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Ultrasonic Study on Binary Liquid Mixture of Toluene with 1, 2 Dichloroethane At 308.15k

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Abstract: *The ultrasonic velocity (u), density (ρ),and viscosity (η) have been measured for the binary liquid mixtures containing toluene with 1,2 dichlorethane at 308.15K. From these data some of acoustical parameters, such as isentropic compressibility(βs) intermolecular free length (Lf), available volume (Va), molar volume(Vm) and Nissan's parameters (d) and their excess values have been calculated. The behavior of these parameters with composition of the mixture has been discussed in terms of molecular interactions between the components of liquids.*

Keywords:*Ultrasonic velocity, Acoustical parameters Molecular interaction.*

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I. Introduction

In the recent years the ultrasonic studies find extensive applications as sound speed in liquids and liquid systems. Intermolecular interaction in various binary liquid mixtures at different temperatures has been studied by several authors [1 – 4]. The study of pure liquids and their properties can not be altered continuously with in a reasonable range by varying the concentration till an optimum value of some desired parameter is attain. This is only possible by considering the liquid mixtures and solutions which find direct applications in many chemical industries and technological processes. Further such studies as a function of concentration are useful in understanding the intermolecular interactions between the component molecules and more insight in to the structure and bonding associated molecular complexes and other molecular processes. Since ultrasonic velocity is fundamentally related to the bonding forces between the constituents of the medium [5], so it is highly sensitive to the structure and interactions present in the liquid system. The measurement of ultrasonic velocity of sound in liquids enables determination of some useful acoustic and thermodynamic parameters that are found to be very sensitive to molecular interactions. Hence these measurements are useful to study the strength of molecular interactions in liquid mixtures. The thermodynamic studies of binary liquid mixture have attracted much attention of scientist and experimental data on number systems are available from review and publication [6 -10]. Ultrasonic investigation of liquid mixtures consisting polar and polar components is of considerable importance in understanding intermolecular interaction between the component molecules and they find application in several industrial and technological processes. Many investigations [11 – 20] have been engaged in the task of collecting more and more data and explaining in terms of the properties of pure liquid.

In view of the importance mentioned, at attempt has been made to elucidate the molecular interactions in the mixture of toluene with 1,2, dichloroethane at 308.15K. Further the excess values of some of the acoustical and thermo dynamical parameters likemolar volume (Vm), isentropic compressibility (βs), intermolecular free length (Lf), available volume (Va) and Nissan's parameter (d)have been calculated from the measurements of ultrasonic velocity, density and viscosity of the mixture. These excess functions are used to explain intermolecular interactions in their binary mixture.

II. Material And Methods

In the present study the chemical used were of analytical grade [E-Merck]. They were purified by recommended methods. The density of pure liquids and liquid mixtures was determined using a pycnometer with an accuracy of ±0.053 % at 308.15K. An Ostwald's viscometer was used for the viscosity measurement of pure liquid and liquid mixtures. The flow of time of pure liquid and liquid mixtures were measured using an accurate stopwatch with a precision of ±0.15. Density and viscosity measurements were carried out using a thermostatically controlled well-stirredwater bath to maintained temperature. The speed of sound waves ware obtained by using ultrasonic interferometer model M – 84 at 2MHz frequency.All measurements were made in a thermostatically controlled water bath with temperature accuracy of $\pm 0.1^0$ C.The molar volume of binary liquid mixture is given by

$Vm = [X1M1 - X2M2] - \rho$ ---------- (1)

Where Vm is molar volume, M1 and M2 are molecular weight of pure compounds and X1,X2 are mole fractions ofthe component 1and 2, ρ is the density of liquid. The isentropic compressibility (βs) and molecular free length (Lf)are calculated using following methods

$\beta s = 1/u^2 \rho$ ---------- (2)

$Lf = K/u\ \rho^{1/2}$ ---------- (3)

Where K is temperature constant, u is speed of sound and ρ is the density of liquid

Nissan's parameter $d = Ln\ \eta^E / X1X2$ ---------- (4)

Where $\eta^E$is the excess value of viscosity, X1, X2 are the mole fraction of the liquid 1and 2.

III. Results And Discussion

Experimentally determined density and ultrasonic velocity were used to calculate isentropic compressibility (βs), intermolecular free length (Lf),available volume and their excess values using the standard relations with accuracy up to second decimal digit. The variation of these thermodynamic parameters with entire concentration range of toluene with 1,2 dichloroethane are shown in Table [1 – 4]. Deviation in the properties computed demonstrated that their exist a molecular interaction between the liquid mixture of unlike molecules. Thesemay be attributed to the change the adhesive and cohesive forces. The experimental values of ultrasonic velocities, densities, molar volumes and their excess values for the system toluene and 1,2 dichloroethane are shown in Table -1 at 308.15 K.The Table -2 shows isentropic compressibility; inter molecular free length and their excess values for the entire system. Table -3 shows available volume and their excess values and Table – 4 shows the viscosity, their excess values, $Ln\eta^E$ and Nissan's parameter (d) have been calculated for the system toluene and 1,2 dichloroethane at 308.15K.

