

Molecular Interactions in Binary Organic Liquid Mixtures Containing Ethyl Oleate and Ethanol at 2MHz Frequency

Srilatha Manukonda¹, G. Pavan Kumar², Ch. Praveen Babu²

¹Research Scholar, Department of Chemistry, A.U. College of Engineering, Visakhapatnam, India

²Research Scholar, Department of Physics, Andhra University, Visakhapatnam, India

E-mail address: bvsaradhi70@gmail.com

ABSTRACT

Molecular interactions of binary mixtures of Ethanol with a new organic compound Ethyl Oleate are investigated at a constant ultrasonic frequency of 2MHz under the temperature range of 303.15K-318.15K. The effect of mole fraction of Ethyl Oleate on velocity of sound wave and the density and viscosity of binary mixtures at various temperatures were studied. The effects on density (ρ), viscosity (η), adiabatic compressibility (β_{ad}), inter molecular free length (L_f) and internal pressure (Π_i) also was studied.

Keywords: Ethyl Oleate, Ethanol, molecular interactions, adiabatic compressibility

1. INTRODUCTION

Molecular interactions are interactions between electrically neutral molecules or atoms. Other than atomic bonds these are electrical in nature and consist of attractive forces (orientation, induction, and dispersion forces) and repulsive forces. Molecular interaction first taken into consideration by J. D. van der Waals (1873) in explaining the properties of real gases and liquids. These depend on the distance between the molecules and usually are described by the potential energy of interaction. Studies on liquid- liquid mixtures either binary, ternary or more has importance of its own in various fields of contemporary civilized societies like chemical engineering, food processing, preparation of cosmetics, polymer paints and cleansing agents, petroleum, edible and non edible oil, preparation of bio diesel etc. Ultrasonic waves have their extensive applications in various fields like nondestructive tests for solids and liquids in medical and engineering, food processing, pharmaceutical, polymer and chemicals, metallurgical industries etc. It will be an advantageous tool if these two fields were combined for conducting studies on inter and intra particulate behavior. Ultrasonic investigations of binary mixtures have been taking place since decades by so many scholars under various heads like acoustic, thermodynamic, molecular interactions etc. Lot of literature survey has been conducted as part of author's doctoral program and found some new compounds with an observation that there were no publications till now in the field of ultrasonic studies on binary mixtures with fatty acid ethyl ester (Z)-9-Octadecenoic Acid Ethyl Ester. The author has been carrying out the studies on binary organic liquid mixture of

fatty acid ethyl ester (Z)-9-Octadecenoic Acid Ethyl Ester (here after called as Ethyl Oleate) with some selected alcohols (ethanol, butanol, iso propyl alcohol), amines (aniline, o-toluidine, m-toluidine), aromatic and halogenated aromatic hydrocarbons (toluene, o-xylene, o-chlorotoluenes), carbonyl compounds (acetophenane, benzaldehyde, cyclohexanone) and some esters as doctoral research work. In the present paper the author submitting part of the studies as the effect of temperature and concentration on ultrasonic velocity(v) of 2MHz wave in the pure and mixtures of two organic liquids Ethyl Oleate and Ethanol at various temperatures 303.15K, 308.15K, 313.15K and 318.15K. The effects on density (ρ), viscosity (η), Adiabatic compressibility (β_{ad}), Inter molecular free length (L_f) and Internal pressure (Π_i) also were studied. Results were tabulated and the relations among the mentioned parameters were represented as Graph.1.

2. MATERIALS

Organic liquids Ethyl Oleate ($C_{20}H_{38}O_2$, 310.51g /mol) and Ethanol (C_2H_6O , 46.08644 gm/mol) of AR grade were procured from Sigma-Aldrich with CAS no.111-62-6 and 64-17-5 respectively are used directly without purification. The densities and viscosities of the liquid compounds were measured with specific gravity bottle/pycnometer and Ostwald viscometer pre calibrated with 3D water of Millipore to nearest mg/ml. The time taken for flow of viscous fluid in Ostwald viscosity meter is measured to a nearest 0.01 sec. Borosilicate glassware, Japan make Shimadzu electronic balance of sensitivity ± 0.001 gm and constant temperature water bath of accuracy ± 0.1 K were used while conducting the experiments 2MHz ultrasonic interferometer model no. **F-05 (S.No.1314421)** with least count of micrometer 0.001mm of Mittal Enterprises was used for calculating velocities of sound waves and all the tests were conducted as per ASTM standard procedures.

