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Acoustical and Excess Thermodynamical Parameters of Sesame Oil in Different Organic Solvents

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ABSTRACT

The ultrasonic velocity has been measured for the mixtures of sesame oil with organic solvents like butyl acetate and ethyl acetate at 298.15K. The experimental data have been used to calculate the acoustical parameters namely intermolecular free length, adiabatic compressibility and specific acoustic impedance. The excess values of the above parameters are also calculated and discussed in terms of molecular interactions existing in the binary mixture.

Keywords: ultrasonic velocity, sesame oil, excess parameters, intermolecular interactions.

INTRODUCTION

The ultrasonic study of liquid and liquid mixtures has been employed in understanding the nature of the molecular interactions in pure components and their mixtures. The measurement of speed of sound gives valuable information about the physical properties and strength of molecular interactions in the mixtures [1-6]. In oil industry, organic solvents are used for extraction of oils from their seed at various stages of processes. There is great demand in the oil industry for data on the physical properties of mixture of organic solvents with edible oils in order to obtain high quality refined oils. Several reports and research works are made on the oil-solvent mixtures, but less work is made on the work on sesame oil and their mixtures with organic solvents. In the present paper, the ultrasonic velocity measurement in the oil-solvent mixtures is made and acoustical parameters and excess parameters are derived in order to study the intermolecular interactions.

MATERIALS AND METHODS

Ethyl acetate and Butyl acetate are supplied by Merck. The density of pure liquids and mixtures were measured by relative density method using 25ml relative density bottle with an accuracy of $0.001 kg/m^3$. The ultrasonic velocities of pure and liquid mixtures are measured by an ultrasonic interferometer (Mittal) at a frequency of 2 MHz with an accuracy of 0.01m/s. The measurements are made at constant temperature of 298.15K with the help of digitally controlled temperature bath with an accuracy of 0.01K.

RESULTS AND DISCUSSION

The experimental densities (ρ) and ultrasonic velocity (u) for the pure liquids are compared with the literature values and are given in Table 1.

Adiabatic compressibility (Ks)[7] has been calculated from the equation,

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

where ρ and u are density and ultrasonic velocity in liquid mixture.

The intermolecular free length (L_f)[8,9] is calculated using the Jacobson's relation,

$$L_f = \frac{K}{u\rho^{1/2}} \quad ------(2)$$

where K is the temperature Jacobson's constant given by the relation $K=(93.875+0.375\ T)\times10^{-8}$.

The specific acoustic impedance (Z)[10] is given by the formula,

$$Z = u.\rho \quad ------(3)$$

The excess values of the above parameters are calculated using the relation

$$A^E = A_{EXP} - A_{IDEAL} \quad ------(4)$$

where $A_{IDEAL} = \sum X_i A_i$ and X_i is the mole fraction and and A_i are the parameters of the ith component in the liquid mixture.
The experimental values of ultrasonic velocities of different mole fractions and the values of the various parameters namely isentropic compressibility, intermolecular free length, and acoustic impedance and their excess values are tabulated in Table-2 and 3.
The ultrasonic velocity is found to decrease when the concentration of solvents is increased and hence a corresponding increase in the isentropic compressibility is observed (Tables 2 and 3). The increase in the concentration of the solvents weakens the molecular forces and hence the abrupt change in velocity is observed at higher mole fraction.

Table-1: Comparison of density & ultrasonic velocity of pure liquids with literature values

Components	Density ρ (x10^3 Kg/m^3)		Ultrasonic velocity u (m/s)	
	Experimental	Literature[4]	Experimental	Literature
Sesame oil	0.91579	0.915-0.925[5]	1456.0	-
Butyl acetate	0.87661	0.87636	1192.0	1190[6]
Ethyl acetate	0.89507	0.89455	1147.5	1148[6]

Table-2: Ultrasonic velocity, adiabatic compressibility, intermolecular free length, acoustic impedance, excess values of acoustical parameters of binary mixture of sesame oil and butyl acetate at 298.15K.

