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ULTRASONIC VELOCITY STUDIES AND RELATED THERMODYNAMIC PARAMETERS OF ANILINE + 1-OCTANOL 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 concentration of aniline +1-octanol 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 and acoustic impedance (Z) increases as the concentration of aniline increases.

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

INTRODUCTION-

The knowledge of behavior of the molecules in the liquid and its mixture is very important for the application of that liquid in pure and applied fields, such as biological, automobile, pharmaceutical, chemical, industrial, and other research areas. It is a well known fact that in spite of many other studies used to understand and the nature of intermolecular interaction the ultrasonic studies have played an important role. The dependence of ultrasonic velocity of liquid on the bonding forces between the atoms and molecules provides the knowledge about the nature of molecular interactions occurring in the liquids and their mixtures [1-5].The liquids acetone, aniline and pyridine are very useful liquids as they have wide applications in different areas. Pyridine is used currently in the extraction process for coal to analyse its compounds and in the manufacture of vitamin B6 and other drugs. Similarly Acetone and Aniline are also important in many applications such as bio-medical, chemical and pharmaceuticals. These liquids and their mixtures are of interest to organic chemists to know about the type of bond and the complexes [6-8].The different ultrasonic parameters are to be discussed in terms of their excess values rather than actual in order to understand the nature of molecular interactions between the components of the liquid mixtures.

In this paper, the sonochemical study of the aniline + 1-octanol binary liquid system was studied. The prepared solutions of binary mixture of aniline + 1-octanol of different concentrations are used to measure the experimental properties like ultrasonic velocity (U), density (ρ) and viscosity (η) at temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K. The density (ρ) and ultrasonic velocity (U) measurements provide systematic information regarding ion-ion, ion-solvent, solvent-solvent interactions and also structural effects of solute and solvent in solution.

This experimentally measured data of experimental properties is used to calculate the various acoustic and thermodynamic properties, which play a very useful role in understanding the molecular interactions, molecular association and dissociation occurring in solutions under investigation.

EXPERIMENTAL:

The aniline used was supplied by s.d. fine chemicals having purity > 99.5%, while the 1-octanol used was of Fluka chemika made, having purity > 99.0%. Both the organic liquids were used without their further purification. The binary liquid mixtures of aniline +1-octanol of various concentrations were prepared by mass in grams using a Mettler-balance (Switzerland, Model AE-240) with a precision of ± 0.0001 gm. in airtight stoppered glass bottles. Care was taken to avoid evaporation and the contamination of solvent during their mixing. In order to carry out the ultrasonic study of aniline + 1-octanol binary liquid system, the six solutions of different mole fractions of aniline as 0.0000, 0.2590, 0.4824, 0.6771, 0.8483 and 1.0000 are prepared and the experimental properties such as ultrasonic velocity (U), density (ρ) and viscosity (η) were measured at 298.15, 303.15, 308.15, 313.15 and 318.15K temperatures. The measurement of ultrasonic velocity (U) of solutions of all concentrations are carried at different temperatures by interferometer method, using Mittal's F-81 model of ultrasonic interferometer having the 2 MHz frequency of ultrasonic waves. The density measurements were carried out by using density bottle i.e. specific gravity bottle with accuracy of ± 0.0001 gm/cc. The viscosity (η) measurements of solutions were completed by using Ostwald's viscometer. The thermostatically controlled water bath with thermal stability of ± 0.05^{0}C for 15 min. to attain thermal equation at the desired temperature, is used to maintain the desired temperature during the measurements of experimental properties such as velocity (U), density (ρ) and viscosity (η) of solutions of different concentrations. The measurements were carried out at temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K. The measurements were repeated thrice and average reading is considered.

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

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. X10^{-3}
1	0.0000	1316	822.30	6.5
2	0.2590	1352	854.30	4.0
3	0.4824	1414	888.30	3.2
4	0.6771	1473	923.60	2.9
5	0.8483	1547	964.20	2.8
6	1.0000	1622	1009.60	3.2

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

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. X10^{-3}
1	0.0000	1296	819.30	5.5
2	0.2590	1340	851.70	3.5
3	0.4824	1395	885.50	2.8
4	0.6771	1459	920.40	2.6
5	0.8483	1532	961.40	2.6
6	1.0000	1616	1006.20	2.8

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

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. X10^{-3}
1	0.0000	1282	815.80	4.9
2	0.2590	1323	847.50	3.2
3	0.4824	1373	882.20	2.5
4	0.6771	1431	916.50	2.2
5	0.8483	1517	957.10	2.3
6	1.0000	1595	1002.40	2.5