3. EXPERIMENT AND RESULTS

Ethyl Oleate and Ethanol were mixed in different mole fractions and the physical parameters density and viscosity were measured with standard methods by varying the temperature from 303.15 K to 318.15 K. The velocity of 2MHz ultrasonic wave in pure and liquid mixtures was determined with interferometer at each temperature. The results obtained for pure liquids were compared with the available literature and presented in Table.1.

Table 1. Density, viscosity and velocity of pure compounds.

| Compound | Temp. K | Density (ρ) kg/m ³ | | Viscosity(η) Ns/m ² | | Velocity (U) m/s | |
|--------------|---------|--------------------------------------|---------------------|---------------------------------------|---------------------|------------------|---------------------|
| | | Expe. | Lite. | Expe. | Lite. | Expe. | Lite. |
| Ethyl Oleate | 303.15 | 863.50 | 863.20 ³ | 5.3101 | 5.3094 ³ | 1368.16 | - |
| | 308.15 | 859.34 | 859.50 ³ | 4.7164 | 4.7156 ³ | 1340.78 | - |
| | 313.15 | 855.62 | 855.80 ³ | 4.2163 | 4.2137 ³ | 1324.00 | - |
| | 318.15 | 852.04 | 852.20 ³ | 3.7820 | 3.7876 ³ | 1305.09 | - |
| Ethanol | 303.15 | 787.90 | 781.00 ² | 0.9917 | 0.9944 ⁸ | 1127.80 | 1132.2 ⁸ |
| | 308.15 | 785.30 | - | 0.8974 | 0.9015 ⁸ | 1115.20 | 1117.6 ⁸ |
| | 313.15 | 784.00 | 772.90 ² | 0.8133 | 0.8306 ⁸ | 1100.60 | 1101.6 ⁸ |
| | 318.15 | 780.90 | 768.00 ⁷ | 0.7553 | 0.7642 ⁸ | 1084.40 | 1084.7 ⁸ |

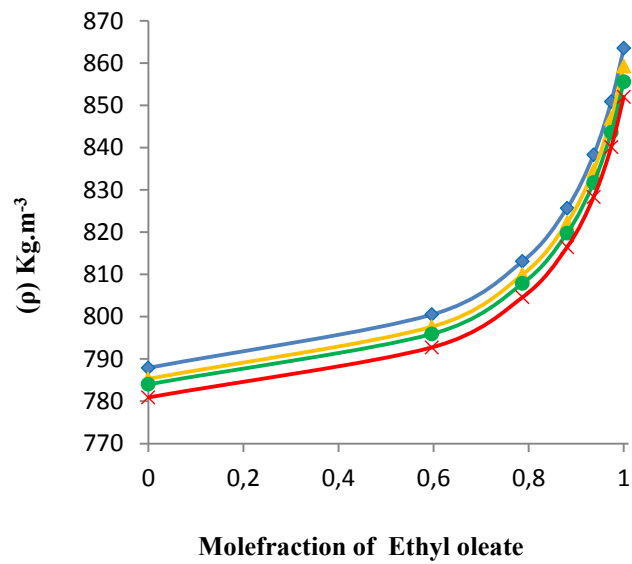
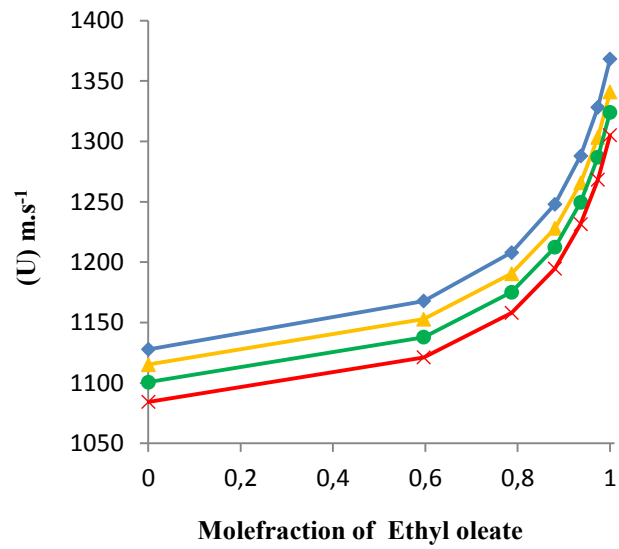
The density, viscosity and velocity for mixtures of various mole fractions of Ethyl Oleate are presented in Table 2. along with the some thermodynamic parameters Adiabatic compressibility, Inter molecular free length and Internal pressure. The density, viscosity and velocity for pure solutions are decreasing with the increase of temperatures.

