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Study of Thermo Physical Properties of Binary Liquid Mixture At 303.15 K

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Abstract:
Thermo physical properties can provide good information about the molecular interaction s between liquid mixtures. Ultrasonic studies and densities in binary liquid mixture of ethylamine and cyclo hexanol have been measured. Acoustic parameters like isentropic compressibility, intermolecular free length, available volume, molar volume, Nissan's parameter and their excess function have been calculated for this binary liquid mixture at 303.15K. The corresponding excess functions are a better measure of the extent of interactions present between the component molecules of the system. It is used in so many fields of scientific researches in physics , chemistry, biology, medicines and industry. These properties also provide important information about molecular packing, molecular motion and the chemical nature of the component molecules.

Keywords: *Binary mixture, , Density, Viscosity, ethylamine, cyclo hexanol, Ultrasonic interferometer.*

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I. Introduction:

The study of thermo physical properties of binary liquid mixtures in order to understand possible associations existing between the various species in the solution . The ultrasonic studies find extensive applications as sound speed intrinsically related with many parameters which characterized the physico chemical behavior of the liquids and liquid systems. Intermolecular interaction in various binary liquid mixtures at different temperatures have been studied by several authors [1-4]. Besides the theoretical importance, the knowledge of physico chemical properties of binary mixtures is indispensable for many chemical process industries, examples are the petroleum, petrochemical etc. are commonly used in industries where physico chemical processes are involved to handle the mixture of hydrocarbons, alcohols, aldehydes, ketones etc. Importantly for accurate designing equipment, it is necessary to know the interaction between the components of mixtures. A considerable progress has been made theoretical understanding of liquid-liquid mixture [5-8]. The thermodynamic studies of binary solutions have attracted much attention of scientists and experimental data on a number of systems are available for review and publications [9-22].

In the frame work of a research work, which aims to study the ultrasonic study, density, viscosity measurements and the properties derived. These are excellent tools to detect solute-solute and solute-solvent interactions. It is used in so many fields of scientific researches in physics, chemistry, biology, medicines and industry. The present paper deals with the measurement of density, viscosity, speed of sound, molar volume, available volume, isentropic compressibility, intermolecular free length, Nissan's parameter and their excess values of binary liquid mixture at 303.15K. This technique using ethylamine and cyclo hexanol ultrasonic instrument is in the tremendous use in measuring the rate of flow of blood through the human body and getting images of vital organs of the body like kidney , liver, blood vessel, foetus etc.

II. Materials And Methods :

Both were obtained from E-Merck ethylamine and cyclo hexanol . They were purified by the recommended method . The weighing was done on an electronic balance with precision ±0.1mg. The density of pure liquid and mixtures were measured using pre calibrated bi capillary pycknometer with an accuracy 0.053%. The viscosities of binary liquid mixture were measured by Ostwald viscometer designed properly to minimize the loss of liquid components through vaporization. Ultrasonic velocity was measured by multi frequency ultrasonic interferometer model (M-84) at 2 M Hz frequency and data were accurate up to ± 0.04 %. All measurement were made in a thermostatically controlled water bath with temperature accuracy of ± 0.1°c . The purity of components was ascertained by comparing the boiling points and density of pure components with those reported in literature [23, 24] .

The volume of mixing of binary mixture is given by

$$Vm = V - X_1V_1 - X_2V_2 \quad \text{----------} \quad (1)$$

Where V is molar volume, V_1 and V_2 are molar volume of pure components and X_1 and X_2 are mole fractions of the components 1 and 2.

Excess volume (V^E) of binary liquid mixture of varying composition was calculated using relations

$$V^E = V^{obs} - V^{id} \quad \text{----------} \quad (2)$$

Where V^{obs} is the experimental value of volume of binary liquid mixture

$$V^{obs} = M_1X_1 + M_2X_2 / \rho \quad \text{----------} \quad (3)$$

'ρ' is the measured density of binary liquid mixture of given composition. V^{id} refers to the value for ideal binary mixture.

$$V^{id} = X_1V_1+X_2V_2 = X_1M_1 / \rho_1 + X_2M_2 / \rho_2 \text{-------} (4)$$

