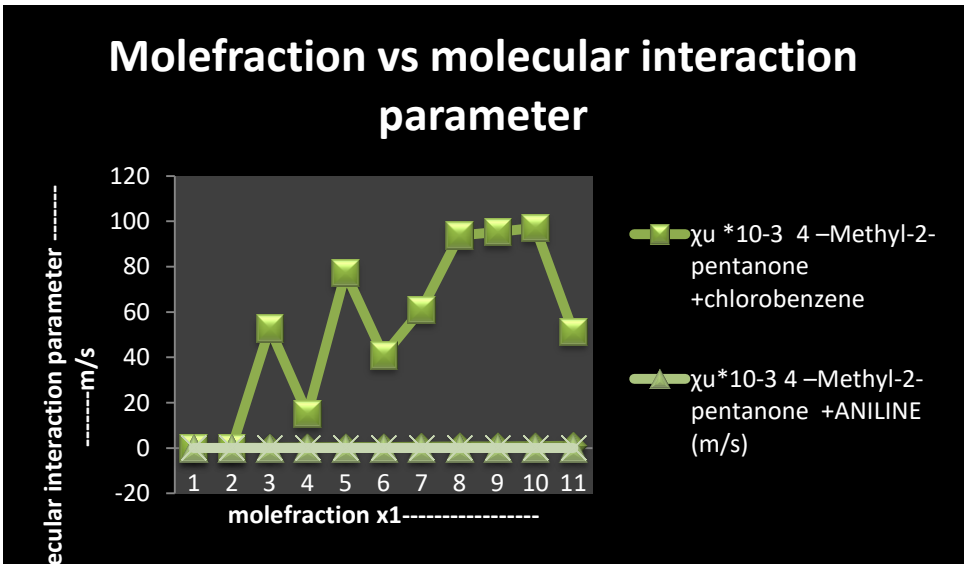


Fig. 3. *Mole Fraction Vs Molecular Interaction Parameter.*

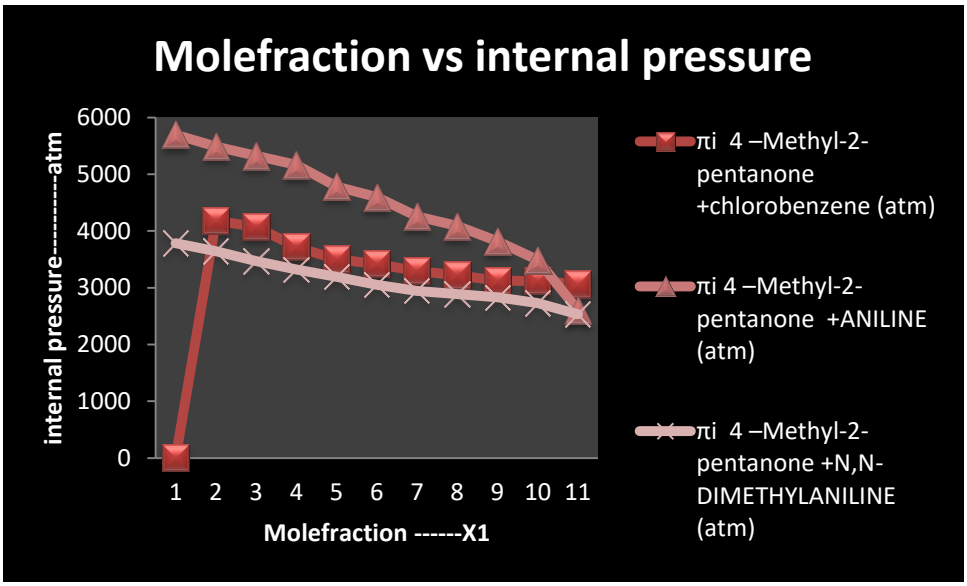


Fig. 4. *Mole Fraction Vs Internal Pressure.*

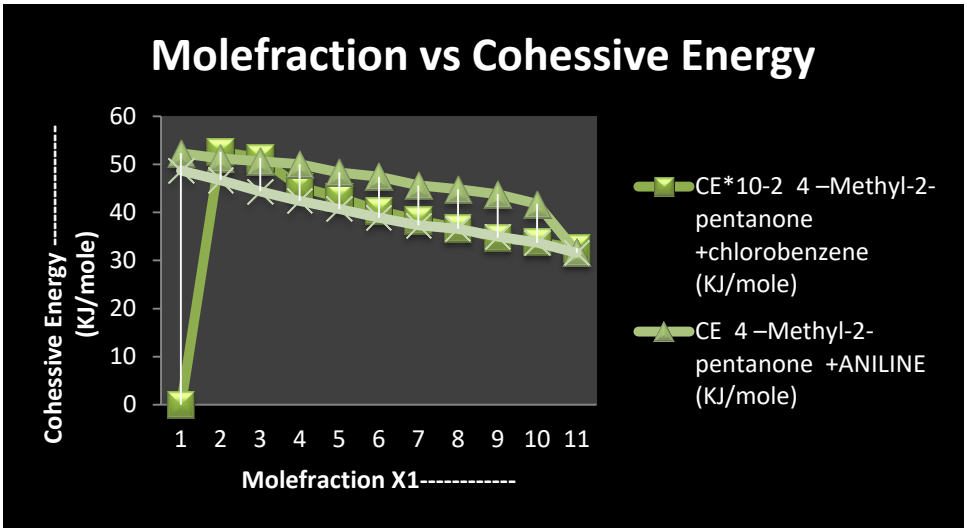


Fig. 5. *Mole Fraction Vs Cohesive Energy.*

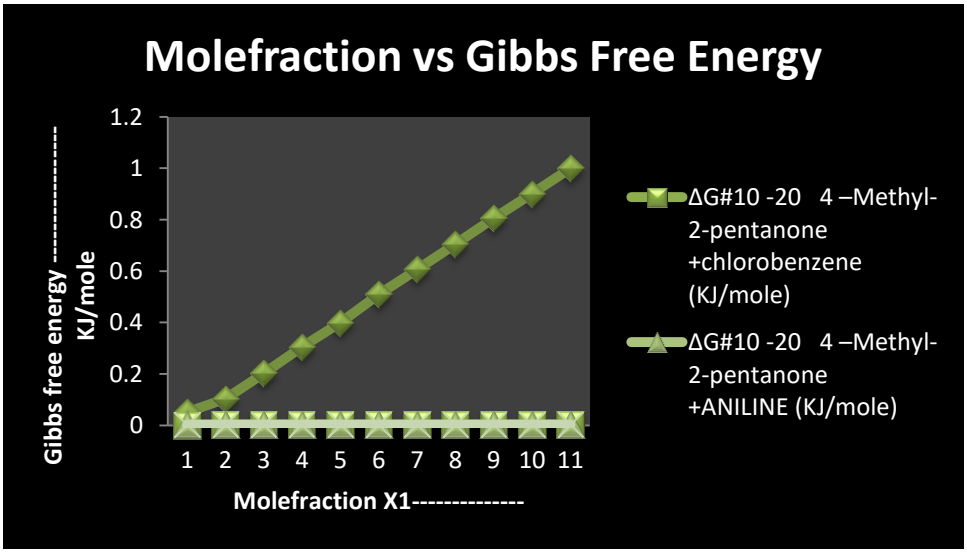


Fig. 6. *Mole Fraction Vs Gibbs Free Energy.*

RESULTS AND DISCUSSION

From the Tables 1 and 4, it is noted that the density decreases with increase in mole fraction for 4-methyl-2-pentanone+buyan-2-one, 4-methyl-2-pentanone+cyclohexanone and 4-methyl-2-pentanone+furfuraldehyde. Ultrasonic velocity and viscosity decreases with increase in mole fraction of the solute in 4-methyl-2-pentanone+buyan-2-one, 4-methyl-2-pentanone+cyclohexanone and 4-methyl-2-pentanone+furfuraldehyde.