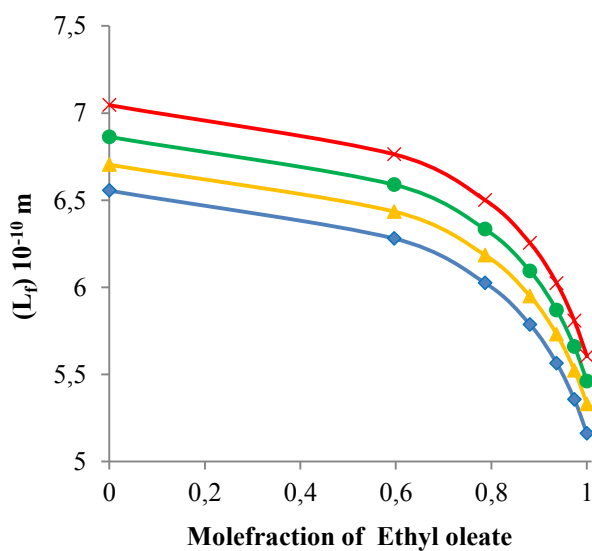
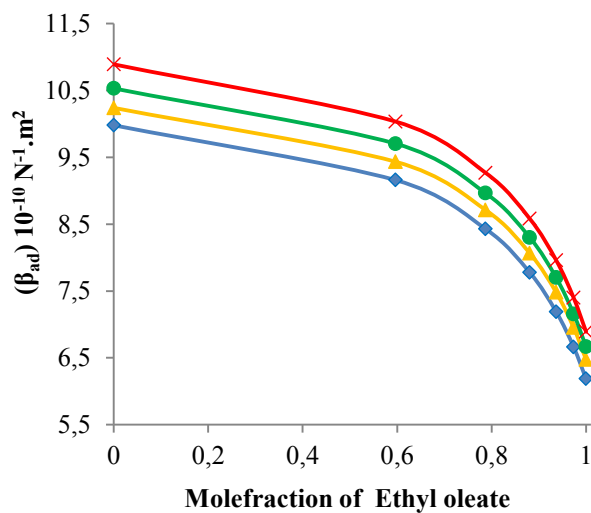
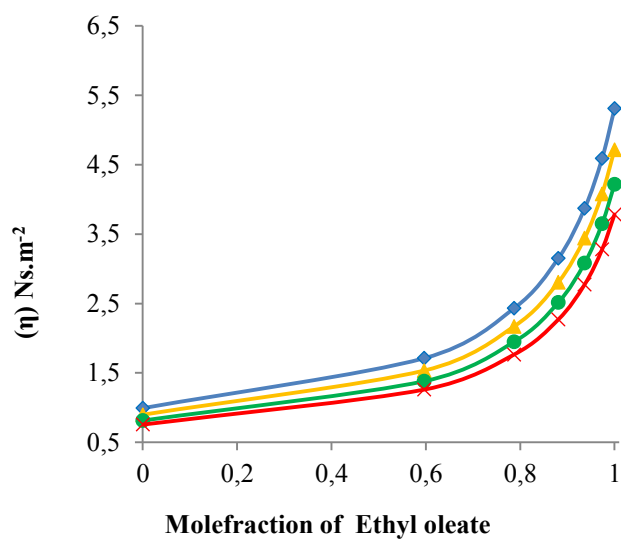
From the graphs drawn it is observed that adiabatic compressibility and inter molecular free length are decreasing with the increase of mole fraction of Ethyl Oleate at a constant temperature where as density, viscosity, velocity and internal pressure are increasing.