Mole Fraction X1	U m/s	K_s Tpa^{-1}	L_f 10^{-9}m	Z X10^3 Kg/m^2/s	K_s^E Tpa^{-1}	L_f^E 10^{-9}m	Z^E (X10^{3}Kg/m^2/s)
0.0497	1453.2	517.10	1.4790	1330.77	-12.29	-0.01529	11.71
0.0991	1451.2	518.70	1.4810	1328.49	-24.91	-0.03112	23.68
0.1501	1448.0	521.23	1.4840	1324.95	-37.05	-0.04621	34.86
0.2068	1444.0	524.19	1.4890	1321.13	-50.41	-0.06282	47.40
0.2485	1440.0	527.28	1.4930	1317.02	-59.32	-0.07373	55.32
0.3017	1436.0	530.51	1.4980	1312.66	-71.40	-0.08868	66.30
0.3480	1429.4	535.72	1.5050	1305.90	-79.52	-0.09833	72.90
0.4022	1428.0	537.17	1.5070	1303.65	-93.66	-0.11618	86.28
0.4498	1420.0	543.49	1.5160	1295.75	-101.04	-0.12480	92.11
0.4990	1412.6	549.76	1.5250	1287.68	-108.93	-0.13413	98.24
0.5492	1408.0	554.03	1.5300	1281.93	-119.10	-0.14663	106.97
0.5996	1400.0	560.85	1.5400	1273.58	-126.79	-0.15573	113.16
0.6501	1394.0	566.18	1.5470	1267.01	-135.99	-0.16694	121.15
0.6999	1379.2	579.65	1.5650	1250.87	-136.86	-0.16692	119.38
0.7515	1368.0	590.69	1.5800	1237.52	-140.66	-0.17100	120.92
0.8028	1352.0	606.12	1.6010	1220.30	-140.00	-0.16932	118.50
0.8502	1336.0	622.84	1.6230	1201.76	-136.91	-0.16476	113.63
0.9005	1304.0	657.22	1.6670	1166.83	-117.00	-0.13901	93.21
0.9499	1264.4	704.30	1.7260	1122.94	-84.14	-0.09845	63.57
0.9792	1231.0	747.87	1.7780	1086.21	-49.00	-0.05660	35.29

The intermolecular free length depends upon the intermolecular attractive and repulsive forces. Eyring and Kincaid[11] have proposed that L_f is a predominating factor in determining the variation of ultrasonic velocity of solution. The values of intermolecular free length listed in the tables show an increasing trend with concentration of solvents. In both the binary systems, the specific acoustic impedance is seen to decrease with increasing values of mole fraction of the solvents.

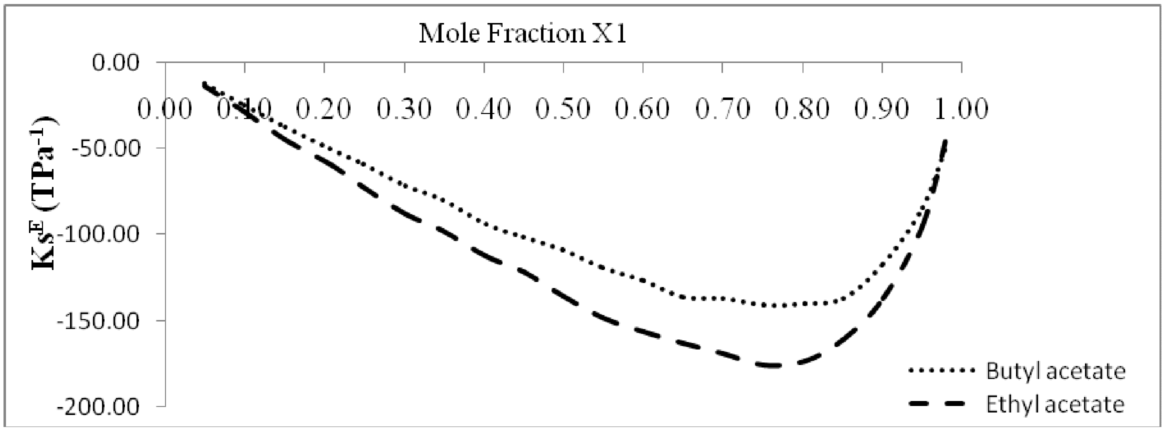

Fig.-1: Excess adiabatic compressibility of mixtures of sesame oil with various acetates at 298.15 K with mole fraction of acetate (X1).

