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REVIEW OF RESEARCH

ULTRASONIC BEHAVIOR OF ANILINE +1-HEXANOL SYSTEM

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ABSTRACT

Ultrasonic velocity (U), density and viscosity with different concentration of aniline +1- hexanol binary system at temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K temperatures were measured. The measured values were used to evaluate the various acoustic and thermodynamic properties like adiabatic compressibility (β) and specific acoustic impedance (Z). The linear increase in acoustic impedance (Z) with increase in mole fraction of aniline and at a given concentration the acoustic impedance decreases with increase in temperature was observed. Whereas a linear decrease in adiabatic compressibility (β) with increase in mole fraction of aniline and decrease in adiabatic compressibility (β) with increase in concentration was observed.

KEYWORDS – Density, viscosity, ultrasonic velocity, adiabatic compressibility, specific acoustic impedance.

INTRODUCTION :

Ultrasonic wave in recent years, acquired the status of an important probe for the study of structure and properties of matter in basic essence. Many workers found the ultrasonic propagation parameters, determined Intermolecular free-Length (Lf) in liquids and liquid mixtures using the Jacobson's relation, studied many acoustical parameters of liquid fluorine and H_2S, CO,CD and HCN, C_2N_2 and $POCl_3$ and also plastic crystals parameters like adiabatic compressibility β_{ad} etc. of solvent, solvent mixtures and the soap solutions have also been made[1-2]. Ultrasonic parameters of solvent and solvent mixtures have also been studied at various temperatures [3-4]. Properties of surface active solutions are very important to access the thermodynamic, acoustic and transport aspects [5]. Ultrasonic technique is a powerful means for characterizing the various aspects of physicochemical behavior of the system and also for studying the interaction between the molecules [6]. A number of workers [7-8] have discussed the physico-chemical aspects of ultrasonic velocity and related parameters on different types of soaps and detergents. The Gruneisen parameter and internal pressure obtained from ultrasonic velocity and density data play a significant role in understanding internal structure, clustering phenomenon and quasi-crystalline nature of binary mixture[9]. Ultrasonic measurements have also been used to determine solvation number in aqueous media [10].

The present work is ultrasonic study of binary organic liquid system aniline+1-hexanol. The study has been carried out for a wide range of temperature and concentration to observe the dependence of experimentally measured properties such as ultrasonic velocity (U), density (ρ) and viscosity (η) and also of various derived acoustic and thermodynamic parameters, on temperature and concentration.

The temperature range for ultrasonic study of aniline + 1-hexanol in the present work is from temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K and that of concentration is from 0%, 20%, 40%, 60%, 80% to 100% concentration of aniline. The experimentally measured properties like ultrasonic velocity (U), density (ρ) and viscosity (η) are utilized to calculated the various acoustic and thermodynamic parameters such as adiabatic compressibility (β) and specific acoustic impedance (Z).

EXPERIMENTAL:

The aniline (s.d. fine chemicals, purity > 99.5%) and 1-hexanol (Merck Schuchardt, purity 99.0%) were used for preparation of aniline +1-hexanol binary liquid mixtures of various concentrations. All the six mixtures were prepared by mass 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 solvent contamination during mixing. To study the ultrasonic behaviour of aniline + 1-hexanol binary liquid system, their six solutions of varying mole fraction values of aniline as 0.0000, 0.2152, 0.4224, 0.6220, 0.8144 and 1.0000 were prepared and the experimental properties are measured at five different temperature viz. 298.15, 303.15, 308.15, 313.15 and 318.15K for solutions of all concentration. The ultrasonic velocity (U) of solution of all concentrations is measured at the temperature 298.15, 303.15, 308.15, 313.15 and 318.15K by interferometer method, using Mittal's F-81 instrument, having the frequency of ultrasonic waves 2MHz. The error in these measurements was ± 0.15%. The density (ρ) measurements were carried out by using specific gravity bottle with an accuracy of ± 0.0001 gm /cc. The viscosity (η) measurements of solutions of all the concentrations that were under investigation in the present work, were completed by using Ostwald's viscometer. The desired temperature is maintained during the measurements of experimentally determined properties viz. ultrasonic velocity (U), density (ρ) and viscosity (η) of the solutions of al concentration with the help of thermostatically controlled water bath. What thermal stability of ± 0.05^{0}C to attain thermal equilibrium at the desired temperature. The measurements of experimental properties are carried out thrice and average reading is considered.