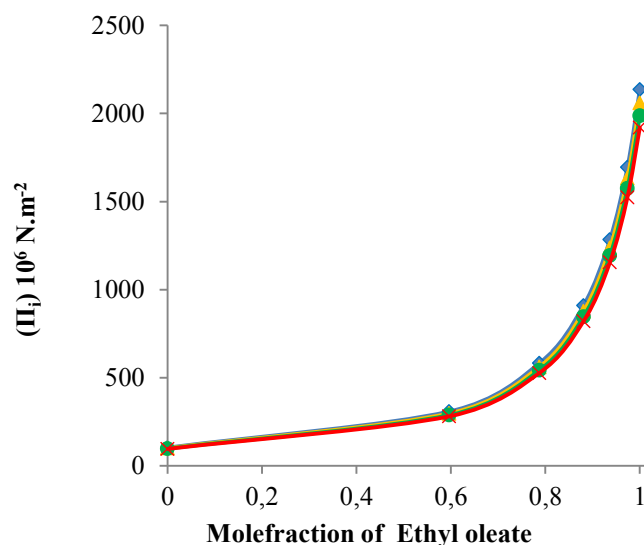
Tables 2. Binary mixture of Ethyl Oleate + Ethanol.

| Mole fraction X_1 | Velocity m/sec U | Density Kg/m^3 ρ | Viscosity Nsm^{-2} η | Adiabatic Compressibility $10^{-10} \text{N}^{-1}.\text{m}^2$ β_{ad} | Intermolecular free length 10^{-10}m L_f | Internal Pressure 10^6N.m^{-2} Π_i |
|------------------------|------------------------|--------------------------------------|--|---|---|---|
| 303.15 K | | | | | | |
| 0.0000 | 1127.8 | 787.9 | 0.9917 | 9.9784 | 6.5546 | 103.2532 |
| 0.5964 | 1167.86 | 800.5 | 1.7112 | 9.1591 | 6.2798 | 308.0956 |
| 0.7870 | 1207.92 | 813.1 | 2.4307 | 8.4290 | 6.0243 | 581.9620 |
| 0.8808 | 1247.98 | 825.7 | 3.1502 | 7.7761 | 5.7862 | 910.2278 |
| 0.9366 | 1288.04 | 838.3 | 3.8697 | 7.1902 | 5.5640 | 1283.1988 |
| 0.9736 | 1328.1 | 850.9 | 4.5892 | 6.6628 | 5.3560 | 1693.7541 |
| 1.0000 | 1368.16 | 863.5 | 5.3087 | 6.1867 | 5.1611 | 2136.3686 |
| 308.15K | | | | | | |
| 0.0000 | 1115.2 | 785.3 | 0.8974 | 10.2390 | 6.7036 | 100.1830 |
| 0.5964 | 1152.8 | 797.63 | 1.5338 | 9.4338 | 6.4347 | 297.4857 |
| 0.7870 | 1190.4 | 809.96 | 2.1702 | 8.7126 | 6.1838 | 561.1592 |
| 0.8808 | 1228 | 822.29 | 2.8066 | 8.0645 | 5.9493 | 877.3912 |
| 0.9366 | 1265.6 | 834.62 | 3.443 | 7.4802 | 5.7298 | 1236.9985 |
| 0.9736 | 1303.2 | 846.95 | 4.0794 | 6.9521 | 5.5238 | 1633.2170 |
| 1.0000 | 1340.8 | 859.28 | 4.7158 | 6.4734 | 5.3303 | 2060.7837 |
| 313.15 K | | | | | | |
| 0.0000 | 1100.6 | 784 | 0.8133 | 10.5299 | 6.8631 | 97.4537 |
| 0.5964 | 1137.85 | 795.93 | 1.3804 | 9.7040 | 6.5885 | 287.8926 |
| 0.7870 | 1175.1 | 807.86 | 1.9475 | 8.9642 | 6.3323 | 542.0498 |
| 0.8808 | 1212.35 | 819.79 | 2.5146 | 8.2992 | 6.0929 | 846.7372 |
| 0.9366 | 1249.6 | 831.72 | 3.0817 | 7.6998 | 5.8688 | 1193.1741 |
| 0.9736 | 1286.85 | 843.65 | 3.6488 | 7.1578 | 5.6584 | 1574.8874 |
| 1.0000 | 1324 | 855.58 | 4.2159 | 6.6675 | 5.46125 | 1986.9125 |
| 318.15 K | | | | | | |
| 0.0000 | 1084.4 | 780.9 | 0.7553 | 10.8899 | 7.0454 | 95.8705 |
| 0.5964 | 1121.18 | 792.75 | 1.2598 | 10.0349 | 6.7632 | 280.7083 |
| 0.7870 | 1157.96 | 804.6 | 1.7643 | 9.2689 | 6.5000 | 526.5448 |
| 0.8808 | 1194.74 | 816.45 | 2.2688 | 8.5807 | 6.2540 | 820.8146 |
| 0.9366 | 1231.52 | 828.3 | 2.7733 | 7.9602 | 6.0236 | 1155.1250 |
| 0.9736 | 1268.3 | 840.15 | 3.2778 | 7.3994 | 5.8076 | 1523.2791 |
| 1.0000 | 1305.08 | 852 | 3.7823 | 6.8910 | 5.6045 | 1920.4477 |