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

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. $X10^{-3}$
1	0.0000	1260	812.00	4.1
2	0.2590	1308	843.00	2.7
3	0.4824	1354	878.70	2.1
4	0.6771	1411	912.30	1.9
5	0.8483	1497	951.90	2.0
6	1.0000	1575	997.50	2.1

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

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. $X10^{-3}$
1	0.0000	1246	805.80	3.6
2	0.2590	1281	837.90	2.5
3	0.4824	1342	871.90	1.9
4	0.6771	1396	905.60	1.7
5	0.8483	1460	945.90	1.8
6	1.0000	1563	992.40	1.9

RESULTS AND DISCUSSION:

The data obtained of experimentally measured properties viz. ultrasonic velocity (U), density (ρ) and viscosity (η) for aniline+ 1-octanol system at temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K are given in Tables 1D, 2D, 3D, 4D and 5D respectively.

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

Sr. No	Mole fraction	β $(m^2/N) \times 10^{-10}$	Z $(Kg/m^2s) \times 10^5$
1	0.0000	7.0262	10.81
2	0.2590	6.4064	11.54
3	0.4824	5.6314	12.55
4	0.6771	4.9912	13.60
5	0.8483	4.3334	14.91
6	1.0000	3.7630	16.37

Table: 7 D- Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-Octanol 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	7.3918	10.52
2	0.2590	6.5428	11.40
3	0.4824	5.8139	12.32
4	0.6771	5.1040	13.42
5	0.8483	4.4318	14.72
6	1.0000	3.8061	16.25

Table: 8 D- Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-Octanol 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	7.4630	10.45
2	0.2590	6.7392	11.21
3	0.4824	6.0106	12.11
4	0.6771	5.3292	13.11
5	0.8483	4.5406	14.51
6	1.0000	3.9229	15.98

Table: 9 D- Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-Octanol 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	7.7517	10.23
2	0.2590	6.9331	11.02
3	0.4824	6.1223	11.98
4	0.6771	5.5019	12.87
5	0.8483	4.6885	14.24
6	1.0000	4.0428	15.70

Table:10D-Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-Octanol 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	7.9920	10.04
2	0.2590	7.2684	10.73
3	0.4824	6.3684	11.70
4	0.6771	5.6620	12.65
5	0.8483	6.2780	12.27
6	1.0000	4.1177	15.54

The variation of ultrasonic velocity (U), density (ρ) and viscosity (η) as a function of concentration at different temperatures studied are graphically represented in Fig. 1D, 2D, 3D respectively.

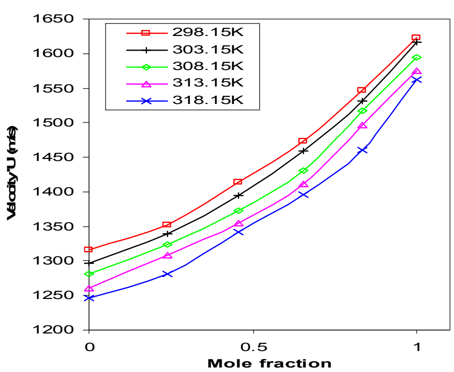


Fig. 1D: Variation of Ultrasonic velocity with concentration of aniline + 1-octanol