Where M_1 and M_2 are molar masses and ρ_1 and ρ_2 are densities of component liquid in pure state X_1 and X_2 are mole fractions of first and second component. Thermodynamic properties like isentropic compressibility (βs) and inter molecular free length (Lf) are calculated using following relations

$$\beta s = 1/u^2\rho \quad \text{----------} \quad (5)$$

$$Lf = K / u\,\rho^{1/2} \quad \text{----------} (6)$$

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

III. Results And Discussion:

The various experimental results of acoustic parameters are shown in table [1-4] . Deviation in the properties demonstrated that their exist a molecular interaction between unlike molecule of the liquid mixture . These may be attributed to the change in the adhesive and cohesive forces, the experimental values of ultrasonic speeds, densities, molar volumes and their excess values for the system of ethylamine and cyclo hexanol at 303.15K [Table -1]. Table -2 shows isentropic compressibility intermolecular free length and their excess value for the system at 303.15 K. Table -3 presents available volume and their excess values for the system at 303.15 K. Table -4 shows the viscosity and their excess values , Ln η^E (Logarthem of excess value of viscosity) and Nissan's parameter (d) for the system at 303.15 K .

TABLE-1
ULTRASONIC VELOCITIES, DENSITIES, MOLAR VOLUMES AND THEIR EXCESS VALUES FOR THE SYSTEM ETHYLAMINE AND CYCLOHEXANOL AT 303.15K

Mole fraction of Ethylamine (X_1)	Ultrasonic Velocity m/sec	Density gm/ml	Molar Volume (exp) ml/mole	Molar Volume (add) ml/mole	Excess molar Volume ml/mole
0.0000	1450	0.9438	106.12	106.12	0.00
0.1032	1444	0.9357	100.97	100.85	+ 0.12
0.2029	1439	0.9267	96.08	95.81	+ 0.27
0.3007	1435	0.9163	91.23	90.77	+ 0.46
0.4023	1431	0.9055	86.14	85.58	+ 0.56
0.5004	1427	0.8940	81.20	80.56	+ 0.64
0.6008	1420	0.8811	76.11	75.43	+ 0.68
0.7007	1416	0.8684	70.89	70.33	+ 0.56
0.8003	1414	0.8544	65.63	65.25	+ 0.38
0. 8992	1422	0.8390	60.46	60.30	+ 0.16
1.0000	1446	0.8190	55.04	55.04	0.00

TABLE 2
ISENTROPIC COMPRESSIBILITIES, INTER MOLECULAR FREE LENGTHS AND THEIR EXCESS VALUES FOR T ETHYLAMINE AND CYCLOHEXANOL THE SYSTEM AT 303.15K

Mole fraction of Ethylamine X_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	50.39	50.39	0.00	0.4479	0.4479	0.0000
0.1032	51.26	51.22	+ 0.04	0.4517	0.4513	+ 0.0004
0.2029	52.11	52.01	+ 0.10	0.4555	0.4547	+ 0.0008
0.3007	52.99	52.81	+ 0.18	0.4593	0.4581	+ 0.0012
0.4023	53.91	53.62	+ 0.29	0.4633	0.4616	+ 0.0017
0.5004	54.93	54.41	+ 0.52	0.4676	0.4649	+ 0.0027
0.6008	56.27	55.21	+ 1.06	0.4733	0.4684	+ 0.0049
0.7007	57.43	56.01	+ 1.42	0.4781	0.4718	+ 0.0063

0.8003	58.54	56.82	+ 1.72	0.4827	0.4752	+ 0.0075
0. 8992	58.94	57.59	+ 1.35	0.4844	0.4790	+ 0.0054
1.0000	58.39	58.39	0.00	0.4821	0.4821	0.0000

TABLE - 3
AVAILABLE VOLUMES AND THEIR EXCESS VALUES FOR THE SYSTEM ETHYLAMINE AND CYCLOHEXANOL AT 303.15K

Mole fraction of Ethylamine X_1	Available volume (exp) ml /mole	Available volume (add) ml / mole	Excess available volume ml /mole
0.0000	99.48	99.48	0.00
0.1032	98.57	94.67	+ 3.90
0.2029	96.68	90.08	+ 6.60
0.3007	94.08	95.38	+ 8,70
0.4023	90.87	80.76	+ 10.11
0.5004	87.59	76.20	+ 11.39
0.6008	85.62	71.53	+ 14.09
0.7007	81.52	66.88	+ 14.64
0.8003	76.29	62.25	+ 14.04
0. 8992	67.26	57.75	+ 9.51
1.0000	52.97	52.97	0.00

