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STUDY OF MOLECULAR INTERACTION IN BINARY LIQUID MIXTURES OF METHYL SALICYLATE AND BENZENE

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ABSTRACT

The acoustic parameters for binary liquid mixtures namely Methyl Salicylate – Benzene has been determined at three different temperatures. The acoustical parameters such as the isentropic compressibility (β_s), intermolecular free length (L_f), molar volume (V_m), available volume (V_a) and also excess parameters such as excess density, excess isentropic compressibility, excess intermolecular free length, excess molar volume, excess available volume and excess viscosity are computed for the one system at 303K, 308K and 313K from the measured ultrasound velocity, density and viscosity values. The extent of interactions existing between component molecules has been found out in methyl salicylate and benzene system. The interaction parameter values have been out to be negative suggesting the presence of week dipole-dipole interaction with increase in temperature.

Keywords: Isentropic compressibility **,** intermolecular free length, ultrasonic interferometer, viscosity.

INTRODUCTION

Ultrasonic velocity measurements have been employed extensively to detect and assess weak and strong molecular interactions in binary1-4 and ternary5-6 mixtures, because mixed solvents find practical applications in many chemical and industrial processes. To meet the needs of applications, ultrasound velocity measurements are generally carried out at different temperatures. The parameters such as ultrasound velocity (U), density (ρ) and viscosity (η) and computed parameter such as isentropic compressibility (β_s), molar volume (V_m) and intermolecular free length (V_a) provide better inside into intermolecular interaction.

The present investigation is carried out to study molecular interactions in binary liquid mixtures of methyl sylicylate and benzene at the temperatures 303K, 308k and 313K.

EXPERIMENTAL

Material and Methods

The chemical used were of analytical reagent grade obtained from loba chemicals. All the components were dried over anhydrous calcium chloride and fractionally distilled ultrasound velocity is determined by interferometric technique and used the ultrasonic interferometer model F-81 that is manufactured by M/s Mittal Enterprises, New Delhi. Density will be determined by calibrated double walled bi-cappilary pycknometer. The viscosity was measured by calibrated suspended label canon ubbehalaude type viscometer. The source of errors and precautions taken has also been mentioned. The temperature is maintained throughout the experience by thermostate manufactured by Scientific Instrument Co. Ltd., Mumbai.

Using experimentally measured values of ultrasonic velocity (U) density (ρ) and viscosity (η) the following acoustic and thermodynamic parameters are evaluated.

$$\beta_s = \frac{1}{v^2 \rho} \qquad (1)$$

$$L_f = K\sqrt{\beta_s} \quad (2)$$

$$V_m = \frac{\overline{M}}{\rho} \quad (3)$$

$$V_a = V_T\left\{1 - V/V_\infty\right\} \quad (4)$$

The excess values were calculated using the formula :

$$A^E = A_{\exp} - A_{add}$$

RESULTS AND DISCUSSION

This paper deals with the study of molecular interaction in binary liquid mixtures of methyl salicylate and benzene at 303, 308 and 313K. We have reported ultrasound velocity (U), density (ρ) and viscosity (η) of binary liquid mixture with the help of experimental data, the thermodynamic and acoustic properties like isentropic compressibility (β_s), intermolecular free length (V_a), molar volume (V_m), available volume (V_a) and their excess values have been computed at three different temperatures 303, 308 and 313K. The above functions and their excess values are tabulated and graphed in figures. The methyl salicylate in benzene act as polar associating is mixed in different mole fractions, which show almost negative excess values. The computed excess isentropic compressibility reflects negative trend of variation with mole fraction.

The excess values of isentropic compressibility and intermolecular free length are some positive and both increases with the increasing mole fraction of methyl salicylate and then gradually decrease according to Ramamurthy and Shastry8, the negative excess free length indicates that the sound wave needs to cover a larger distance. The trend of variation of excess isentropic compressibility also supported specific interaction, interaction as already reflected by negative trend of variation. The tabulated molar volume and available volume and their excess values are also observed in supporting trends. The temperature depends upon the study of binary system has reverted that with increasing of temperature, the density, ultrasound velocity and viscosity decrease. However, isentropic compressibility increases and other parameters such as molar volume show definite trend.