In Toluene + 1,2 dichloroethane mixture the ultrasonic velocity, molar volume available volumes, isentropic compressibility increase with increase in mole fraction. However the density, viscosity decreases under similar condition. Excess molar volumes Vm^E, excess isentropic compressibility βs^E, excess available volume Va^E and excess intermolecular free length Lf^E are all positive under all condition of composition and temperature. In the table -4 shows the excess viscosity and Nissan's parameter 'd' are negative

IV. Tables

Table- 1 Ultrasonic velocities, Densities, Molar volumes and their excess values for the system Toluene + 1,2 dichloroethane at 308.15 K

Mole fractionofToluene(X_1)	Ultrasonic Velocity m/sec	Density g/ml	Molar Volume (exp) ml/mole	Molar Volume (add) ml/mole	Excess Molar Volume ml/mole
0.0000	1170	1.2392	79.85	79.85	0.00
0.1000	1176	1.1890	82.62	82.63	+0.02
0.2015	1182	1.1411	85.51	85.44	+0.07
0.3011	1190	1.0968	88.31	88.17	+0.14
0.4007	1200	1.0550	91.21	90.97	+0.24
0.5000	1210	1.0155	94.09	93.73	+0.36
0.5981	1222	0.9786	96.95	96.45	+0.50
0.7020	1236	0.9457	99.57	99.33	+0.24
0.8002	1251	0.9150	102.16	102.05	+0.13
0. 8995	1264	0.8852	104.86	104.81	+0.05
1.0000	1278	0.8553	107.60	107.60	0.00

Table – 2 Isentropic compressibility's, intermolecular free length and their excess values for the system Toluene + 1,2dichloro ethane at 308.15K

Mole fraction of TolueneX_1	Isentropic compressibility (exp) cm^2/dyne $X10^{12}$	Isentropic compressibility (add)cm^2/dyne$X10^{12}$	Excess isentropic compressibilitycm^2/dyne$X10^{12}$	Inter molecular Free length (exp) A^0	Inter molecular Free length (add) A^0	Excess inter molecular Free Length A^0
0.0000	61.02	61.02	0.00	0 .4972	0.4972	0.0000
0.1000	63.28	62,33	+0.94	0.5063	0.5022	+0.0041
0.2015	65.35	63.66	+1.68	0.5145	0.5074	+0.0071
0.3011	66.85	64.97	+1.87	0.5204	0.5124	+0.0080
0.4007	68.40	66.28	+2.12	0.5264	0.5174	+0.0090
0.5000	69.78	67.58	+2.20	0.5316	0.5226	+0.0090
0.5981	71.04	68.86	+2.18	0.5364	0.5275	+0.0089
0.7020	72.22	70.23	+1.99	0.5409	0.5327	+0.0082
0.8002	72.88	71.51	+1.37	0.5433	0.5378	+0.0055
0.8995	73.38	72.82	+0.56	0.5452	0.5428	0.0024
1.0000	74.13	74.13	0.00	0.5480	0.5480	0.0000

Table -3 Available volumes and their excess values for the system Toluene + 1,2 dichloroethane at 308.15K

Mole fraction of Toluene X_1	Available volume (exp) ml /mole	Available volume (add) ml / mole	Excess available volume ml /mole
0.0000	22.41	22.41	0.00
0.1000	23.04	22.47	+ 0.57
0.2015	23.57	22.54	+ 1.03
0.3011	23.79	22.61	+ 1.18
0.4007	24.04	22.68	+ 1.36
0.5000	24.15	22.75	+ 1.40
0.5981	24.20	22.81	+ 1.39
0.7020	24.18	22.88	+ 1.30
0.8002	23.89	22.95	+ 0.94
0.8995	23.45	23.02	+ 0.43
1.0000	23.10	23.10	0.00

Table- 4 Viscosity and their excess values, $L n\eta^E$ and Nissan's parameter (d) for the system Toluene + 1, 2 dichloroethane at 308.15K

Mole fraction of Toluene X_1	Viscosity (exp) Cp	Viscosity (add) Cp	Excess Viscosity Cp	$L n\eta^E$	'd'
0.0000	0.742	0.742	0.000	0.000	0.000
0.1000	0.721	0.723	- 0.002	- 0000	0.000
0.2015	0.701	0.706	- 0.005	- 0.002	- 0.008
0.3011	0.676	0.684	- 0.008	- 0.004	- 0.019
0.4007	0.654	0.665	- 0.011	- 0.007	- 0.029-
0.5000	0.634	0.646	- 0.012	- 0.009	- 0.036
0.5981	0.614	0.627	- 0.013	- 0.010	- 0.041
0.7020	0.596	0.607	- 0.011	- 0.010	- 0.047
0.8002	0.581	0.588	- 0.007	- 0.007	- 0.043
0.8995	0.565	0.569	- 0.004	- 0.004	- 0.044
1.0000	0.550	0.550	0.000	0.000	0.000

V. Conclusion

Thus it can be concludedfrom these studies of ultrasonic speed /density and viscosity measurements The negative values of excess viscosity and Nissan's parameter shows different molecular size attributed to the presence of dispersive forces between the mixing components and suggest the presence of specific and weak intermolecular interactions. While the positive value of excess molar volumes (Vm^E) , excess available volume (Va^E),excess isentropic compressibility (βs^E) and intermolecular free length (Lf^E) shows the presence of weak molecular interaction between the unlike molecules of the binary liquid mixture (Toluene and 1,2 dichloroethane) at the temperature 308.15K.

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