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ADIABATIC COMPRESSIBILITY AND SPECIFIC ACOUSTIC IMPEDANCE STUDIES OF ANILINE + 1-HEPTANOL MIXTURE

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ABSTRACT:

Adiabatic compressibility (β) and specific acoustic impedance (Z) parameters were evaluated by measuring ultrasonic velocity (U), density and viscosity with different concentrations of aniline +1-heptanol binary system at temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K temperatures. It is observed that the adiabatic compressibility (β) decreases with increase in mole fraction of aniline. Comparatively greater decrease is observed between 40% to 60% concentration range of aniline. Acoustic impedance (Z) increases as the concentration of aniline increases. However, high increase in it is observed between 40% to 60% concentration range of aniline, than in case of other concentration of aniline.

KEYWORDS : Adiabatic compressibility, specific acoustic impedance and ultrasonic velocity.

INTRODUCTION

Now a day, ultrasonic studies are extensively used for characterizing the thermodynamic properties of liquid mixtures. This method plays an important role in understanding the nature of molecular interactions. A large number of studies have been made on the molecular interaction in liquid mixtures of different organic and inorganic liquid mixtures [1-5].

Velocity of sound waves in a medium is fundamentally related to the binding forces between the molecules. The variation of ultrasonic velocity and other thermodynamic parameters in ternary liquid mixtures with changing mole fraction of one or two components has been investigated by different authors [6-10].

In the present paper, measurements of ultrasonic velocity (U), density (ρ) and viscosity (η) of aniline +1-heptanol binary liquid system at temperature 298.15, 303.15, 308.15, 313.15 and 318.15K. The data obtained of these measurements was used to evaluate the various acoustic and thermodynamic properties, so that the variation of these derived properties as a function of concentration is indicative of various molecular and ion-ion interactions occurring in the solutions.

EXPERIMENTAL:

The 1-heptanol used was manufactured by Merck Schuchardt which is (>99 %) pure in form, while the aniline used was supplied by s.d. fine chemicals and it is (>99.5%) pure. Both the organic liquids were used for preparation of binary liquid mixtures without their further purification. The solutions of different concentration were prepared by using a Mettler balance (Switzerland model AE-240) with a precision of ± 0.0001 gm in air-tight stoppered glass bottles. Care was taken to avoid evaporation and solvent contamination during mixing of one into another. To study the ultrasonic behaviour of aniline +1-heptanol binary system, their six solutions of different concentrations expressed in as 0% to 100% concentration of aniline were prepared and the experimental properties viz. ultrasonic velocity (U), density (ρ) and viscosity (η) were measured at different temperatures viz. 298.15, 303.15, 308.15, 313.15 and 318.15K. The ultrasonic velocity (U) of solutions of different concentrations is measured by interferometer method using Mittal's F-81 instrument, having the 2MHz frequency of ultrasonic waves. The error in these measurements was found to be ± 0.15%.

The measurements of density (ρ) of solutions under investigation were carried out by using specific gravity bottle i.e. density (ρ) bottle with an accuracy in measurements ± 0.0001 gm/cc.

The viscosity (η) measurements of solutions of all concentrations were completed by using Ostwald's viscometer. The desired temperature is maintained during the measurements of experimentally measured properties like ultrasonic velocity (U), density (ρ) and viscosity (η) by using thermostatically controlled water bath with thermal stability of ± 0.05^{0}C for 15 min. to attain the thermal equilibrium at the desired temperature. All the experimentally measured properties i.e. ultrasonic velocity (U), density (ρ) and viscosity (η) of solutions of different concentrations were measured at temperature 298.15, 303.15, 308.15, 313.15 and 318.15K. The measurements were carried out thrice and average reading is considered.

Table: 1C- Ultrasonic velocity (U), density (ρ) and viscosity (η) of aniline+1-heptanol system at 298.15 K

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. X10^{-3}
1	0.0000	1325	812.50	5.13
2	0.2377	1357	842.60	3.73
3	0.4540	1393	876.30	3.08
4	0.6517	1486	930.30	3.04
5	0.8330	1544	962.70	2.86
6	1.0000	1622	1009.60	3.18

Table: 2 C-Ultrasonic velocity (U), density (ρ) and viscosity (η) of aniline+1-heptanol system at 303.15 K

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. X10^{-3}
1	0.0000	1309	809.60	4.72
2	0.2377	1333	839.20	3.34
3	0.4540	1383	871.50	2.87
4	0.6517	1459	927.10	2.73
5	0.8330	1527	957.30	2.49
6	1.0000	1616	1006.20	2.83

Table: 3 C-Ultrasonic velocity (U), density (ρ) and viscosity (η) of aniline+1-heptanol system at 308.15 K

