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Ultrasonic studies on binary mixtures of (Z)-9-octadecenoic acid ethyl ester with o-chlorotoluene at 303.15K, 308.15K 313.15K and 318.15K temperatures

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ABSTRACT

Density, viscosity and ultrasonic velocities at various temperatures for organic ester Ethyl Oleate in pure and as binary mixture with o-Chlorotoluene were measured at different mole fractions. The relationship among the derived quantities adiabatic compressibility and intermolecular free length were calculated. The effect of mole fraction on the velocity of 2M Hz frequent ultrasonic wave at 303.15K 308.15K, 313.15K and 318.15K is measured with interferometer and presented in this paper.

Key words: (Z)-9-Octadecenoic Acid Ethyl Ester (Ethyl Oleate), o-Chlorotoluene, Interferometer

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INTRODUCTION

Studies on liquid- liquid mixtures either binary, ternary or more has importance of its own in various fields of con temporal 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 (acetophenone, benzoldehyde, 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 (**U**) of 2MHz wave in the pure and mixtures of two organic liquids Ethyl Oleate and o-Chlorotoluene at various temparatures 303.15K, 308.15K, 313.15K and 318.15K. The effect of temperature on density (**ρ**), viscosity (**η**), Adiabatic compressibility (β_{ad}), Inter molecular free length (L_f) and internal pressure (Π_i) were calculated. Results were tabulated and the relations among the mentioned parameters were represented as graphs.

MATERIALS AND METHODES

Organic liquids Ethyl Oleate ($C_{20}H_{38}O_2$, 310.51g/mol) and o-Chlrotoluene (C_7H_7Cl, 126.586g/mol) of AR grade were procured from Sigma-Aldrich with CAS no.111-62-6 and 95-49-8 respectively. The densities and viscosities of the liquid compounds were measured with pyknometer and Ostwold viscometer pre calibrated with 3D water of Millipore to nearest mg/ml. The time taken for flow of viscous fluid in Ostwold viscosity meter is measured to a nearest 0.01 sec. Borosilicate glassware, Japan make Shimadzu electronic balance of sensitivity $\pm$0.001gm and constant temperature water bath of accuracy $\pm$0.1K 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.

RESULTS AND DISCUSSION

Velocity of 2MHz ultrasonic wave in pure liquids, densities and viscosities of Ethyl Oleate and o-Chlorotoluene were measured with pre calibrated interferometer, Pycknometer and viscosity meters respectively to nearest mg in the temperature range of 303.15K to 318.15K. The results were compared with available literature and shown in table.1. The velocities, densities and viscosities of binary mixtures at other said temperatures were also measured. The derived quantities adiabatic compressibility, intermolecular free length and internal pressure also were calculated and given in table.2. The graphs for mole fraction of Ethyl Oleate X_1 vs velocity (U), density (ρ), viscosity (η), adiabatic compressibility (β_{ad}), inter molecular free length (L_f) and internal pressure (Π_i) were drawn and presented as Fig.1.

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

Compound	Temp. K	Density(ρ) kg/m^3		Viscosity(η) Ns/m^2		Velocity (v) m/s	
		Exp.	Lit.	Exp.	Lit.	Exp.	Lit.
Ethyl Oleate	303.15	863.50	863.20[4]	5.3101	5.3094[4]	1368.16	-
	308.15	859.34	859.50[4]	4.7164	4.7156[4]	1340.78	-
	313.15	855.62	855.80[4]	4.2163	4.2137[4]	1324.00	-
	318.15	852.04	852.20[4]	3.7820	3.7876[4]	1305.09	-
o-Chlorotolune	303.15	1072.76	1072.46[10]	0.8869	0.885[6]	1276.96	1284[6]
	308.15	1068.26	1067.57[10]	0.8086	0.805[6]	1265.90	1266[6]
	313.15	1064.00	1064.01[14]	0.7351	-	1247.80	1248[14]
	318.15	1063.60	-	0.6902	-	1227.20	-

