OPEN ACCESS

Thermodynamic Study of Properties in Certain Binary Liquid Mixtures Containing Anisole with 2-Butoxyethanol at Different Temperatures (303.15K to 318.15K)



Abstract: Comprehensive experimental investigations were carried out on density (ρ), viscosity (η), and ultrasonic velocity (u) for binary mixtures comprising Anisole and 2-Butoxyethanol within the temperature range of 303.15K to 318.15K, covering the complete range of mole fractions. These parameters were measured at intervals of 5K. Derived excess parameters, including acoustic impedance (Z^E), intermolecular free length (L^E_f), molar volume (V^{E}_{m}) , excess ultrasonic velocity (u^{E}) , and excess viscosity (n^{E}) , were calculated to probe the molecular interactions present in the mixture. These excess parameters were correlated with temperature and mole fraction, revealing the complexity and nature of intermolecular interactions. Notably, the Arrhenius, Bingham, Eyring, Grunberg, Kurata, Nissan, and Tamura models were employed to validate the acquired empirical data theoretically. This study aims to offer invaluable insights into the thermodynamics and molecular dynamics that govern these binary liquid mixtures.

Keywords: Viscosity, Density, Ultrasonic Velocity, Excess Parameters, Molecular Interaction

I. INTRODUCTION

Density (ρ), ultrasonic velocity (u), and viscosity (η) are critical physicochemical properties of liquid mixtures that play a crucial role in various industrial processes. Their relevance extends to optimizing energy efficiency in chemical reactions and is essential for processes such as ion-exchange systems, organic synthesis, and mass-transfer operations involving solvents and adsorbates.

Manuscript received on 25 August 2023 | Revised Manuscript received on 05 September 2023 | Manuscript Accepted on 15 September 2023 | Manuscript published on 30 September 2023. *Correspondence Author(s)

Mahesh. P, Department of Physics, Andhra University, Visakhapatnam (A.P.), India. E-mail:<u>maheshpeyyala18@gmail.com</u>, ORCIDID: 0009-0003-2348-612X

Dr. M. Bonju Babu*, Department of Humanities and Basic Sciences, Wellfare Engineering College, Pinagadi, Visakhapatnam (A.P.), India. E-mail:<u>bonjumphd86@gmail.com</u>, ORCIDID:<u>0009-0008-3049-8416</u>

K. Poornima, Department of Humanities and Basic Sciences, Wellfare Engineering College, Pinagadi, Visakhapatnam (A.P.), India. E-mail:<u>chinnuk1916@gmail.com</u>, ORCIDID:<u>0009-0009-8148-2120</u>.

K. Samatha, Department of Physics, Andhra University, Visakhapatnam (A.P.), India. E-mail:<u>samatha_k2002@yahoo.co.in</u>, ORCIDID: 0000-0001-8199-2715.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an <u>open access</u> article under the CC-BY-NC-ND license <u>http://creativecommons.org/licenses/by-nc-nd/4.0/</u>

Retrieval Number: 100.1/ijrte.C79030912323 DOI: <u>10.35940/ijrte.C7903.0912323</u> Journal Website: <u>www.ijrte.org</u>

Understanding the excess thermodynamic properties and transport phenomena in binary liquid mixtures can yield critical insights into molecular-level interactions and the architecture of liquid structures [1]. In the industrial context, the utility of 1-isobutane is especially noteworthy, given its role as an alkylating catalyst in organic reactions. Aromatic hydrocarbons also serve as potent organic solvents in various processes and are particularly instrumental in fuel applications where they act as octane boosters [2]. The behavior of excess properties, such as excess viscosity (η^E) and deviations in molar volume (V^E_m), can provide vital clues about various kinds of molecular interactions. These excess parameters can be used as indicators to understand molecular mobility, structural packing, and the range and strength of molecular forces in binary mixtures. Factors like the shape, size, and chemical characteristics of the component molecules play a significant role in these interactions [3–5]. In light of its industrial applicability and scientific relevance, the current study focuses on the binary mixture of Anisole and 2-butoxyethanol, examining its behaviour across temperatures ranging from 303.15 K to 318.15 K at atmospheric pressure. This investigation explores key excess parameters, namely density, ultrasonic velocity, and viscosity, to provide a nuanced understanding of the underlying molecular interactions. For a comprehensive analysis, we have referenced well-established models, including the Arrhenius, Bingham, Eyring, Grunberg, Kurata, Nissan, and Tamura models, to corroborate our experimental findings.

