Ultrasonic and Transport Study of Binary Liquid Mixture Containing Ethyl Amine and Allyl Alcohol

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ABSTRACT

Ultrasonic and transport study of binary liquid mixture Ethyl Amine and Allyl Alcohol at 303.15 K can provide good information about the molecular interactions between liquid mixtures. Ultrasonic studies and densities in binary liquid mixture of Ethyl Amine and Allyl Alcohol 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, Allyl Alcohol, Ultrasonic interferometer.

INTRODUCTION

Ultrasonic and Transport study of Excess Acoustical study and experimental analysis of binary liquid mixture Ethyl Amine and Allyl Alcohol at 303.15 K 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 Acoustical study 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 ethyl amine and allyl alcohol at 303.15K. This technique using ethylamine and allyl alcohol 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.

MATERIALS AND METHODS

Ethylamine and allyl alcohol both were obtained from E-Merck. 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 pyknometer 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 ± 0.1c. 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

$$Vm = V – X1V1 – X2V2 \text{ ---------- ----------} \quad (1)$$

Where V is molar volume, V1 and V2 are molar volume of pure components and X1 and X2 are mole fractions of the components 1 and 2. Excess volume (VE) of binary liquid mixture of varying composition was calculated using relations

$$VE = Vobs – Vid \text{ ----------} \quad (2)$$

Where Vobs is the experimental value of volume of binary liquid mixture

$$Vobs = M1X1 + M2X2 / \rho \text{ ----------} \quad (3)$$

'ρ' is the measured density of binary liquid mixture of given composition. Vid refers to the value for ideal binary mixture.

$$Vid = X1V1+X2V2 = X1M1 / \rho1 + X2M2 / \rho2 \text{ -------} \quad (4)$$

Where M1 and M2 are molar masses and ρ1 and ρ2 are densities of component liquid in pure state X1 and X2 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

$$\beta s = 1/u2\rho \text{ ---------- ----------} \quad (5)$$

$$Lf = K / u\ \rho1/2 \text{ ---------- ----------} \quad (6)$$

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

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 allyl alcohol 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 (Logarithm of excess value of viscosity) and Nissan's parameter (d) for the system at 303.15K .

TABLE-1 Ultrasonic Velocities, Densities, Molar Volumes and Their Excess Values for the System Ethylamine and Allylalcohol 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	1212	0.8440	68.81	68.81	0.00
0.1000	1234	0.8431	67.34	67.44	-0.10
0.1989	1255	0.8417	65.91	66.11	-0.20
0.3008	1274	0.8390	64.55	64.73	-0.18
0.3994	1293	0.8361	63.24	63.39	-0.15
0.4991	1311	0.8327	61.94	62.04	-0.10
0.5995	1331	0.8288	60.66	60.68	-0.02

0.6996	1352	0.8248	59.37	59.33	+0.04
0.7988	1374	0.8210	58.07	57.98	+0.09
0.9006	1400	0.8173	56.72	56.60	+0.12
1.0000	1450	0.8156	55.27	55.27	0.00

TABLE 2 Isentropic Compressibilities, Inter Molecular Free Lengths and Their Excess Values for the System Ethylamine And Allyl Alcohol At 303.15k

Mole fraction of Ethylamine X_1	Isentropic compressibility(exp) $cm^2/dyne X10^{12}$	Isentropic compressibility (add)$cm^2/dyneX10^{12}$	Excess isentropic compressibility$cm^2/dyneX10^{12}$	Inter molecular Free length (exp) A^0	Inter molecular Free length (add) A^0	Excess inter molecular Free Length A^0
0.0000	80.57	80.57	0.00	0.5663	0.5663	0.0000
0.1000	77.89	78.34	-0.45	0.5569	0.5577	-0.0008
0.1989	75.43	76.13	-0.70	0.5480	0.5494	-0.0014
0.3008	73.43	73.86	-0.43	0.5400	0.5418	-0.0001
0.3994	71.53	71.67	-0.14	0.5336	0.5325	+0.0011
0.4991	69.87	69.45	+0.12	0.5274	0.5240	+0.0034
0.5995	68.10	67.21	+0.89	0.5207	0.5156	+0.0051
0.6996	66.32	64.99	+1.33	0.5138	0.5071	+0.0067
0.7988	64.51	62.78	+1.73	0.5063	0.4997	+0.0081
0.9006	62.42	60.54	+1.91	0.4985	0.4911	+0.0084
1.0000	58.31	58.31	0.00	0.4818	0.4818	0.0000