Table.2. Binary mixture of Ethyl Oleate + o-Cholorotoluene

Mole fraction X_1	Velocity m/sec U	Density Kg/m^3 ρ	Viscosity Nsm^{-2} η	Adiabatic Compressibility 10^{-10} N^{-1}.m^2 β_{ad}	Intermolecular free length 10^{-10} m L_f	Internal Pressure 10^6 N.m^{-2} Π_i
303.15 K						
0.0000	1276.96	1072.76	0.8869	5.7166	4.9612	112.7286
0.2831	1292.16	1037.88	1.6241	5.7705	4.9845	183.7650
0.4967	1307.36	1003.00	2.3613	5.8331	5.0115	261.0235
0.6638	1322.56	968.13	3.0985	5.9052	5.0423	346.2954
0.7979	1337.76	933.25	3.8357	5.9874	5.0773	440.3442
0.9080	1352.96	898.38	4.5729	6.0809	5.1168	543.7022
1.0000	1368.16	863.50	5.3101	6.1867	5.1611	656.8710
308.15K						
0.0000	1265.90	1068.26	0.8086	5.8414	5.0634	109.5818
0.2831	1278.38	1033.44	1.4599	5.9209	5.0977	177.5261
0.4967	1290.86	998.62	2.1112	6.0095	5.1357	251.7068
0.6638	1303.34	963.80	2.7625	6.1079	5.1776	333.7625
0.7979	1315.82	928.98	3.4138	6.2172	5.2237	424.4211
0.9080	1328.30	894.16	4.0651	6.3385	5.2744	524.2065
1.0000	1340.78	859.34	4.7164	6.4732	5.3302	633.6198
313.15 K						
0.0000	1247.80	1064.00	0.7351	6.0362	5.1963	106.6610
0.2831	1260.50	1029.27	1.3153	6.1148	5.2300	171.9754
0.4967	1273.20	994.54	1.8955	6.2027	5.2674	243.3615
0.6638	1285.90	959.81	2.4757	6.3008	5.3089	322.3384

0.7979	1298.60	925.08	3.0559	6.4101	5.3548	409.5895
0.9080	1311.30	890.35	3.6361	6.5318	5.4054	505.6117
1.0000	1324.00	855.62	4.2163	6.6671	5.4611	610.8831
318.15 K						
0.0000	1227.20	1063.60	0.6902	6.2429	5.3344	105.8535
0.2831	1240.18	1028.34	1.2055	6.3225	5.3688	168.4244
0.4967	1253.16	993.08	1.7208	6.4120	5.4062	236.9997
0.6638	1266.15	957.82	2.2361	6.5124	5.4484	312.9154
0.7979	1279.13	922.56	2.7514	6.6248	5.4952	396.8032
0.9080	1292.11	887.30	3.2667	6.7503	5.5470	489.1396
1.0000	1305.09	852.04	3.7820	6.8905	5.6043	590.3929