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

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. X10^{-3}
1	0.0000	1298	808.80	4.03
2	0.2152	1335	846.10	2.92
3	0.4224	1392	878.30	2.65
4	0.6220	1458	920.10	2.57
5	0.8144	1538	963.90	2.63
6	1.0000	1622	1009.60	3.18

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

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. X10^{-3}
1	0.0000	1282	806.20	3.63
2	0.2152	1324	839.60	2.71
3	0.4224	1374	875.50	2.41
4	0.6220	1440	917.10	2.27
5	0.8144	1524	960.40	2.36
6	1.0000	1616	1006.20	2.83

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

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. $X10^{-3}$
1	0.0000	1270	803.00	3.18
2	0.2152	1312	837.10	2.38
3	0.4224	1361	871.80	2.14
4	0.6220	1430	913.10	2.01
5	0.8144	1508	957.20	2.08
6	1.0000	1595	1002.40	2.49

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

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. $X10^{-3}$
1	0.0000	1255	799.10	2.84
2	0.2152	1292	832.50	2.03
3	0.4224	1354	867.70	1.86
4	0.6220	1405	908.70	1.74
5	0.8144	1486	952.70	1.82
6	1.0000	1575	997.50	2.12

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

Sr. No	Mole fraction	U m/sec	ρ kg/m^3	η Pas. $X10^{-3}$
1	0.0000	1235	796.10	2.50
2	0.2152	1283	826.50	1.81
3	0.4224	1333	864.60	1.62
4	0.6220	1391	906.20	1.56
5	0.8144	1471	949.90	1.64
6	1.0000	1563	994.40	1.88

RESULTS AND DISCUSSION:

The data obtained of measured properties viz. ultrasonic velocity (U), density (ρ) and viscosity (η) of solutions of Aniline +1-hexanol mixtures having different concentration at temperature 298.15, 303.15, 308.15, 313.15 and 318.15K is given in Tables 1B, 2B, 3B, 4B and 5B respectively.

Table: 6 B- Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-hexanol 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	7.3413	10.49
2	0.2152	6.6548	11.25
3	0.4224	5.8780	12.22
4	0.6220	5.1127	13.41
5	0.8144	4.3854	14.82
6	1.0000	3.7630	16.37

Table: 7 B- Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-hexanol 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	7.5490	10.33
2	0.2152	6.7952	11.11
3	0.4224	6.0470	12.03
4	0.6220	5.2555	13.20
5	0.8144	4.4826	14.63
6	1.0000	3.8061	16.25

Table: 8 B- Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-hexanol 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	7.7288	10.19
2	0.2152	6.9446	10.97
3	0.4224	6.1896	11.86
4	0.6220	5.3562	13.05
5	0.8144	4.5916	14.43
6	1.0000	3.9229	15.98

Table: 9 B- Adiabatic compressibility (β)and acoustic impedance (Z) of aniline+1-hexanol 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	7.97030	10.00
2	0.2152	7.1978	10.75
3	0.4224	6.2855	11.74
4	0.6220	5.5751	12.76
5	0.8144	4.7504	14.16
6	1.0000	4.0428	15.70

Table: 10 B- Adiabatic compressibility (β) and acoustic impedance (Z) of aniline+1-hexanol 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	8.2319	98.34
2	0.2152	7.3457	10.60
3	0.4224	6.5131	11.52
4	0.6220	5.7072	12.60
5	0.8144	4.8683	13.96
6	1.0000	4.1177	15.54

The graphical representation of variation of measured properties as a function concentration of solution at different temperature is given in Fig. 1B, 2B and 3B. The values of these experimentally measured properties are used to evaluate the various acoustic and thermodynamic properties such as adiabatic compressibility (β) and specific acoustic impedance (Z) as a function of concentration at temperature range 298.15, 303.15, 308.15, 313.15

and 318.15K by using the relaxations. The variation in these derived properties as a function of concentration is studied in the light of molecular interactions, solute-solvent interactions and dipolar interactions.