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. $X10^{-3}$
1	0.0000	1292	806.30	4.09
2	0.2377	1324	834.40	3.02
3	0.4540	1359	868.00	2.53
4	0.6517	1436	923.20	2.47
5	0.8330	1505	955.20	2.22
6	1.0000	1595	1002.40	2.49

Table: 4 C-Ultrasonic velocity (U), density (ρ) and viscosity (η) of aniline+1-heptanol system at 313.15 K

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. $X10^{-3}$
1	0.0000	1284	801.80	3.59
2	0.2377	1314	831.50	2.60
3	0.4540	1342	864.70	2.21
4	0.6517	1428	918.70	2.08
5	0.8330	1486	951.80	1.95
6	1.0000	1575	997.50	2.12

Table: 5 C-Ultrasonic velocity (U), density (ρ) and viscosity (η) of aniline+1-heptanol system at 318.15 K

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. $X10^{-3}$
1	0.0000	1260	800.20	3.15
2	0.2377	1289	827.70	2.33
3	0.4540	1328	862.50	1.96
4	0.6517	1415	915.60	1.88
5	0.8330	1471	947.00	1.78
6	1.0000	1563	994.40	1.88

RESULTS AND DISCUSSION:

The data obtained from experimental measurements of properties like ultrasonic velocity (U), density (ρ) and viscosity (η) of solutions of different concentrations of aniline +1-heptanol binary liquid system at temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K is given in tables 1C, 2C, 3C, 4C and 5C respectively. The variation of these experimentally determined properties as a function of concentration at given temperature is represented in Fig. 1C, 2C and 3C.

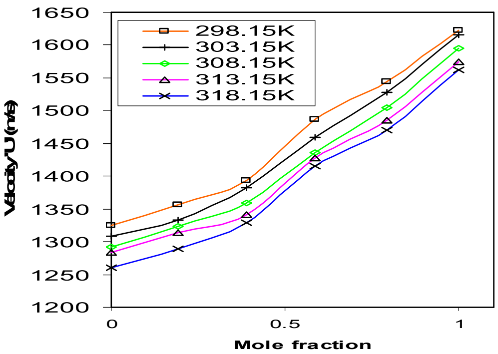

Fig. 1C: Variation of Ultrasonic velocity with concentration of aniline + 1-heptanol

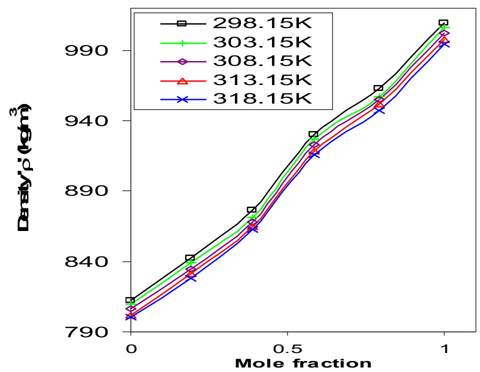

Fig. 2C: Variation of density with mole fraction of aniline + 1-heptanol

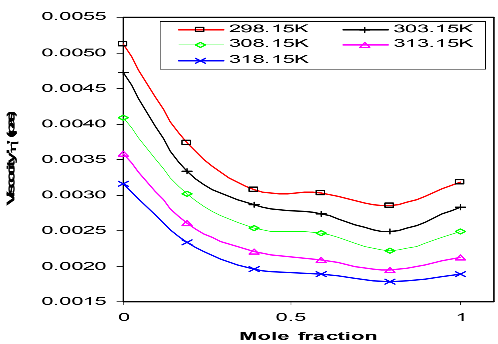

Fig. 3C: Variation of viscosity with mole fraction of aniline + 1-heptanol

The data obtained of experimentally measured properties i.e. ultrasonic velocity (U), density (ρ) and viscosity (η) of the binary mixtures that were under investigation is used for evaluation of various acoustic and thermodynamic properties such as adiabatic compressibility (β), specific acoustic impedance (Z), intermolecular free length (L_f), relaxation time (τ) and classical absorption factor (α/f^2) by using the relation (referred in chapter 3). The data obtained of derived thermodynamic parameters is given in Tables 6C, 7C, 8C, 9C and 10C for temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K respectively.