II. MATERIALS AND METHODS

Analytical grade reagents of Anisole, 2-Butoxyethanol (purity > 99%) were procured from SD Fine Chemicals Ltd, Mumbai, India, which were used to prepare the binary mixtures the mole percentage purity of these mixtures was determined adopting Gas Chromatography method (HP 6890) using the FID detector and are reported in Table 1 in the results section. Obtained values are compared with density, velocity and viscosity data measured at the temperature 308.15 K for pure Anisole and 2-Butoxyethanol (2-BE) values already published in the literature. Specially designed conical flasks were used to prepare the binary mixtures of 2-Butoxyethanol and Anisole using a digital electronic balance.

Published By: Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP) © Copyright: All rights reserved.



Thermodynamic Study of Properties in Certain Binary Liquid Mixtures Containing Anisole with 2-Butoxyethanol at Different Temperatures (303.15K to 318.15K)

(Mettler, AE 240, Switzerland) was used to measure the mass of the binary mixtures of different proportions of 2-Butoxyethanol and anisole to an accuracy of 0.01mg five different compositions of binary mixtures were prepared wherein, the proportions of 2-Butoxyethanol and anisole were taken in the ratio of 1:0, 5:1, 2:1, 1:1, 1:2, 1:5, and 0:1. Physical properties of the obtained mixtures were measured for the seven proportions of 2-Butoxyethanol and anisole on the mole fraction scale from 0.23 to 0.88 with an interval of 0.1 unit and remaining mixture ratio first one and last one is pure components, The uncertainty in measured values of the mole fraction was less than 0.0002 units. Density (ρ), ultrasonic velocity (u) and viscosity (η) of binary mixtures in

complete range of composition were measured at different temperatures 303.15 K to 318.15 K with an interval of 5K in a thermo-stated water bath consisting of an accuracy of \pm 0.1 K, setting the temperature at the required level. Densities of different composition binary mixtures were measured using a capillary pycnometer with a bulb volume of 5 cm³ and an internal capillary diameter of 0.75 mm. The accuracy of density measurements was \pm 0.2% % % % and the uncertainty was found to be \pm 5 × 10^-5 g/cm^3. A 10 ml capacity specific gravity bottle with \pm 0.001 g/cm³ accuracy was used in the measurements. Viscosity was measured using Ostwald's viscometer, which has an accuracy of 0.001 Ns/m².

Table I: Comparison of Experimental and literature values of densities (ρ), ultrasonic velocities (u), and viscosity of pure liquids with literature at 308.15 K.

Liquid	Density(p) x 10 ⁻³ Kg m ⁻³		Ultrasonic Velocity (u) m.s ⁻¹		Viscosity(η) x 10 ⁻³ Ns.m ²	
	EXP	LIT	EXP	LIT	EXP	LIT
Anisole	979.74	979.73[6]	1369.94	1368.00[7]	0.906	0.854[6]
2-Butoxyethanol	891.13	888.70[8]	1276.21	1275.10[9]	2.418	2.287[10]

III. CALCULATIONS

The following are equations 1, 2 and 3, which were used to calculate the ultrasonic velocity (u), density (ρ) and viscosity(η), the different acoustical parameters, namely acoustic impedance (Z), intermolecular free length (L_f) and molar volume (V_m).

$Z = U\rho \text{ Kg m}^{-2}\text{s}^{-1}$	(1)
$L_{\rm f} = KT(\beta ad)^{1/2}m$	(2)

where 'K ' refers to Jacobson's constant.

The results were presented in the table-2 of the results' section. The excess functions Y^E were computed using the equation:

$$\mathbf{Y}^{\mathrm{E}} = \mathbf{Y}_{\mathbf{mix}} - (\mathbf{X}_1 \mathbf{Y}_1 + \mathbf{X}_2 \mathbf{Y}_2)$$

Where Y indicates u, Z, V_m and L_f commonly, X is the mole fraction, and suffixes 1 & 2 represent the components 1 & 2 in the binary mixture, as shown in Table 3.

