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Ultrasonic Studies on Binary Mixtures of Acetyl Acetone at Room Temperature

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ABSTRACT

The ultrasonic velocity (U), density (ρ) and viscosity (η) measurements have been carried out for the binary mixtures of acetyl acetone with benzene, carbon tetra chloride and isoamyl alcohol at room temperature. From the measured values of ultrasonic velocity, density and viscosity, parameters such as internal pressure (π_i), Free volume (V_f) and acoustical parameters such as adiabatic compressibility (β), inter molecular Free length (L_f), acoustic impedance (Z), relaxation time (τ) have been calculated. The results have been analyzed and interpreted in terms of molecular interactions.

Key words: Adiabatic compressibility, free volume, Binary mixtures, Relaxation time, internal pressure, Free length.

INTRODUCTION

Ultrasonic methods find extensive applications for characterizing aspects of physicochemical behaviour such as the nature of molecular interactions in pure liquids as well as liquid mixtures. The thermodynamic functions of binary liquid mixtures provide insight into the structure breaking and making effect of the component liquids. Derived parameters such as internal pressure and free volume studies will be useful to know the molecular interactions of the systems. Ultrasonic velocity is one of the important parameters, frequently used to investigate intermolecular interactions in binary liquid mixtures [1-4]. Ultrasonic velocity measurements

have been successfully employed to detect and assess weak and strong molecular interactions, present in binary [5,6] and ternary [7,8] liquid mixtures. In this paper, an attempt to investigate the ultrasonic studies of acetyl acetone in benzene, carbon tetrachloride, isoamyl alcohol binary liquid mixture systems at room temperature are made. We have measured density (ρ), ultrasonic velocity (U), viscosity (η) of mixtures of acetyl acetone + benzene, + carbon tetra chloride, + isoamyl alcohol with different mole fractions at a temperature of 301 K. From this data, acoustical parameters like adiabatic compressibility (β), Inter molecular Free length (L_f), Acoustic impedance (Z), Relaxation time (τ) are computed. Results are used to explain the nature of molecular interactions between mixing compounds.

METHODOLOGY

All the chemicals used in present work were analytical reagent (AR) grade (99.9% pure) The liquids were thoroughly distilled to remove dissolved impurities using standard chemical procedures[9] . The purity of the samples was checked by the density measurements and the results were compared with the literature values. Ultrasonic velocities were measured with ultrasonic interferometer (model F80) supplied by Mittal enterprises, New Delhi, operating at a frequency of 2 MHz. It has an accuracy of ±0.1%. Viscosities of pure compounds and their mixtures were determined using Ostwald's viscometer with an accuracy of ±0.002%, calibrated with double distilled water. The densities of pure compounds and their solutions were measured accurately using 10 mL specific gravity bottles in Dhona electric balance precisely and the accuracy in weighing is ±0.1 mg. Acoustic parameters such as adiabatic compressibility (β), acoustic impedance (Z), relaxation time (τ), free length (L_f), internal pressure (π_i) and free volume (V_f) were determined using the following relations [10] .

RESULTS AND DISCUSSIONS

The binary mixture systems taken up for the present study are: acetyl acetone + benzene (I) and acetyl acetone + carbon tetra chloride (II). The experimentally determined values of velocity, density and viscosity these value listed in Table 1. The two binary systems, the ultrasonic velocity increases with increasing concentration of acetyl acetone. The variation of ultrasonic velocity in a solution depends upon the increase or decrease of intermolecular free length after mixing the components.

Table 1: Velocity (U), density (ρ), viscosity (η), of binary liquid systems I & II at room temperature.

System I

X	Velocity (m/sec)	Density (10^3kg/m^3)	Viscosity (Pa)
0.0000	1260.0	0.8722	0.6167
0.0757	1262.1	0.8737	0.6188
0.1681	1264.6	0.8930	0.6224
0.2405	1266.3	0.8950	0.6248
0.5292	1272.4	0.9183	0.6604

System II

X	Velocity (m/sec)	Density (10^3kg/m^3)	Viscosity (Pa)
0.0000	893.0	1.6279	1.0416
0.1558	931.7	1.6259	1.0415
0.3600	1047.8	1.6107	0.9995
0.5875	1086.5	1.6026	0.9989
0.7487	1163.9	1.5783	0.9752