Table: 6 C- Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-heptanol system at 298.15 K

Sr. No	Mole fraction	**β** **(m^2/N) ×10^{-10}**	**Z** **(Kg/m^2s) ×10^5**
1	0.0000	7.0075	10.76
2	0.2377	6.4487	11.43
3	0.4540	5.8789	12.20
4	0.6517	4.8647	13.82
5	0.8330	4.3550	14.86
6	1.0000	3.7630	16.37

Table: 7 C- Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-heptanol system at 303.15 K

Sr. No	Mole fraction	β $(m^2/N) \times 10^{-10}$	Z $(Kg/m^2s) \times 10^5$
1	0.0000	7.2108	10.59
2	0.2377	6.7074	11.18
3	0.4540	6.0016	12.05
4	0.6517	5.0680	13.52
5	0.8330	4.4783	14.62
6	1.0000	3.8061	16.25

Table: 8 C- Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-heptanol system at 308.15 K

Sr. No	Mole fraction	β $(m^2/N) \times 10^{-10}$	Z $(Kg/m^2s) \times 10^5$
1	0.0000	7.4353	10.41
2	0.2377	6.8398	11.04
3	0.4540	6.2426	11.79
4	0.6517	5.2518	13.25
5	0.8330	4.6220	14.37
6	1.0000	3.9239	15.98

Table: 9 C- Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-heptanol system at 313.15 K

Sr. No	Mole fraction	β $(m^2/N) \times 10^{-10}$	Z $(Kg/m^2s) \times 10^5$
1	0.0000	7.5663	10.29
2	0.2377	6.9684	10.92
3	0.4540	6.4256	11.60
4	0.6517	5.3409	13.11
5	0.8330	4.7587	14.14
6	1.0000	4.0428	15.70

Table: 10C-Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-heptanol system at 318.15 K

Sr. No	Mole fraction	β $(m^2/N) \times 10^{-10}$	Z $(Kg/m^2s) \times 10^5$
1	0.0000	7.8731	10.08
2	0.2377	7.2746	10.66
3	0.4540	6.5715	11.45
4	0.6517	5.4542	12.95
5	0.8330	4.8814	13.92
6	1.0000	4.1177	15.54

The variation of evaluated parameters such as adiabatic compressibility (β) and specific acoustic impedance (Z) as a function of concentration of solutions at different temperatures is graphically represented in Fig. 4C and 5C. The study of the variation of acoustic and thermodynamic parameters as a function of concentration at temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K is important tool to predict about the various specific interactions, due to formation of donor-acceptor type complexes.

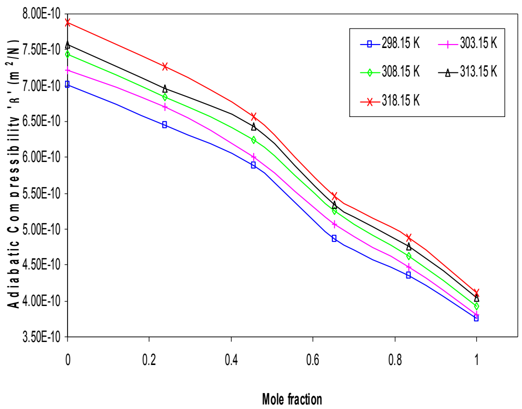

Fig. 4C: Variation of adiabatic compressibility with mole fraction of aniline + 1-heptanol

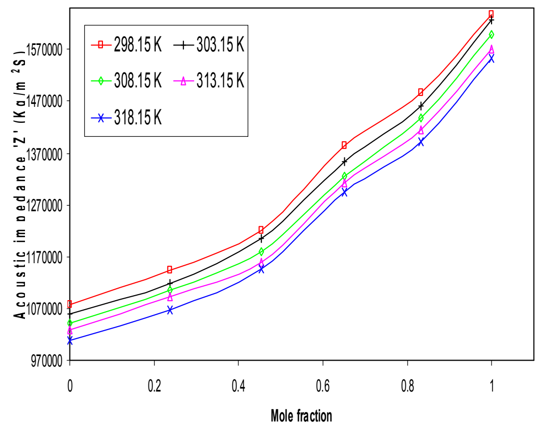

Fig. 5C: Variation of acoustic impedance with mole fraction of aniline + 1-heptanol

The plots of variation of ultrasonic velocity (U) with the mole fraction of aniline in aniline+1-heptanol binary system, are shown in Fig. 1C. The figure indicates that the ultrasonic velocity (U) of solutions increases linearly with increase in concentration of solution. Comparatively, greater increase in ultrasonic velocity (U) is observed for 0.4540 to 0.6517 mole fraction range of aniline than that of for the 0.2377 to 0.4540 mole fraction range. For a given concentration value, the ultrasonic velocity (U) is maximum at 298.15K and it decreases as temperature increases. The concentration dependence of density (ρ) of aniline +1-heptanol, system is given in Fig. 2C. The density (ρ) increases linearly as the concentration of solution increases. The increase in density (ρ) is comparatively higher at the 0.2377 to 0.4540 mole fraction range.

The variation of viscosity (η) with the concentration of aniline+1-heptanol solution is shown in Fig. 3C. Comparatively, higher decrease in viscosity (η) values is observed for the mole fraction in the range of 0.0000 to 0.4540, after which the slower decrease in viscosity (η) is observed between 0.4540 and 0.8330 mole fractions.