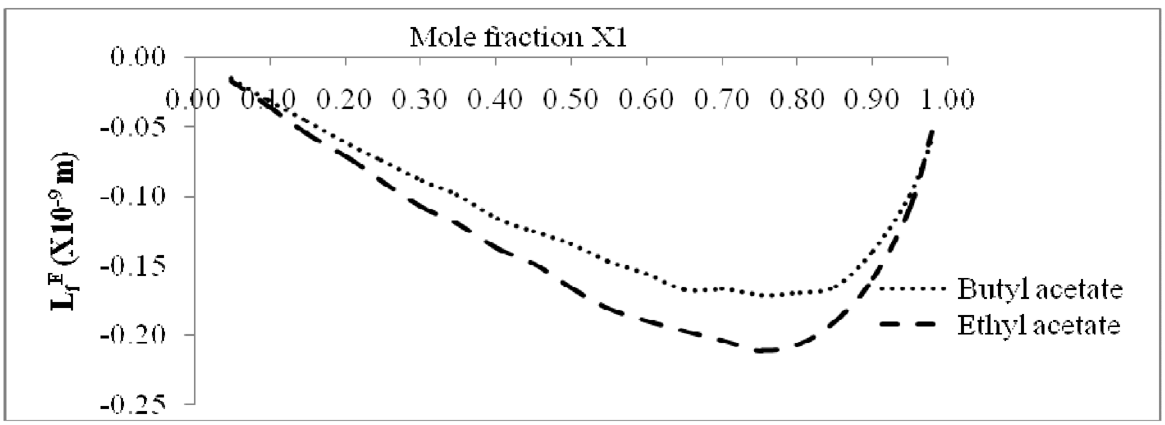

Fig.-2: Excess intermolecular free length of mixtures of sesame oil with various acetates at 298.15 K with mole fraction of acetate (X1).

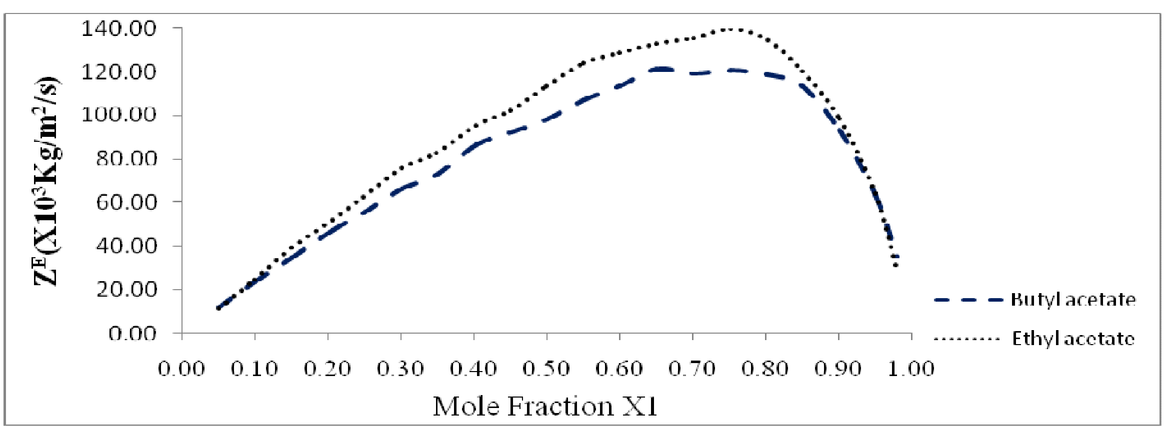

Fig.-3: Excess acoustic impedance of mixtures of sesame oil with various acetates at 298.15 K with mole fraction of acetate (X1).

The excess parameters play a major role in understanding the nature of intermolecular interactions in liquid mixtures. K_s^E values are negative over the whole concentration range for all the systems. The negative K_s^E values may be attributed to the existence of dispersion and dipolar interactions between unlike molecules indicating that mixing structures are less compressible than the ideal mixture. The negative values of the excess intermolecular free length L_f^E may be due to the geometrical effect allowing the fitting of molecules of two different sizes into each other structure[12,13]. The excess acoustic impedance shows positive values at all concentration of the mixtures. In both the mixtures, maximum effect is seen at 0.75 mole fraction of solvents. (Figures 1, 2 and 3).