IV. RESULTS AND DISCUSSION

From Table 2, it is clear that the values of u, Z, and L_f varied with the mole fraction of anisole. This indicates the presence of interactions between the components in these binary liquid mixtures. The variations of ultrasonic velocity for the mixtures depend on the values of L_f . It is observed that an increase in ultrasonic velocity and the corresponding rise in L_f with mole fraction of anisole (Table 2) for all the systems are consistent with the view proposed by Eyring and Kincaid [11]. However, the excess functions, which are a measure of the deviations from the ideal behaviour, are relatively more sensitive to the intermolecular

interactions between the unlike molecules of the mixture than the pure acoustical parameters, as explained above.

The positive deviations in u^E and Z^E (Figs. 1 and 3) for all the systems (Anisole + 2-Butoxyethanol) are found to be complete. This tendency in this series towards encouragement in the view that these combinations among unlike molecules are serenely achievable. Generally, the general media is compact, so the ultrasonic velocity estimate will be high. If it is compacted to a minor extent, the ultrasonic velocity can be low. When the combinations of two liquids mix by condensing or suppressing, the ultrasonic velocity range may be positive [12]. From Figure 2.1, it is conveyed that the uE range is acceptable among the temperatures. It is noted that the mixtures have high approval and, in general, yield favourable ultrasonic velocity. In Figure 2.3, the excess acoustic impedance (ZE) by composition of fluid minerals displays approval deviations according to analogy 1. A common attention was monitored by Eswari Bai et al [13], Vijaya Lakshmi et al [14] and Sastry et al [15].

In the figures 2.2,2.4, and 2.5 ηE , L^{E} , and V_{m}^{E} Negative in all the systems above the whole mole fraction range. In general, these three values, ηE , L^{E} , and V_{m}^{E} Are dependable. (i) The correlated disruption of related present in the pure

- liquids, stated by Jacobson [16]
- (ii) Creation of weak H-bonding by dipole-induced dipole interaction between unlike molecules.
- (iii) Geometrical complex fitting creation among the component molecules [17].

In advance, it is observed from the observational results that the negative amalgamation increases with the chain length of 2-Butoxyethanol. This shift in the magnitude of the negative range of ηE , L^{E} , and V_m^E From the above homologues' components. This data suggests that the vigour of different formations among the chemicals. From this epilogue, it is stated by Fort and Moore [18], Mahendran Roy [19], Douhéreta [20] and Sastry et al [21].

Published By: Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP) © Copyright: All rights reserved.



Retrieval Number: 100.1/ijrte.C79030912323 DOI: <u>10.35940/ijrte.C7903.0912323</u> Journal Website: <u>www.ijrte.org</u>



Table II: Values of Density (ρ), ultrasonic velocity (u), viscosity(η), acoustic impedance (Z), intermolecular free length
(Lf) for the binary liquid mixtures of anisole with 2-Alkoxy Ethanols at 303.15K to 318.15K