Table-1

Methyl Salicylate + Benzene at 303K

Mole Fraction of Methyl Salicylate	U (ms^{-1})	ρ (gm/ml.)	β_s^E (cm^2/ dyne. 10^{12})	L_f (A°)	V_m^E (ml/mole)	V_a^E (ml/mole)	η^E (C.P.)
0.0000	1280	0.8041	0.00	0.0000	0.00	0.00	0.0000
0.1269	1288	0.8501	-0.99	-0.0019	1.42	0.98	0.0686
0.2465	1297	0.8933	-1.58	-0.0031	2.23	1.65	0.0870
0.3593	1305	0.9342	-1.72	-0.0030	2.55	2.18	0.0988
0.4659	1317	0.9723	-1.92	-0.0036	2.60	2.28	0.1080
0.5668	1327	1.0092	-1.76	-0.0031	2.30	2.37	0.0898
0.6625	1340	1.0417	-1.55	-0.0027	2.10	2.16	0.0694
0.7533	1352	1.0727	-1.16	-0.0017	1.70	1.91	0.0506
0.8396	1363	1.1022	-0.60	-0.0011	1.19	1.65	0.0339
0.9217	1380	1.1301	-0.38	-0.0004	0.60	0.82	0.0155
1.0000	1396	1.1562	0.00	0.0000	0.00	0.00	0.0000

Methyl Salicylate + Benzene at 308K

Mole Fraction of Methyl Salicylate	U (ms^{-1})	ρ (gm/ml.)	β_s^E (cm^2/ dyne. 10^{12})	L_f (A°)	V_m^E (ml/mole)	V_a^E (ml/mole)	η^E (C.P.)
0.0000	1260	0.7813	0.00	0.0000	0.00	0.00	0.0000
0.1269	1272	0.8271	-1.58	-0.0039	3.70	0.75	0.0360
0.2465	1287	0.8704	-2.88	-0.0077	4.51	1.00	0.0600
0.3593	1301	0.9114	-3.58	-0.0098	4.85	1.08	0.0890
0.4659	1316	0.9496	-3.98	-0.0114	4.90	0.91	0.0950
0.5668	1329	0.9867	-3.97	-0.0112	4.56	0.72	0.0700
0.6625	1338	1.0192	-3.30	-0.0096	4.36	0.76	0.0457
0.7533	1350	1.0504	-2.78	-0.0079	3.96	0.47	0.0294
0.8396	1361	1.0800	-2.09	-0.0056	3.44	0.16	0.0188
0.9217	1369	1.1079	-1.13	-0.0029	2.85	0.03	0.0090
1.0000	1375	1.1343	0.00	0.0000	0.00	0.00	0.0000

Methyl Salicylate + Benzene at 313K

Mole Fraction of Methyl Salicylate	U (ms^{-1})	ρ (gm/ml.)	β_s^E (cm^2/ dyne. 10^{12})	L_f (A°)	V_m^E (ml/mole)	V_a^E (ml/mole)	η^E (C.P.)
0.0000	1242	0.7623	0.00	0.0000	0.00	0.00	0.0000
0.1269	1279	0.7625	-2.28	-0.0051	8.07	0.38	0.0204
0.2465	1283	0.8084	-3.43	-0.0095	8.46	1.22	0.0435
0.3593	1298	0.8522	-4.29	-0.0114	8.36	1.05	0.0735
0.4659	1312	0.8934	-4.66	-0.0127	7.96	0.78	0.0815
0.5668	1326	0.9320	-4.59	-0.0128	7.38	0.38	0.0615
0.6625	1334	0.9697	-3.90	-0.0110	6.47	0.32	0.0349
0.7533	1341	1.0025	-3.41	-0.0096	5.85	0.34	0.0220
0.8396	1348	1.0339	-2.75	-0.0073	5.08	0.28	0.0131
0.9217	1353	1.0639	-1.85	-0.0049	4.23	0.33	0.0057
1.0000	1356	1.1192	0.00	0.0000	0.00	0.00	0.0000

CONCLUSION

Experimental data of the ultrasonic velocity, density and viscosity of methyl salicylate and benzene mixtures have been measured over the entire composition range 303K, 305K and 313K. It has been observed that positive deviations of excess velocity, excess internal pressure, excess Gibbs energy where as negative deviations were observed for excess free volume at 303K, 308K and 313K. The observed deviation of theoretical values of velocity from the experimental values is attributed to the presence of intermolecular interaction in the systems studied. It may be concluded that out of three theories and relations, Nomoto's relations is best studied for the binary mixture of autophenone and benzene at 303, 308 and 313K.