TABLE – 3 Available Volumes And Their Excess Values For The System Ethylamine And Allyl Alcohol 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	16.66	16.66	0.00
0.1000	15.40	15.51	-0.11
0.1989	14.21	14.37	-0.16
0.3008	13.15	13.19	-0.04
0.3994	12.13	12.06	+0.07
0.4991	11.18	10.92	+0.26
0.5995	10.29	9.77	+0.42
0.6996	9.20	8.62	+0.58
0.7988	8.20	7.48	+0.72
0.9006	7.09	6.31	+0.78
1.0000	5.18	5.18	0.00

TABLE -4 Viscosities and Their Excess Values, $Ln\eta^e$ and Nissan's Parameter (D) For the System Ethylamine and Allylalcohol 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	0.884	0.8840	0.000	0.000	0.000
0.1000	0.8911	0.8896	+0.0015	+0.001	+0.011
0.1989	0.8978	0.8954	+0.0024	+0.003	+0.018
0.3008	0.9043	0.9008	+0.0035	+0.004	+0.019

0.3994	0.910	0.906	+0.0040	+0.003	+0.012
0.4991	0.9162	0.9128	+0.0034	+0.004	+0.016
0.5995	0.923	0.9179	+0.0025	+0.002	+0.008
0.6996	0.927	0.922	+0.0010	+0.001	-0.004
0.7988	0.927	0.927	0.000	-0.001	-0.012
0.9006	0.927	0.927	0.000	- 0.002	- 0.004
1.0000	0.940	0.940	0.000	0.000	0.000

In the system ethylamine and allyl alcohol mixture, the ultrasonic velocity and molar volumes decrease 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, Excess available volume and excess intermolecular free length are all negative under all condition of composition and temperature which shows strong interactions between the molecule of ethylamine and allyl alcohol , thus the positive values predict weak interaction involving dispersion forces. Excess value of viscosity and Nissan's parameter 'd' were found to be positive which also shows the weak interactions between the molecule of ethylamine and allyl alcohol at 303.15K.

CONCLUSION

The mixture of Ethyl amine and Allyl alcohol are polar compounds and in addition the alcohol are associating in nature. Thus the mixture are polar - polar system. The values of isentropic compressibility and intermolecular free length are negative in amine rich mixture and Nissan parameter are positive in alcohol rich mixture. The negative value of excess molar volume, excess available volume, excess isentropic compressibility and intermolecular free length shows the presence of strong molecular interactions between the unlike molecules of the binary liquid mixture (ethylamine and Allyl alcohol) at the temperature 303.15K. Where the positive 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 Allyl alcohol) at the temperature 303.15K.

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REFERENCES

1. M.K. Binkar, R.B. Ramteke, J.N. Ramteke (2025) Ultrasonic investigation of binary liquid mixture's excess thermodynamic characteristics at various temperatures Journal: Chemical Thermodynamics and Thermal Analysis DOI: → https://doi.org/10.1016/j.ctta.2025.100223
2. Shakila, A. Srinivasa Krishna et al. (2020) Molecular interaction studies in binary mixtures of tetrahydrofuran with arene substituted alcohols: acoustic and volumetric studyJournal: Physics and Chemistry of Liquids DOI: → https://doi.org/10.1080/00319104.2018.1564752
3. Bindhani S.K., Roy G.K. et al. (2020) Prediction of thermophysical properties of binary liquid mixtures of propiophenone and ethyl acetate at 303.15, 308.15 and 313.15 K Journal: Russian Journal of Physical Chemistry A DOI: → https://doi.org/10.1134/S0036024420100045
4. Arunachalam Mathana Gopal, Paulraj Padmavathi et al. (2024) Pseudo-Grüneisen Parameters for Binary Liquid Mixtures at Different Temperatures Journal: ACS Omega DOI: https://doi.org/10.1021/acsomega.4c02163
5. Kaur Parminder, Juglan K.C. et al. (2023) Volumetric and Ultrasonic Studies of PEG200, PEG400, and Ethanol–Chlorhexidine Solutions at Various Temperatures Journal: Journal of Chemical & Engineering Data. DOI: → https://doi.org/10.1021/acs.jced.2c00886