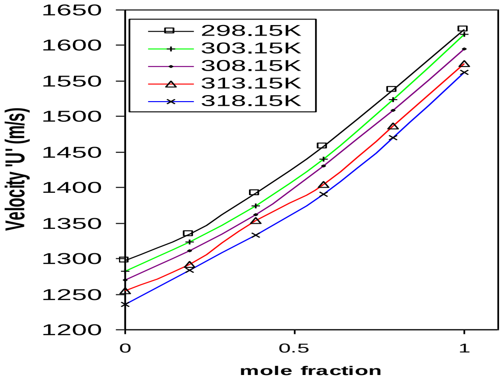

Fig. 1B: Variation of Ultrasonic velocity with concentration of aniline + 1-hexanol

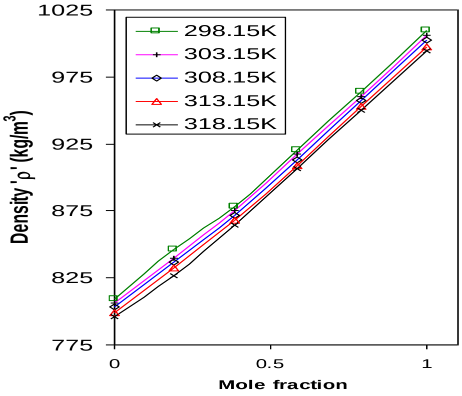

Fig. 2B: Variation of density with mole fraction of aniline + 1-hexanol

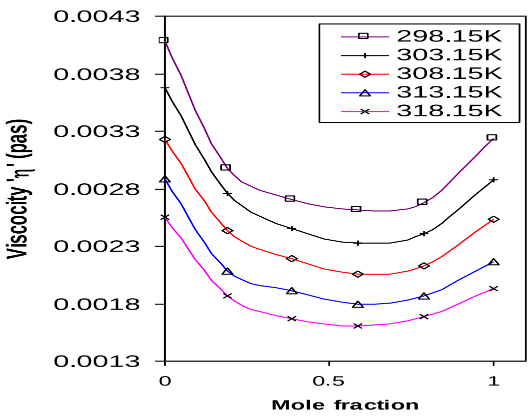

Fig. 3B: Variation of viscosity with mole fraction of aniline + 1-hexanol

The graphical representation of variation of the derived parameters adiabatic compressibility (β) and specific acoustic impedance (Z) as a function of concentration for temperatures 298.15, 303.15, 308.15, 313.15 and 318.15K is shown is Fig. 4B and 5B.

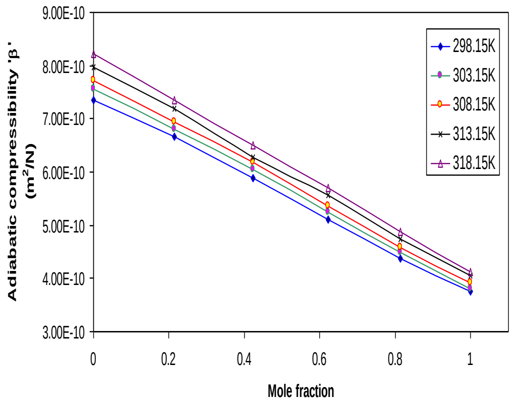

Fig. 4B: Variation of adiabatic compressibility with mole fraction of aniline ++ 1-hexanol