Mole fraction of	o v 10 ⁻³ Kg m ⁻³	u m c ⁻¹	Z x 10 ⁻⁴	η x 10 ⁻³	$I = 10^{12} m$	V _m x 10 ⁻⁵
Anisole	px to Kg m	u m.s	Kg.m ² s ⁻¹	Ns.m ²	L _f X IV III	m ³ /mol ⁻¹
Anisole + 2-Butoxy Ethanol (2BE) at 303.15 K						
0	895.38	1295.39	1.6214	2.741	4.9031	106.7178
0.2386	915.24	1316.84	1.5881	2.356	4.9614	102.1742
0.4396	933.17	1335.34	1.544	2.014	5.0128	99.2587
0.6105	948.47	1350.67	1.4951	1.708	5.0595	96.5114
0.7581	961.82	1364.19	1.4411	1.428	5.1025	93.7412
0.8868	973.54	1377.95	1.3764	1.178	5.1402	91.1751
1	984.46	1390.13	1.2978	0.971	5.171	88.8471
		Anisole + 2-Butox	y Ethanol (2BE) at 308	8.15 K		
0	891.13	1276.21	1.5842	2.418	5.0099	112.2147
0.2386	910.24	1295.52	1.5491	2.095	5.0704	107.3215
0.4396	927.41	1313.82	1.5063	1.792	5.1244	104.0147
0.6105	942.54	1328.97	1.4571	1.532	5.1714	101.2178
0.7581	955.59	1343.98	1.4024	1.287	5.2154	98.5214
0.8868	968.34	1357.87	1.3414	1.072	5.2575	95.8725
1	979.74	1369.94	1.2654	0.906	5.2901	93.7125
	A	nisole + 2-Butoxy E	thanol (2BE) at 313.15	K		
0	885.94	1256.24	1.544	2.147	5.1124	117.7471
0.2386	904.26	1275.18	1.5091	1.835	5.1802	112.8852
0.4396	921.29	1291.89	1.4661	1.555	5.2321	109.4147
0.6105	936.37	1307.26	1.4204	1.335	5.2756	106.3471
0.7581	949.54	1320.97	1.3652	1.132	5.3182	103.4751
0.8868	962.24	1336.26	1.3052	0.967	5.3582	100.8246
1	975.02	1349.83	1.2318	0.841	5.3914	99.0712
Anisole + 2-Butoxy Ethanol (2BE) at 318.15 K						
0	881.72	1236.25	1.5071	1.8778	5.219	117.7471
0.2386	899.28	1255.44	1.4702	1.587	5.286	112.8852
0.4396	915.41	1270.27	1.4282	1.325	5.3428	109.4147
0.6105	930.27	1285.24	1.3811	1.132	5.3881	106.3471
0.7581	944.27	1301.25	1.3277	0.976	5.4274	103.4751
0.8868	956.57	1314.81	1.2701	0.869	5.4615	100.8246
1	970.3	1329.14	1.2002	0.793	5.219	99.0712

Table III: Values of excess Ultrasonic velocity (u^E), excess Viscosity (η^E), excess Acoustic impedance (Z^E), Intermolecular free length (L_f^E), and Molar volume (V_m^E), for the binary liquid mixtures of anisole with 2-Alkoxy Ethanols at 303.15 to 318.15K

	1	E 10-3			**K
Mole fraction	u ^E m s ⁻¹	$\eta^{\mu} x 10^{\circ}$	Z ^E x 10-4	E v 10 ¹² m	$V_{\rm m} \times 10^{-5}$
of	u mis	Ns.m ⁻²	Kg m ⁻² s ⁻¹		m ³ /mol ⁻¹
Anisole					
	L.	Anisole + 2-Butoxy]	Ethanol (2BE) at 303	.15K	
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.2386	12.5412	-0.0556	0.0402	-0.0174	-0.1827
0.4394	19.2145	-0.0941	0.0668	-0.0275	-0.2721
0.6105	20.7414	-0.1071	0.0745	-0.0295	-0.2841
0.7581	15.4565	-0.0931	0.0637	-0.0257	-0.2421
0.8868	12.5412	-0.0552	0.0367	-0.0159	-0.1481
1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Anisole + 2-Butoxy Ethanol (2BE) at 308.15K					
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.2386	17.2854	-0.0471	0.0351	-0.0149	-0.2074
0.4394	25.8749	-0.0822	0.0577	-0.0239	-0.2997
0.6105	26.9412	-0.0968	0.0640	-0.0259	-0.3151
0.7581	20.7172	-0.0837	0.0557	-0.0220	-0.2744
0.8868	11.2251	-0.0468	0.0314	-0.0132	-0.1731
1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Anisole + 2-Butoxy Ethanol (2BE) at 313.15 K					
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.2386	21.8575	-0.0384	0.0301	-0.0128	-0.2324
0.4394	32.4815	-0.0698	0.0492	-0.0207	-0.3314
0.6105	33.3874	-0.0855	0.0544	-0.0227	-0.3481