TABLE -4
VISCOSITIES AND THEIR EXCESS VALUES, $Ln\eta^E$ AND NISSAN'S PARAMETER (d) FOR THE SYSTEM ETHYLAMINE AND CYCLOHEXANOL AT 303.15 K

Mole fraction of Ethylamine X_1	Viscosity (exp) Cp	Viscosity (add) Cp	Excess Viscosity Cp	$Ln\eta^E$	'd'
0.0000	20.274	20.274	0.000	0.000	0.000
0.1032	12.256	19.279	– 6.023	– 0.187	– 2.020
0.2029	8.358	16.371	– 8.013	– 0.267	– 1.656
0.3007	5.939	14.461	– 8.522	– 0.267	– 1.271
0.4023	4.371	12.497	– 8.126	– 0.302	– 1.255
0.5004	3.412	10.601	– 7.188	– 0.248	– 0.992
0.6008	2.506	8.660	– 6.154	– 0.249	– 1.038
0.7007	1.904	6.729	– 4.825	– 0.217	– 1.034
0.8003	1.451	4.804	– 3.352	– 0.183	– 1.145
0. 8992	1.130	2.912	– 1.782	– 0.133	– 1.452
1.0000	0.944	0.944	0.000	0.000	0.000

In the system ethylamine and cyclo hexanol mixture, the ultrasonic velocity and molar volumes increase with the increase in mole fractions of ethylamine [Table-1]. However, the density, available volume, isentropic compressibility, intermolecular free length and viscosity decrease under similar condition (shown Table 2- 4). Excess molar volume, Excess isentropic compressibility, Exces available volume and excess intermolecular free length are all positive under all condition of composition and temperature which shows weak interactions between the molecule ofethylamine and cyclohexanl , thus the positive values predict weak interaction involving dispersion forces. Excess value of viscosity and Nissan;s parameter 'd' were found to be negative which also shows the weak interactions between the molecule of ethylamine and cyclohexanl at 303.15K.

IV. Conclusion:

The positive value of excess molar volume, excess available volume, excess isentropic compressibility and intermolecular free length shows the presence of weak molecular interactions between the unlike molecules of the binary liquid mixture (ethylamine and cyclo hexanol) at the temperature 303.15K. Where the negative value of logarithm value of excess viscosity and Nissan's parameter (d) also shows the weak interactions between the unlike molecules of the binary liquid mixture (ethylamine and cyclo hexanol) at the temperature 303.15K.

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References:

[1]. B.Thanuja,Charles Kanagam et al. Studies on intermolecular interactions on binary mixtures of methyl orange – water system. Excess molar functions of ultrasonic parameters at different temperatures. Journal of ultrasonics sonochemistry volume 18, 2011, 1274 – 1278

[2]. prediction of thermo physical properties of binary liquid mixtures of propiophenone and ethyl acetate at 303.15,308.15 and 313.15K. S.K.Bindhani, G.K.Roy &Y.K.Mohanty Russian Journal of Physical Chemistry A. Vol.94 (1827-1835) 2020

[3]. Excess Acoustical study of binary liquid mixture with experimental parameters at different temperatures. Timmeswara sarma nori, Ch srinivasu et al. Research and Riviews: Journal of physics vol. 8 No. 2 (30-41) 2019

[4]. Bhoj Bhadur Gurung , Mahendra Nath Roy, Study of densities , viscosities and ultrasonic speeds of binary mixtures containing 1,2 diethoxy ethane with alkane 1-ol at 298.15 K .Journal of solution chemistry volume 35, (1587-1606), 2006.

[5]. Zareena Begaum et al. Thermodynamic, ultrasonic studies or binary liquid mixtures of anisaldehyde with alkoxy ethanols at different temperatures. Journal of molecular liquids, volume 178, February 2013 pages 99-112.

[6]. K. Rajgopal, S.Chenthilnath. Study on excess thermodynamic parameters and theoretical estimation of ultrasonic velocity of 2-methyl 2-propanol with nitriles at different temperatures. Journal of chemical engineering, volume 18, 2010, 806 – 816.