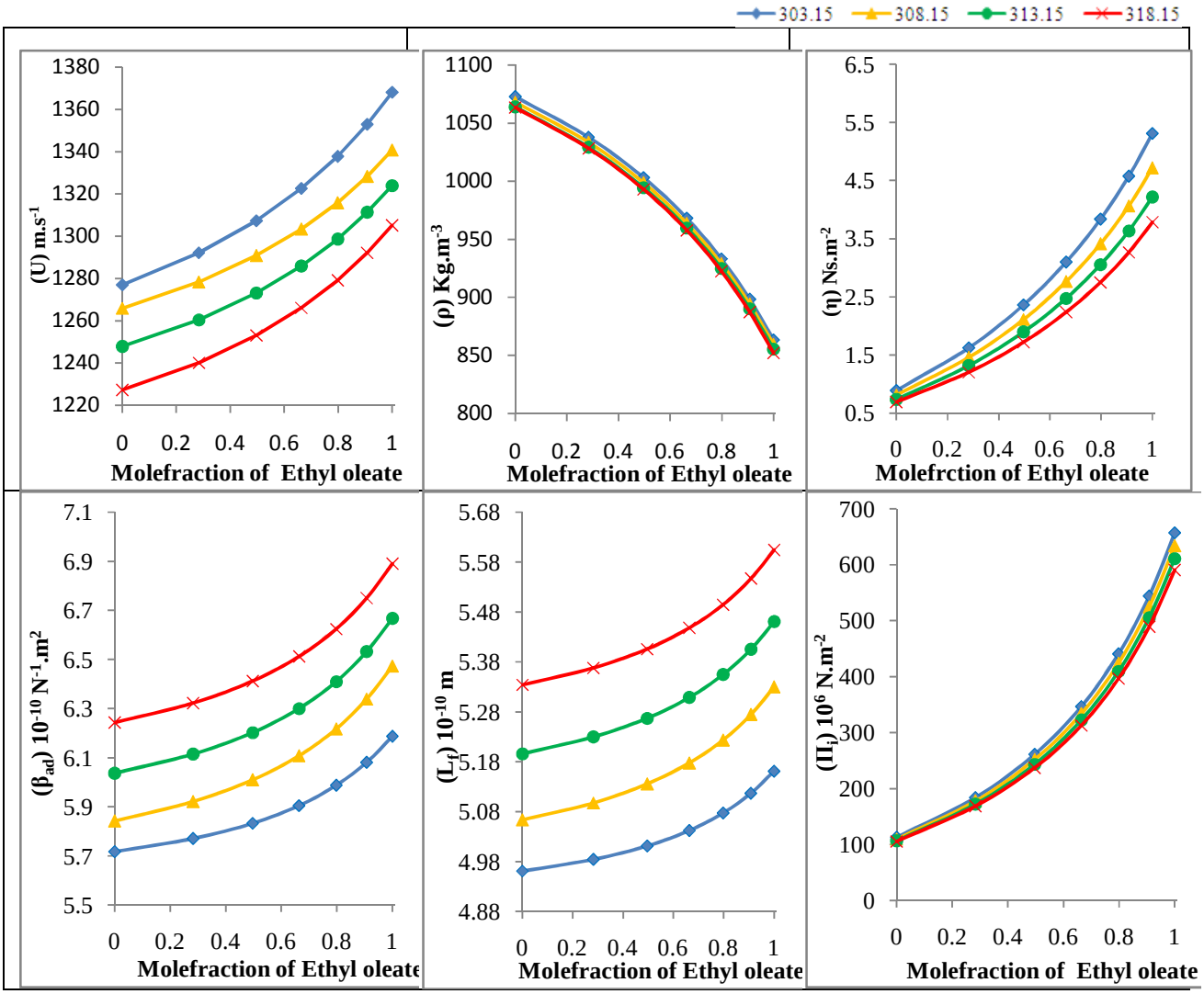

Fig.1.Graphs showing mole fraction X_1 VS velocity (v), density (ρ), viscosity (η), Adiabatic compressibility (β_{ad}), Inter molecular free length (L_f) and Internal pressure (Π_i) for binary mixture Ethyl Oleate+o-Chlorotoluene

From the above values and graphs it is observed that the velocity of the 2MHz wave is increasing with the increase of mole fraction of Ethyl Oleate. The experimental values are matching with previous literature as presented in the table.1.Velocity is decreasing with the temperature both in Ethyl Oleate and o-Chlorotoluene. Density and viscosity are following the same trends. Adiabatic compressibility and intermolecular free length both are increasing with mole fraction of Ethyl Oleate and temperature. The same trend that of velocity is observed in the case of internal pressure. Both are increasing with the increase of mole fraction of Ethyl Oleate. At all the temperatures Velocity

(U), Viscosity (η), Adiabatic compressibility (β_{ad}), Inter molecular free length (L_f) and Internal pressure (Π_i) are increasing with the mole fraction of Ethyl Oleate where as density (ρ) is decreasing.

CONCLUSION

The ultrasonic velocity, density and viscosity were measured for a new organic compound Ethyl Oleate in pure and in mixture with o-Chlorotoluene. Except the density all the mentioned parameters are increasing with the mole fraction of Ethyl Oleate. Acceptable interactions can be expected as the adiabatic compressibility is increasing with the molefraction of Ethyl Oleate. Depending on the excess parameters the exact molecular interactions can be estimated.

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