6. Kheireddine Nadhir, Indra Bahadur et al. (2025) Thermodynamic, Ultrasonic and Transport Study of Binary Mixtures Containing 1-Hexene and Alcohols at 293.15–303.15 K.Journal: Journal of Chemical & Engineering Data DOI: → https://doi.org/10.1021/acs.jced.4c00865
7. Gangwar Vikas S., Singh Ashish K. et al. (2017) Refractive properties of liquid mixture at different temperatures. Journal: International Journal of Applied Chemistry.
8. Mullainathan S., Nithiyananthan E. (2010) Ultrasonic study of molecular interactions in binary mixture at 303 K. Journal: E-Journal of Chemistry. DOI:→ https://doi.org/10.1155/2010/429125
9. Zareena Begum et al. (2020) Ultrasonic studies of binary liquid mixtures of anisaldehyde with alkoxyethanols Journal: Journal of Molecular Liquids. DOI: → https://doi.org/10.1016/j.molliq.2020.113070
10. Rajagopal K., Chenthilnath S. (2010).Molecular interaction studies and theoretical estimation of ultrasonic speeds of toluene with nitriles. Journal: Thermochimica Acta DOI: https://doi.org/10.1016/j.tca.2009.10.021
11. Shalini Gupta, Vikas Jain et al. (2024). Ultrasonic Study of Binary Mixture of DHMOH and Acetone at 288.15–313.15 K.Journal: Rasayan Journal of Chemistry. DOI: → https://doi.org/10.31788/RJC.2024.1747996
12. Swetha Sandhya M., Biswas Piyashi et al. (2019) Molecular interaction studies of aniline and alkanol mixtures. Journal: Journal of Molecular Liquids . DOI:→ https://doi.org/10.1016/j.molliq.2018.11.143
13. Zareena Begum et al. (2013)Thermodynamic and ultrasonic studies of anisaldehyde with alkoxy ethanols Journal: Journal of Molecular Liquids. DOI: → https://doi.org/10.1016/j.molliq.2013.05.020
14. Thanuja B., Charles Kanagam et al. (2011).Studies on intermolecular interactions in methyl orange–water system.Journal: Ultrasonics Sonochemistry. DOI: https://doi.org/10.1016/j.ultsonch.2011.03.009
15. Baragi Jagdish G., Maganur Seema et al. (2013) Excess molar volumes and refractive indices of binary liquid mixtures of acetyl acetone with n-nonane and n-decane Journal: Journal of Molecular Liquids.DOI:→ https://doi.org/10.1016/j.molliq.2012.11.023
16. Raj Kumar, Singh Y.P. (2017). Intermolecular interaction in binary liquid mixture by ultrasonic measurements. Journal: International Journal of Research in Applied, Natural and Social Sciences
17. Ratnam M.V., Reema T. Sayed et al. (2012).Molecular interaction study of binary mixtures of methyl benzoate.Journal: Journal of Molecular Liquids. DOI: → https://doi.org/10.1016/j.molliq.2011.11.006
18. Dubey G.P., Kishan Kumar (2011).Thermodynamic properties of binary liquid mixtures of diethylene triamine with alcohols. Journal: Thermochimica Acta DOI:→ https://doi.org/10.1016/j.tca.2011.07.004
19. Kumar S., Jeevandham P. (2012).Densities, viscosities and excess properties of aniline and o-anisidine with 2-alkoxyethanol.Journal: Journal of Molecular Liquids. DOI:→ https://doi.org/10.1016/j.molliq.2012.05.017
20. Nain Anil Kumar (2013).Ultrasonic study of molecular interactions in binary mixtures of methyl acrylate with 1-alkanols. Journal: Journal of Chemical Thermodynamics. DOI:→ https://doi.org/10.1016/j.jct.2012.11.016
21. Dean J.A. (1987)Lange's Handbook of Chemistry
22. David R. Lide (2000). CRC Handbook of Chemistry and Physics