54



		-		-)	
0.7581	26.5247	-0.0738	0.0469	-0.0189	-0.3079
0.8868	15.2971	-0.0397	0.0264	-0.0108	-0.2045
1.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		Anisole + 2-Butox	y Ethanol (2BE) at 31	18.15K	
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.2386	27.1412	-0.0308	0.0253	-0.0109	-0.2614
0.4394	38.2941	-0.0578	0.0412	-0.0177	-0.3659
0.6105	39.3699	-0.0736	0.0448	-0.0193	-0.3840
0.7581	32.6475	-0.0631	0.0382	-0.0158	-0.3451
0.8868	19.4127	-0.0317	0.0214	-0.0087	-0.2295
1.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Thermodynamic Study of Properties in Certain Binary Liquid Mixtures Containing Anisole with 2-Butoxyethanol at Different Temperatures (303.15K to 318.15K)

Figure I:- Density (p), ultrasonic Velocity (u), acoustic impedance (Z), viscosity (η), itemkulrfree length (Lf) for the binary liquid mixtures of anisole with 2,2-butoxy ethanol at 303.15K and 308.15K.









Fig. 1. 3 Variation of Acoustic impedance



Fig. 1. 5 Variation of free length



Fig. 1. 6 Variation of molar volume



Retrieval Number: 100.1/ijrte.C79030912323 DOI: 10.35940/ijrte.C7903.0912323 Journal Website: www.ijrte.org

Published By:



Figures-II:- Figures for excess Ultrasonic velocity (u^E), excess Viscosity (η^E), excess Acoustic impedance (Z^E), Intermolecular free length (L_f^E), and Molar volume (V_m^E), for the binary liquid mixtures of anisole with 2-Alkoxy Ethanol's at 303.15 to 318.15K (L_f) for the binary liquid mixtures of anisole with 2 2-ethoxy ethanol at 303.15K to 308.15K.



Fig. 2. 1 Variation of excess Ultrasonic velocity



Fig. 2. 3 Variation of excess Acoustic impedance

0.4

0.2

Molefraction of Anisole

0.6

0.8











Fig. 2. 5 Variation of excess molar volume

V. CONCLUSIONS

The above statements support the following conclusions. • Density, ultrasonic velocity, and intermolecular free length for binary liquid mixtures of anisole and 2-Butoxyethanol observed at different temperatures, 303.15 to 315.18, increase with the increase in proportion of anisole.

Retrieval Number: 100.1/ijrte.C79030912323 DOI: <u>10.35940/ijrte.C7903.0912323</u> Journal Website: <u>www.ijrte.org</u> • The value of acoustic impedance, viscosity and molar volume decreases with the increase in the mole fraction of anisole in all four observed temperatures.





56

Thermodynamic Study of Properties in Certain Binary Liquid Mixtures Containing Anisole with 2-Butoxyethanol at Different Temperatures (303.15K to 318.15K)

• There is a linear positive relationship between the mole fraction of anisole and its density, ultrasonic velocity & intermolecular free length and the relationship is linear but negative for acoustic impedance, viscosity and molar volume.

• The excess parameters of ultrasonic velocity (u^E) and acoustic impedance (Z^E) showed positive deviation. The deviation is maximum between 0.4394 and 0.6105 mole fraction of anisole at the four different temperatures. For acoustic impedance, the deviation is maximum at 0.6105 mole fraction of anisole.

• The excess parameters for viscosity, intermolecular free length and molar volume showed negative deviations, which are maximum at 0.6 mole fractions for all three parameters at four observed temperatures.

• The deviations are attributed to the compression of liquid mixtures, chain length and creation of weak hydrogen bonds between the component molecules.

• The vigour of the binary mixture is higher at a mole fraction of 0.6105 of anisole at a 1:1 proportion of 2-Butoxyethanol Anisole.

DECLARATION STATEMENT

Authors are required to include a declaration of accountability in the article, including review-type articles, that stipulates the involvement of each author. The level of detail differs; some subjects yield articles that consist of isolated efforts that are easily detailed, while other areas function as group efforts at all stages. It should be after the conclusion and before the references.

Funding/ Grants/ Financial Support	No, we did not receive.
Conflicts of Interest/ Competing Interests	No conflicts of interest to the best of our knowledge.
Ethical Approval and Consent to Participate	No, the article does not require ethical approval or consent to participate, as it presents evidence.
Availability of Data and Material/ Data Access Statement	Not relevant.
Authors Contributions	Under the guidance of the fourth author, the first author, working towards a Ph.D. degree, and the remaining authors contributed to the preparation of the paper for publication.