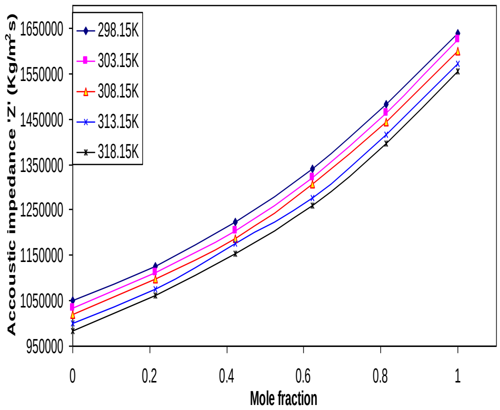

Fig. 5B: Variation of acoustic impedance with mole fraction of aniline + 1-hexanol

The plots of ultrasonic velocity (U) versus concentration at different temperature are shown in Fig. 1B. The change in ultrasonic velocity occurs as the concentration of solutions changes for a given temperature. The ultrasonic velocity (U) increases with increase in the concentration of aniline in the aniline +1-hexanol binary mixture. For a given temperature a ultrasonic velocity (U) carries minimum value to the solution which do not contain aniline. The increase in ultrasonic velocity is steady with concentration but the magnitude in increase in its value in comparatively high between the 60% to 100% concentration of aniline.

The variation of density with concentration of Aniline +1-hexanol solution in shown in Fig. 2B. The density (ρ) goes on increasing with increase in concentration. For a given concentration the density is found to be minimum at 318.15K and it increases as temperature decreases hence is minimum at 298.15K

Fig. 3B indicates the concentration dependence of viscosity (η) of aniline +1-hexanol mixtures at different temperatures. It is clear from the plots obtained that the viscosity initially decreases as a concentration of solutions increases but from 60% to 100% concentration of solution it shows slight increase in viscosity (η) with increase in concentration. There is comparatively higher decrease in viscosity (η) from 0% to 20% concentration and the rate of decrease in viscosity (η) becomes slower from 20% to 60% concentration.

The variation of adiabatic compressibility (β) with concentration of aniline +1-hexanol mixtures expressed in mole fraction of aniline is shown in Fig. 4B. The figure indicates the linear decrease in adiabatic compressibility (β) as the concentration of aniline in solution increases. For a given concentration value, the adiabatic compressibility (β) value is minimum at temperature 298.15K and found to be maximum at temperature 318.15K.

The change in acoustic impedance (Z) with change in concentration of solution at given temperature is represented in Fig. 5B. The figure indicates that as the concentration of aniline +1-hexanol solution increase the acoustic impedance (Z) also increases. The magnitude of increase in acoustic impedance is comparatively low between 0% to 60% concentration range but it marginally increases for concentration range 60% to 100%. For a given concentration of aniline +1-hexanol binary mixture, the acoustic impedance carries minimum value at 318.15K and it increases with decrease in temperature thus maximum at 298.15K.

CONCLUSION:

The increasing trend of ultrasonic velocity (U) with increase in concentration of aniline is observed in Fig. 1B. The variation of density with the mole fraction of aniline for the aniline +1-hexanol system is shown in Fig. 2B. The figure indicates that the density increases linearly with increase in mole fraction of aniline. For a given concentration, as expected, the density decreases with increase in temperature. The concentration dependence of viscosity (η) of aniline +1-hexanol binary liquid system is shown in Fig. 3B. The curve like nature of plots for all temperature studied, is observed from Fig. 3B, showing that the change in viscosity (η) is comparatively slow between the 20% to 80% concentration range.

The plots showing change in adiabatic compressibility (β) with the change in mole fraction of aniline are given in Fig. 4B. The figure shows a linear decrease in adiabatic compressibility (β) with increase in mole fraction of aniline. The compressibility is a measure of an capacity of solute to attract solvent molecules. The increase in density as evident from Fig. 2B and decrease in adiabatic compressibility (β) with increase in concentration shown in Fig. 4B indicates the existence of attractive forces between the aniline and 1-hexanol molecules. The Fig. 5B depicts the variation of acoustic impedance (Z) with the change in aniline concentration. The figure indicates the linear increase in acoustic impedance (Z) with increase in mole fraction of aniline. At a given concentration the acoustic impedance decreases with increase in temperature as evident from the Fig. 5B.

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