The Fig. 4C shows the variation of adiabatic compressibility (β) against change in concentration of aniline at different temperatures. It is clear from Fig. 4C that adiabatic compressibility (β) is showing a linearly decreasing nature with the increase in mole fraction of aniline. However, the decrease in adiabatic compressibility (β) is comparatively higher in 40% to 60% concentration of aniline than that of other concentration range.

The plots of variation of acoustic impedance (Z) with mole fraction of aniline are shown in Fig. 5C. The figure indicates linear increase in acoustic impedance (Z) with the increase in mole fraction value of aniline. Marginally a greater increase in acoustic impedance (Z) is observed from 0.454 to 0.6517 mole fraction, as compared to other concentration ranges.

CONCLUSION:

The variation of ultrasonic velocity (U) with the concentration of aniline is graphically represented in Fig. 1C. ultrasonic velocity (U) is considered as a important thermodynamic parameter used to elucidate the different interactions occurring in solutions. In this particular system, ultrasonic velocity (U) increases with mole fraction of aniline. The Fig. 2C shows the dependence of density values of aniline+1-heptanol mixtures on the mole fraction of aniline. It is clear from the figure that the density (ρ) goes on increasing with an increase in concentration of aniline.

However, between the 40% to 60% concentration of aniline, comparatively greater increase in density (ρ) is observed. At a given concentration value, the maximum density (ρ) is noticed at 298.15K. The density (ρ) decreases with increase in temperature.

This is as expected in the light of theoretical predictions. The Fig. 3C shows the variation of viscosity (η) of binary liquid mixture of aniline+1-heptanol as a function of concentration of aniline at temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K. The figure shows that the difference in viscosity (η) of solutions in the 40% to 80% concentration of aniline is comparatively small while the viscosity (η) of pure 1-heptanol is found to be higher than that of it's binary solutions with aniline at all the temperatures studied.

Fig. 4C depicts the concentration dependence of adiabatic compressibility (β) for the aniline +1-heptanol binary organic liquid system. The figure shows that the adiabatic compressibility (β) decreases with increase in mole fraction of aniline. Comparatively greater decrease is observed between 40% to 60% concentration range of aniline. It is clear from the Fig. 5C that acoustic impedance (Z) increases as the concentration of aniline increases. However, high increase in it, is observed between 40% to 60% concentration range of aniline, than in case of other concentration of aniline.

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REFERENCES:

1. Praharaj M.K. and Mishra S., Ultrasonic study of certainbinary mixtures in terms of the excess values ofthermodynamic parameters. Int. J. Rec. Sci Res., 7 (2016)9125-9128.
2. Nath G. and Paikaray R., Effect of frequency on acousticparameters in a binary mixture of polar liquids, Ind. J.Phys.,83 (2009) 1567-1574
3. Praharaj M.K. and Mishra S., Study of acoustic andthermodynamic parameters for binary mixture containingcyclohexane and the substituted benzenes at differenttemperatures, J. Chem. Bio. Phy. Sc., Section C, 5 (2014)686-699.
4. Ali A. and Nain A.K., Ultrasonic study of molecularinteractions in N, N-dimethylacetamide + ethanol binarymixtures at various temperatures, Acoust. Lett., 19 (1996)181.
5. Praharaj M.K., Satapathy A., Mohanty J. and MishraS., Thermodynamic parameters and their excess valuesfor binary mixtures of cyclohexane plus benzene andsubstituted benzenes at different ultrasonic frequencies,Int. J. Eng. Res. Tech.,3 (2014) 1060-1065.
6. Praharaj M.K. and Mishra S., Molecular interaction internary liquid mixtures at different temperatures, World J.Pharm. Pharmace. Sc., 5 (2016) 1597-1607.
7. Dash A.K. and Paikaray R., Studies on acousticparameters of ternary mixture of dimethyl acetamide inacetone and isobutyl methyl ketone using ultrasonic and viscosity probes, Int. J. Chem. Phy Sc., 3 (2014) 69-79.
8. Praharaj M.K., Satapathy A., Mishra P. and MishraS., Ultrasonic Studies of Molecular Interactions in pyridine+ N-N dimethylformamide + cyclohexane Ternary LiquidMixtures at Different Temperatures, J. Theo. Appl. Phys.,7 (2013) 1-6.
9. Praharaj M.K. and Mishra S., Comparative study ofmolecular interaction in ternary liquid mixtures of polarand non-polar solvents by ultrasonic velocitymeasurements, Int. J. Sci. Res., 3 (2014) 642-646.
10. Praharaj M.K., Satapathy A., Mishra P. and MishraS., Study of molecular interaction in mixture of n, n-dimethylformamide, cyclohexane and benzene fordifferent frequencies of ultrasonic waves, Golden Res.Thoughts,2 (2013) 1-10.