◆ 303.15 ▲ 308.15 ● 313.15 × 318.15







Graphs 1. Mole fraction of Ethyl Oleate VS velocity, density, viscosity, Adiabatic compressibility, Inter molecular free length and Internal pressure.

4. CONCLUSIONS

The velocity, density and viscosity of the pure liquids Ethyl Oleate and Ethanol are matching with pervious literature at various temperatures. The formation of .dipole-dipole interactions or hydrogen bonding is expected in binary mixture. Excess parameters will help in estimating the molecular interactions.

Acknowledgement

The author is very much thankful to University Grants Commission for the financial support through RGNF and Prof. Battula Venkateswara Rao research guide.

References

- [1] Joseph Kestin, Mordechai Sokolov, Willium A. Wakeham, *J. Phys. Chem. Ref. Data* 7(3) (1978) 941-948.
- [2] G. Sivaramprasad, M. Venkateshwara Rao, *J. Chem. Eng. Data* 35 (1990) 122-124.
- [3] Maria M. Palaiologou, Ioama E. Molinou, *J. Chem. Engs.* 40 (1995) 880-882.
- [4] T. E. Vittal Prasad, K. Chandrika, M. Haritha, N. B. Geetha, D. H. L. Prasad, *Physics and Chemistry of Liquids: An International Journal* 37 (1999) 429-434.
- [5] Hiannie Djojoputro, Suryadi Ismadji, *Journal of Chemical and Engineering Data* 50(3) (2005) 1009-1013.
- [6] Mustafa Vatandas, Ali Bulent Koc, Caner Koc, *Eur Food Res Technol.* 225 (2007) 525-532.

-
- [7] Rui M. Pires, Henrique F. Costa, Abel G. M. Ferreira, Isabel M. A. Fonseca, *J. Chem. Eng. Data* 52 (2007) 1240-1245
- [8] Anil Kumar Nain, *Journal of Molecular Liquids* 140 (2008) 108-116.
- [9] Ezekiel D. Dikio, Simphiwe M. Nelana, David A. Isabirye, Eno E. Ebenso. *Int. J. Electrochem. Sci.* 7 (2012) 11101-11122.
- [10] J. N. Ramteke, *Advances in Applied Science Research* 3(3) (2012) 1832-1835.
- [11] Bhandakkar V. D., Bhat V. R, Asole A.W., Chimankar O. P., *International Journal for Pharmaceutical Research Scholars* V-3(I-1) (2014) 544-549.
- [12] R. S. Watane, P. B. Raghuvanshi, *Der Pharma Chemica* 6(4) (2014) 162-168.
- [13] Bhandakkar V. D., Bhat V. R., Chimankar O. P., Asole A. W., *Advances in Applied Science Research* 5(2) (2014) 80-85.
- [14] Verma R.C., Singh A.P., Gupta J., Gupta R., *International Journal of Pharmaceutical Research and Bio-Science* 3(3) (2014) 66-72.

(Received 01 October 2014; accepted 10 October 2014)