REFERENCES

- J.-H. Yang, L.-Y. Dai, X.-Z. Wang, and Y.-Q. Chen, "Densities and viscosities of binary mixtures of methyl 4-chlorobutyrate with aromatic hydrocarbons at T = (298.15 to 318.15) K," J. Chem. Eng. Data.,54 (2009). https://doi.org/10.1021/je900194v
- M. V. Rathnam, S. Mohite, and M. S. S. Kumar, "Interaction studies in binary liquid mixtures of methyl formate with o, m- and p-xylenes using viscosity data at 303.15K," Ind. J. Chem Techno.,15(2008).
- B. B. Gurung, M. N. Roy, "Study of densities, viscosities and ultrasonic speeds of binary mixtures containing 1,2-dimethoxyethane and an alkanol at 298.15K," J. Sol. Chem., 35(2006). https://doi.org/10.1007/s10953-006-9085-2

Retrieval Number: 100.1/ijrte.C79030912323 DOI: <u>10.35940/ijrte.C7903.0912323</u> Journal Website: <u>www.ijrte.org</u>

- M. Domínguez, J. Santafé, M. C. López, F. M. Royo, and J. S. Urieta, "Viscosities of the ternary mixture (1-butanol + n-hexane + 1-chlorobutane) at 298.15K and 313.15K," Fluid Phase Equilibria,152(1998). https://doi.org/10.1016/S0378-3812(98)00377-X
- M. M. Palaiologou, "Densities, viscosities, and refractive indices of some alkyl esters with 4-chlorotoluene systems at (293.15, 298.15, and 303.15) K," J. Chem. and Eng. Data., 5(1996). https://doi.org/10.1021/je960042w
- Venkatesh Mutalik "Thermodynamic properties of (tetradecane + benzene, + toluene, + chlorobenzene, + bromobenzene, + anisole) binary mixtures at T = (298.15, 303.15, and 308.15) K" J. Chem. Thermodynamics., 38(2006). <u>https://doi.org/10.1016/j.jct.2005.10.022</u>
- M. V. Rathnam "Studies on Excess Volume, Viscosity, and Speed of Sound of Binary Mixtures of Methyl Benzoate in Ethers at = (303.15, 308.15, and 313.15) K" J. Thermo., 8(2013).
- Dr. K. Vijaya Lakshmi "Ultrasonic studies on binary liquid mixtures of methyl acrylate with 2,2-alkoxy ethanols at 308.15 K." Int. J. Adv. Res., 4(8) (2016). <u>https://doi.org/10.21474/IJAR01/1405</u>
- R. Rajalakshmi, S. Ravikumar, "Role of chain length in molecular interactions between monoethanolamide and 2-alkoxyalkanols at various temperatures" Chem. Data Collections, 20(2019). https://doi.org/10.1016/j.cdc.2019.100202
- L. Guganathana, S. Kumara "thermophysical studies of binary liquid mixture of methyl acetate and alkoxyethanols at 308.15 K" Int. J. Mat. Sci., 12(2017).
- John F. Kincaid and Henry Eyring, "Free Volumes and Free Angle Ratios of Molecules in Liquids", J. Chem. Phys., 6(1938). https://doi.org/10.1063/1.1750134
- K. Vijaya Lakshmi, "Study of Thermodynamic and Transport Properties of Binary Liquid Mixtures of Methyl Acrylate with Alkoxy Ethanols at 308.15 K", Int. J. Sci. Res., 5(2016). https://doi.org/10.21474/IJAR01/1405
- Eswari Bai, M., Subha, M.C.S. Narayana Swamy, G. & Chowdoji Rao, K," Acoustical studies of molecular interactions in binary liquid mixtures of Butoxy ethanol with some amines at 308.15 K", J. Pure. Appl. Ultrasonics., 26(2004).
- Vijaya Lakshmi, K., Suhasini, D. M., Jayachandra Reddy, N., Ravi Kumar, K., Chowdoji Rao, K. and Subha M. C. S. "Density and ultrasonic velocity studies on binary mixtures of methyl acrylate with benzenes at 308.15 K", Int. J. Current. Research., 6(2014).
- N. V. Sastry and S. R. Patel, "Densities, viscosities and speed of sound and excess properties of binary mixtures of Methyl methacrylate with alkoxyethanols and 1-alcohols at 298.15 and 308.15 K", Int. J. Thermo. Phy., 21(2000).
- Jacobson. B. "Intermolecular free length in liquid state adiabatic and Isothermal compressibility", Acta Chem. Scand.., 6, 1485 and J. Chem. Phys., 20(1952). <u>https://doi.org/10.3891/acta.chem.scand.06-1485</u>
- Gerard Douhéreta, Cynthia Salgado, Michaël I. Davis, Jesus Loya (1992), "Ultrasonic speeds and isentropic functions of 2-(2-alkoxyethoxy) ethanol + water at 298.15 K", Thermo. Acta., 207(1992). <u>https://doi.org/10.1016/0040-6031(92)80145-M</u>
- Fort, R. J. and Moore, W. R. "Viscosities of binary liquid mixtures", Trans Faraday Soc., 62, (1966). <u>https://doi.org/10.1039/tf9666201112</u>
- Mahendranath Roy, Radhey Shyam Sah, Prasanna Pradhan C. "Densities, Viscosities, Sound Speeds, Refractive Indices and Excess Properties for Binary Liquid Mixtures of Isoamyl alcohol with some Alkoxyethanols", Int. J. ThermoPhys., 31(1966).
- Gerard Douhéreta, Cynthia Salgado, Michaël I. Davis, Jesus Loya, "Ultrasonic speeds and isentropic functions of 2-(2-alkoxyethoxy) ethanol + water at 298.15 K", Thermo. Acta, 207(1992). <u>https://doi.org/10.1016/0040-6031(92)80145-M</u>
- 21. N. V. Sastry and P. Bahadur. "Densities, Speed of Sound, Excess Volumes and Excess Isentropic Compressibilities of Methyl Acrylate + 1-Propanol (or 1-Butanol) + Hydrocarbons (n-Hexane, n-Heptane, Cyclohexane, Benzene and Toluene) at 308.15 K", Inc. Thermo. Physics, 24(2003).