[7]. Anil Kumar Nain. Ultrasonic and viscometric study of molecular interactions in binary mixtures of aniline with 1-propanol, 2-methyl propanol at different temperatures. Journal of Fluid Phase Equilibria,volume259 (2),2007,218-227.

[8]. Shahla Parveen, Divya Shukla et al. Ultrasonic velocity, density, viscosity and their excess parameters of the binary liquid mixtures of tetra hydro Furan with methanol and o- crysol at varying temperatures. Journal of Applied Acoustics volume, 70 (3), 2009, 507-513.

[9]. K. Rajgopal, S.Chenthilnath. Excess parameters studies on binary liquid mixtures of 2- methyl 2 – propanol with aliphatic nitriles at different temperatures. Journal of Molecular Liquids volume160, (2), 2011, 72 -80.

[10]. S.S.Yadav and AniruddhYadav, Ultrasonic study of binary liquid mixture between some brome alkanes and hydrocarbons, Journal of Ultrasonics,43, 2005, 732-735.

[11]. Jagdish G.Baragi,Seema Maganur, et al. Excess of molar volumes and refractive indices of binary liquid mixtures of acetyl acetone with n- nonane, n-decane at 25^0C,30^0C,35^0C. Journal of Molecular Liquid.178, 2013,175-177

[12]. M.V. Ratnam, Reema T.Sayed etal. Molecular interaction study of binary mixtures of methyl benzoate, viscometric and ultrasonic study. Journal of Molecular Liquids. 166, 2012, 9-16 .

[13]. Gyan Prakash Dubey, Kishan Kumar. Thermodynamic properties of binary liquid mixtures of diethylene tri amine with alcohols at different temperatures. Journal of Thermochimica. Acta. 524, (1-2), 2011, 7-17.

[14]. S.kumar, P. Jeevandham. Densities , viscoties and excess properties of aniline and o-anisidine with 2 – alkoxy ethanols at 303.15^0K. Journal of Molecular Liquid 174 , 2012, 34 – 41.

[15]. Anil Kumar Nain. Ultrasonic study of molecular interactions in binary mixtures of methyl acryl ate with 1- alkanols at different temperatures. Journal of Chemical Thermodynamics. 59, april 2013, 49-64.

[16]. K. Rajgopal, S. Chenthilnath. Molecular interaction studies and theoretical estimation of ultrasonic speeds in binary mixtures of toluene with nitriles at different temperatures. Journal of Thermochemica Acta. 498, (1), 2010, 45-53.

[17]. Lovely Sarkar and Mahendra Nath Rao. Density, viscosity and ultrasonic speed of binary mixtures of 1,3 dioxane with 2,methoxy methanol. Journal of Chemical Engineering data. 54, (12), 2009, 3307-3312.

[18]. Riyazuddin and Sadaffarin. Ultrasonic velocities and densities of phenyl alanine with aqueous $NaNO_3$ solution at (298.15-328.15) K. Journal of Chemical Engineering data. 2010, 55 (7) , 2643 – 2648.

[19]. G.R.Bedare, V.D.Bhandakkar et al. Ultrasonic study of molecular interactions in binary mixtures 1,4 dioxan with methanol at 308K. European Journal of Applied Engineering and Scientific Researches.volume-1, issue -1, 2012, 1 -4.

[20]. San-Junbeng, Hai - Yun Hou, et al. Densities and excess volume of binary mixtures of N-N dimethyl formamide with aromatic hydrocarbons at different Temperature. Journal of chemical thermodynamics . 39, 2007, 474 -482.

[21]. P. Venkatesu. Thermo physical contribution of N-N dimethyl formamide in the molecular interactions with other solvents. Journal of fluid phase equlibria 298,2, 2010, 173 – 191.

[22]. Cezary M. K. nart, Magdalena Klimczak, et al. Densities and excess molar volumes for binary mixture of some glycols in 2 – methoxy ethanol at (293.15, 298.15, 303.15)K. Journal of Molecular Liquids. 135, (1–3), 2007, 192 – 195.

[23]. Dean J. A. Lange's Hand book of chemistry,McGraw Hill, New York 1987.

[24]. David R. L. CRC Hand book of chemistry and physics ,CRC Press Florida,2000.

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