From the Tables 1, 3 and 5, the corresponding plots are given in Figures 2 and 4. It is noted that the decrease in velocity is due to the increase in free length and adiabatic compressibility. The decrease in velocity is due to the increase in free length and adiabatic compressibility of the liquid mixtures system 4-methyl-2-pentanone+buyan-2-one, 4-methyl-2-pentanone+cyclohexanone and 4-methyl-2-pentanone+furfuraldehyde. It is observed that for a given concentration as the number of CH group or chain length increases, the sound velocity increases.

From the Tables 2, 4 and 6, the corresponding plots are given in Figures 2 and 4. It is noted that the adiabatic compressibility and free length increases with increase of mole fraction in system 4-methyl-2-pentanone+cyclohexanone and 4-methyl-2-pentanone+furfuraldehyde.
This may lead to the presence of specific molecular interaction between the molecules of the liquid mixture. The adiabatic compressibility and free length are the deciding factors of the ultrasonic velocity in liquid systems. The internal pressure decreases and free volume increases with increasing mole fraction.

The internal pressure free volume values are tabulated in 2, 4 and 6. The corresponding plots are given in Figures 3 and 4, it is noted that the internal pressure may give information regarding the nature and strength of forces existing between the molecules. The decrease in free volume shows that the strength of interaction decreases gradually with the increase in solute concentration. It represents that there is weak interaction between the solute and solvent molecules.

When two liquids are mixed, there is a molecular attraction between the molecules of components and hence the cohesive energy is high. The cohesive energy and absorption coefficient values are decreased with increases in mole fractions in all the systems which may be due to weak induced dipole-induced dipole interactions in all systems.

From the Tables 1, 3 and 5, acoustic impedance decreases with increase of mole fraction in all the three systems. The relaxation time (τ) decreases with increasing concentration for all the three systems.

The dispersion of the ultrasonic velocity in the system should contain information about the characteristic time τ of the relaxation process that causes dispersion.

The relaxation time which is in the order of 10^{-12} sec is due to structural relaxation process[16–28] and in such a situation it is suggested that the molecules get rearranged due to co-operative process.[29]

The Gibb's free energy more or less same with increasing mole fraction for all the systems.

From the Tables 1, 3. The corresponding plots are given in Figures 3, 13 and 23. It is seen that the molecular interaction parameters values are more negative in system 4-methyl-2-pentanone+cyclohexanone and 4-methyl-2-pentanone+furfuraldehyde than 4-

methyl-2-pentanone+butan-2-one. It is suggested that dipole-dipole interactions stronger than induced dipole-induced dipole interactions.

From the Tables 2 and 5, the corresponding plots are given in Figure 6. The Gibb's free energy decreases with increasing mole fraction of all the systems. This may be due to the intermediate compound formation between binary liquids. It is observed generally free energy decrease favors the formation of products from reaction. This Observation confirms the formation of hydrogen bonding in binary mixtures.

Hence, from these factors, there is less intermolecular hydrogen bond formation and less dipole-dipole interaction in 4-methyl-2-pentanone+cyclohexanone and 4-methyl-2-pentanone+furfuraldehyde than 4-methyl-2-pentanone+butan-2-one.

CONCLUSION

The computed acoustical parameters and their values point to the presence of specific molecular interaction in the liquid mixtures 4-methyl-2-pentanone+cyclohexanone and 4-methyl-2-pentanone+furfuraldehyde than 4-methyl-2-pentanone+butan-2-one at 308 K. Hence, it is concluded that the association in these mixtures is the result of strong hydrogen bonding between the molecules and strong dipole–dipole interactions 4-methyl-2-pentanone+cyclohexanone and 4-methyl-2-pentanone+furfuraldehyde than 4-methyl-2-pentanone+butan-2-one in binary liquid mixtures.

The proportional studies of divergence in these systems are given by cumulative order. 4-Methyl-2-pentanone+cyclohexanone and 4-methyl-2-pentanone+furfuraldehyde than 4-methyl-2-pentanone+butan-2-one. These parameters will be useful in pharmacy and perfumes industries for handling and mixing process.

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