Table-3: Ultrasonic velocity, adiabatic compressibility, intermolecular free length, acoustic impedance, excess values of binary mixture of sesame oil and ethyl acetate at 298.15K.

Mole Fraction X1	U m/s	K_s Tpa^{-1}	L_f $10^{-9}m$	Z $X10^3$ $Kg/m^2/s$	K_s^E Tpa^{-1}	L_f^E $10^{-9}m$	Z^E $(X10^3Kg/m^2/s)$
0.0494	1452.0	517.941	1.4802	1329.70	-13.62	-0.0166	11.44
0.0994	1450.1	519.390	1.4823	1327.73	-28.84	-0.0355	24.78
0.1484	1449.6	519.834	1.4830	1327.05	-44.73	-0.0553	39.12
0.1958	1448.0	521.068	1.4847	1325.37	-59.30	-0.0734	51.95
0.2469	1442.6	525.074	1.4904	1320.18	-72.33	-0.0891	62.42
0.2986	1440.0	527.047	1.4932	1317.61	-87.59	-0.1079	75.69
0.3459	1432.0	533.034	1.5017	1310.09	-97.37	-0.1193	82.65
0.3986	1428.8	535.588	1.5053	1306.77	-112.39	-0.1377	95.47
0.4370	1424.0	539.346	1.5105	1302.03	-121.43	-0.1485	102.50
0.4984	1416.0	545.690	1.5194	1294.17	-135.56	-0.1653	113.44
0.5499	1410.7	550.063	1.5255	1288.70	-148.35	-0.1808	123.75
0.5996	1400.0	558.693	1.5374	1278.49	-156.29	-0.1897	128.76
0.6495	1388.6	568.240	1.5505	1267.33	-163.38	-0.1975	132.89
0.6990	1376.0	579.120	1.5652	1254.91	-169.00	-0.2034	135.63
0.7496	1364.8	589.251	1.5789	1243.46	-175.74	-0.2110	139.67
0.7996	1344.0	608.386	1.6043	1222.99	-173.28	-0.2065	134.51
0.8499	1314.0	637.597	1.6424	1193.60	-160.83	-0.0189	120.53
0.8999	1276.0	677.878	1.6934	1156.11	-137.22	-0.0159	98.36
0.9498	1226.4	736.876	1.7656	1106.56	-94.86	-0.0108	64.09
0.9798	1181.7	796.928	1.8361	1061.88	-44.81	-0.0500	28.60

CONCLUSION

In the present paper, the binary mixtures are chosen in order to study the intermolecular interactions between the sesame oil and acetate groups. The negative excess values of isentropic compressibility and intermolecular free length may be attributed to the presence of molecular interactions between the unlike molecules. The positive values for the excess acoustic impedance at all concentrations of the mixtures, reinforces that significant interactions are present among the unlike components. Thus the existence of molecular interactions between the components in the binary mixture is confirmed.

REFERENCES

1. Prasad T.S. and Venkateswaralu P. , Acoustics Lett., **18** (1994)5.
2. Srinivaslu U. and Naidu P. R., Indian J. Pure Appl. Phys., **29**(1991)576.

3. Kinocid, J. Am. Chem. Soc., **S1** (1929)2950.
4. Riddick J., Bunger W., Sakano T.K., 4th edition, Wiley-interscience, Newyork, (1986).
5. Karleskind A., Ed. Oils & Fats Manual,(1996) A comprehensive Treatise, Lavoisier, Paris.
6. Aralaguppi M.I., Jadar C.V. and Aminabhavi T.M., J. Che., Engg, Data., **44**(1999)441.
7. Prakash S. and Pandey J.D., J. Sci. Indus. Res.,**21B**(1962)593.
8. Jacobson B. , Acta Chem. Scand., **5** (1951)1214.
9. Jacobson B. , Acta Chem. Scand., **6**(1952)1485
10. Beyer R.T. and Latcher S.V. , Physical Ultrasonics,(1969) Academic Press, New York.
11. Eyring B. , Kincaid J.F. , J.Chem.Phys., **6**(1938)620
12. Fort R.J., and Moore W.R., Trans. Faraday Soc., **61**(1968)2102.

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