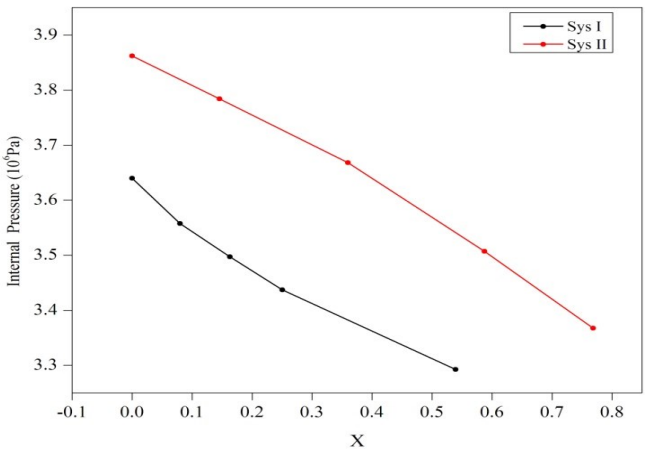


Figure 1.

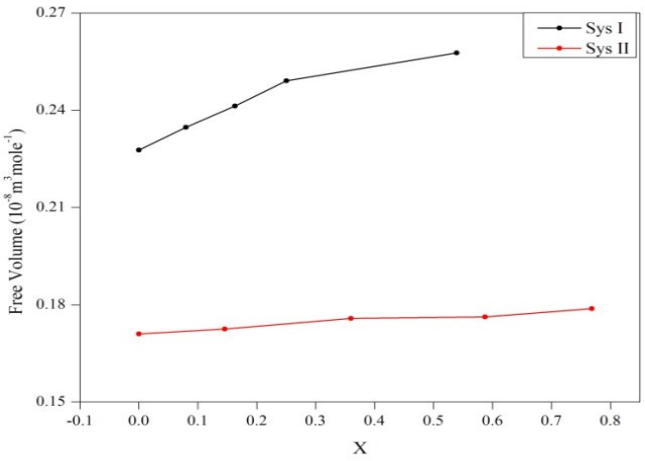
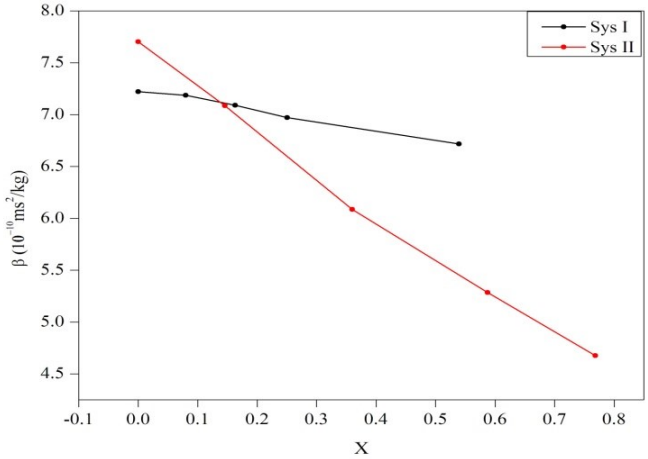


Figure 2.



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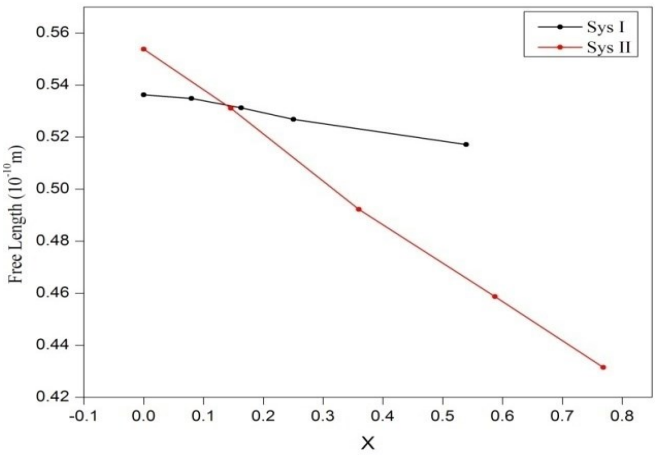