Published By: Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP) © Copyright: All rights reserved.





AUTHORS PROFILE



Mahesh Peyyala is currently doing a Ph.D. program in the Department of Physics, Andhra University, Visakhapatnam. Specialising in Ultrasonics, Electronics and Instrumentation, Material Science, Completed M.Sc.(Tech.) Earned and received the M.Phil. award from Andhra University, Visakhapatnam, Andhra Pradesh, India. In the field of

Sodar Communications. Designed and developed a portable Doppler Sodar system in the systems design department.



Dr. M. Bonju Babu, Assistant Professor, is currently working in WISTM College, Pinagadi, Visakhapatnam, Andhra Pradesh (India), dealing with Engineering Physics in the Humanities and Basic Sciences Department and specialising in Material Science and Ultrasonics. He has over ten years of research experience in the field of ultrasonics and has

published research articles in various Scopus and UGC-listed journals.



K. Poornima is currently working in WISTM College, Pinagadi, Visakhapatnam, Andhra Pradesh (India) as an Assistant Professor dealing with Engineering Physics in the Humanities and Basic Sciences Department.



K. Samatha is a Professor in the Department of Physics, Andhra University. She is a renowned academician, researcher and author with 36 years of experience. She has published 151 research papers in reputed International and National Journals. She is the author of a book on **Statistical Mechanics.** She submitted her PhD thesis under the supervision of Prof. J. Sri Rama Murthy. She has successfully guided 47 research scholars for Ph.D. and 10 for

M.Phil. degrees. Many more are currently doing research under my supervision. She is a specialist in the area of "ULTRASONICS & SOLID-STATE PHYSICS" and has been doing extensive research. She is actively involved in teaching Statistical Mechanics, Classical Mechanics, Electrodynamics, and Quantum Mechanics. Most of her students are well-placed in India as well as abroad.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of the Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)/ journal and/or the editor(s). The Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP) and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.



Retrieval Number: 100.1/ijrte.C79030912323 DOI: <u>10.35940/ijrte.C7903.0912323</u> Journal Website: <u>www.ijrte.org</u> Published By: Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP) © Copyright: All rights reserved.

58