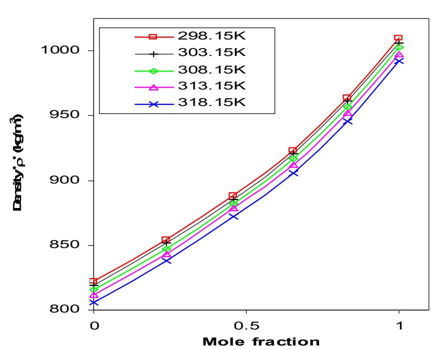


Fig. 2D: Variation of density with mole fraction of aniline + 1-octanol

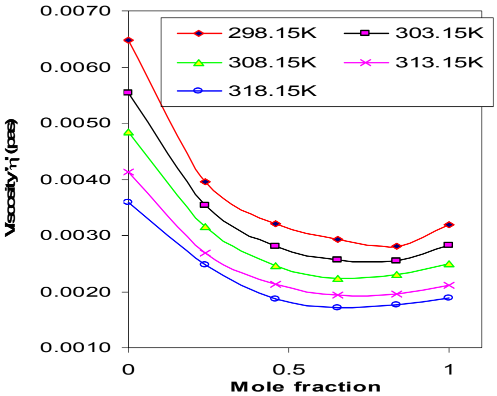
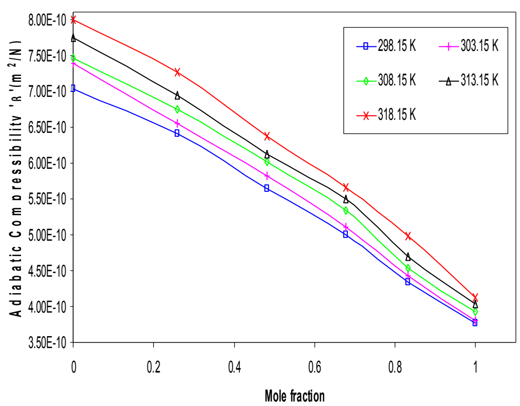


Fig. 3D: Variation of viscosity with mole fraction of aniline + 1-octanol

The data obtained from measurements of experimental properties such as ultrasonic velocity (U), density (ρ) and viscosity (η) at temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K is used to evaluate the 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). The data obtained of these parameters at temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K is given in Tables 6D, 7D, 8D, 9D and 10D respectively. The graphical representation of variation of derived acoustic and thermodynamic parameters with concentration is given in Fig. 4D and 5D. The concentration dependence of ultrasonic velocity (U) of aniline +1-octanol system is graphically represented in Fig. 1D. The figure clearly shows the linear increase in ultrasonic velocity (U) with increase in mole fraction of aniline. The ultrasonic velocity (U) decreases as the temperature increases for a given concentration of solution.



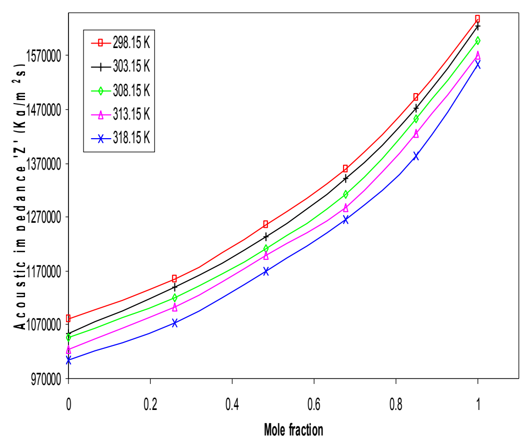


Fig. 4D: Variation of adiabatic compressibility with mole fraction of aniline + 1-octanol

Fig. 5D: Variation of acoustic impedance with mole fraction of aniline + 1-octanol

The variation of density (ρ) with concentration of aniline is graphically shown in Fig. 2D. The linear increase in density (ρ) of solution with increase in mole fraction of aniline is observed from Fig. 2D. For a given concentration of solution the density (ρ) decrease with increase in temperature.

The plots showing variation of viscosity (η) with mole fraction of aniline, are shown in Fig. 3D. It is observed from the figure that the viscosity (η) decreases in higher magnitude for 0.0000 to 0.2590 mole fraction range as compared with other concentration values. There is slower decrease in viscosity (η) observed in the 0.2590 to 0.8483 mole fraction values. However from 0.8483 to 1.0000 mole fraction of aniline, the increase in viscosity (η) is noticed. The variation of adiabatic compressibility (β) with concentration of solution under investigation is graphically represented in Fig. 4D. The figure indicates that the adiabatic compressibility (β) decreases linearly as the amount of aniline in 100 gm of its binary mixtures with 1-octanol increases.

The plots of concentration dependence of acoustic impedance (Z) are given in Fig. 5D. The comparatively higher increase in acoustic impedance is observed for 0.8483 to 1.000 mole fraction range as compared to other concentrations.

CONCLUSION:

Fig. 1D shows variation of ultrasonic velocity (U) with the concentration of aniline, observed the increase in ultrasonic velocity (U) and corresponding decrease in intermolecular free length (L_f) as a result of mixing of component liquids are in accordance with the view proposed by Erying and Kincaid , according to which there is increase in ultrasonic velocity (U) with decrease in intermolecular free length (L_f) and vice versa.

The figures 2D shows the graphical presentation of variation of density (ρ) with the concentration of aniline in aniline +1-octanol binary liquid system. It is observed from figure that there is linear increase in density (ρ) with increase in mole fraction of aniline. The density (ρ) values are maximum at 298.15K and they decrease with increase in temperature at given concentration.

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