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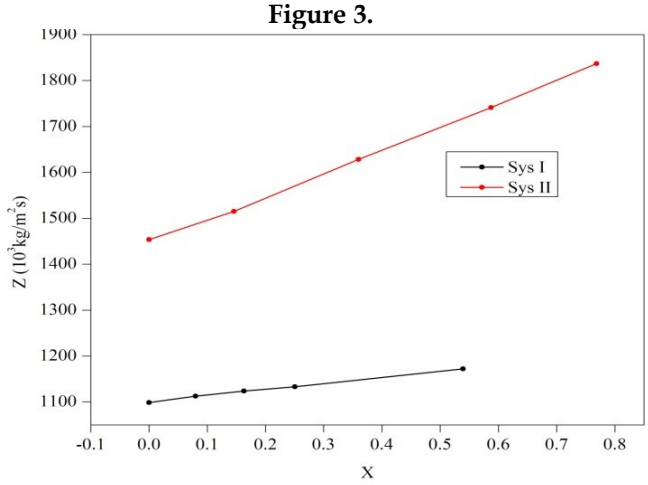

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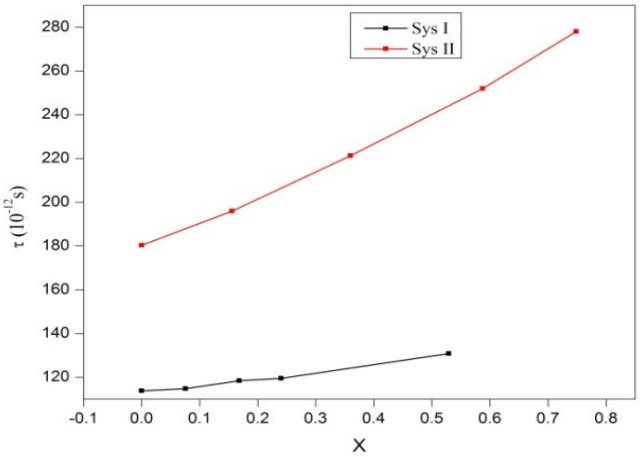

Figure 6.

Figure 1. Variation of internal pressure (π_i), with mole fraction for two systems
Figure 2. Variation of free volume (V_f)), with mole fraction for two systems
Figure 3. Variation of adiabatic compressibility (β), with mole fraction for two systems
Figure 4. Variation of free length (L_f), with mole fraction for two systems
Figure 5. Variation of acoustic impedance (Z), with mole fraction for two systems
Figure 6. Variation of relaxation time (τ), with mole fraction for two systems

Based on the model for sound propagation proposed by eyring and K incaid [11], ultrasonic velocity should increase, if the inter molecular free length decreases and vice versa. This fact was noticed in the present study for all the three binary liquid systems. Same trend was noticed by earlier workers [12] in their liquid mixtures. Using these values to calculated values of internal pressure (π_i), Free volume (V_f), adiabatic compressibility (β), Free length (L_f), acoustic impedance (Z) and relaxation time (τ) for all the systems at room temperature.

Figure 1-6 represents the variation of internal pressure (πi), Free volume (V_f), adiabatic compressibility (β), Free length (L_f), acoustic impedance (Z) and relaxation time (τ) with mole fraction for all the systems I and II.

In system I, benzene is a non polar liquid and as the concentration of acetyl acetone increases there will be induced polarization in the benzene molecule and this result in molecular association. In fact, the molecular association increases ultrasonic velocity (U) and acoustic impedance (Z), decreases intermolecular free length (L_f) and adiabatic compressibility (β). A reduction in adiabatic compressibility (β) is an indication that component molecules are held close to each other. The decrease in the values of adiabatic compressibility (βs) and inter molecular free length (L_f) with increase in ultrasonic velocity (U) further strengthens the strong molecular association between the unlike molecules through hydrogen bonding. In system II, carbon tetra chloride is a non polar liquid and the parameters are expected to show the same trend as in system I. This fact is reflected clearly from the values of ultrasonic velocity (U), intermolecular free length (L_f), adiabatic compressibility (βs) and acoustic impedance (Z) for system II.

CONCLUSION

In system I inter molecular association is weak. In system II the molecular associations are stronger due to inter molecular hydrogen bonding.

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