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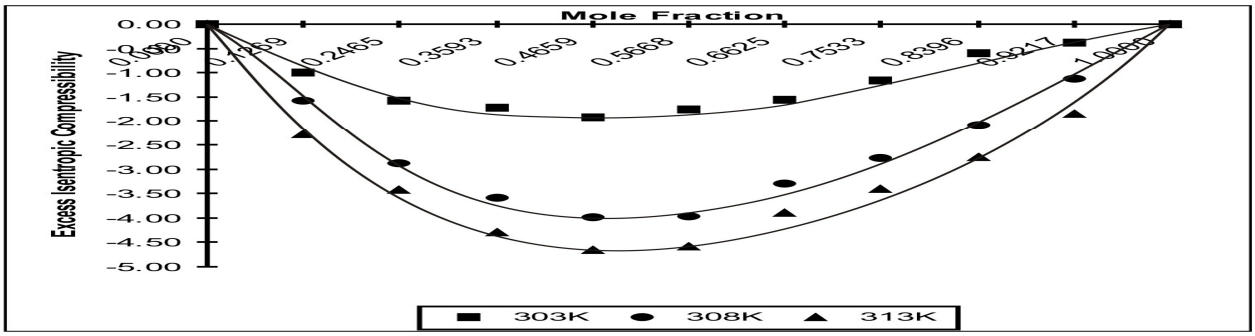
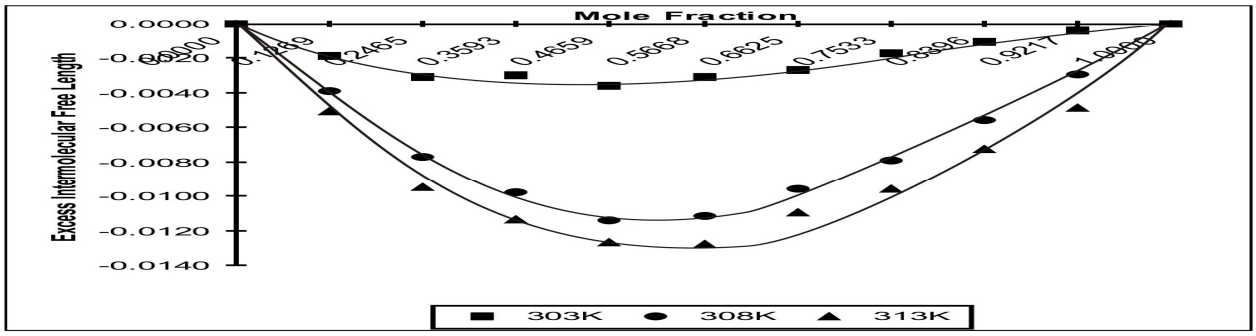
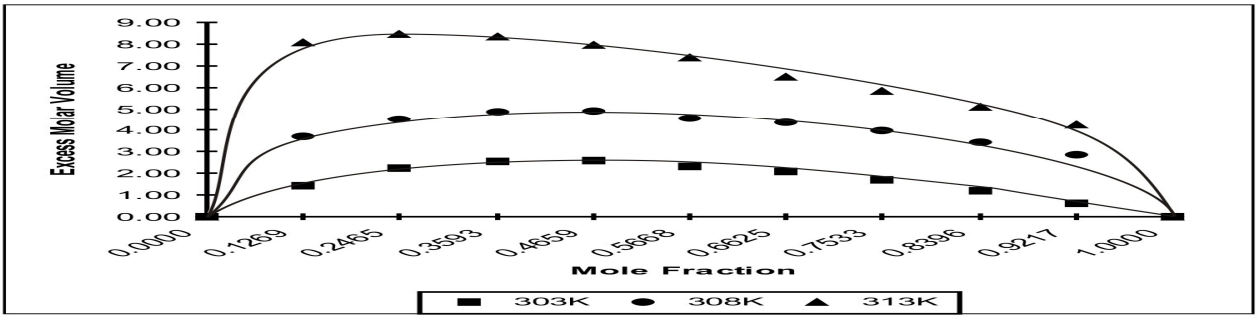
Mole Fraction Vs Excess Isentropic Compressibility



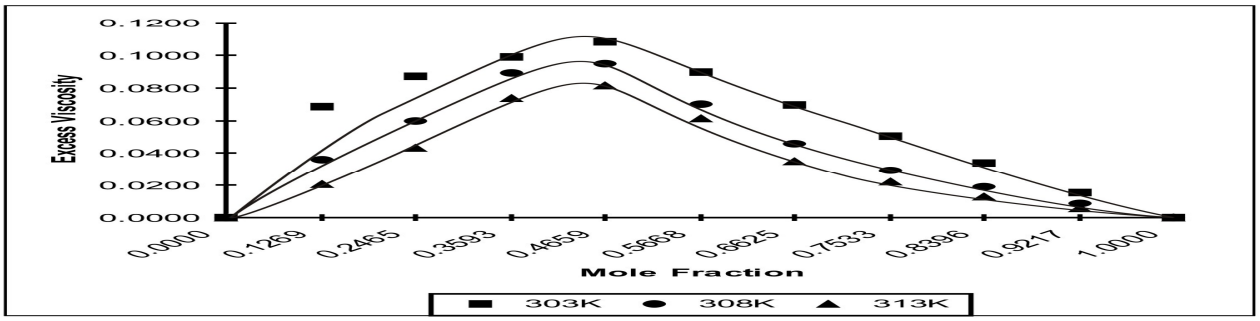
Mole Fraction Vs Excess Intermolecular Free Length



Mole Fraction Vs Excess Molar Volume



Mole Fraction Vs Excess Viscosity



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