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STUDY OF MOLECULAR INTERACTIONS IN THE BINARY LIQUID MIXTURES FROM ACOUSTIC AND THERMODYNAMIC PARAMETERS AT 303K AND 2 MHz FREQUENCY

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ABSTRACT:

Measurements of ultrasonic velocity, density and viscosity have been carried out for n- Hexanol in 1,4Dioxaneat different concentrations at 303 K temperature and 2 MHz frequency, to provide information about molecular environment and extent of molecular interaction by ultrasonic technique. Ultrasonic velocity study of binary liquid mixture has gained much importance in assessing the weak and strong molecular interactions and association between the component molecules. Ultrasonic studies may throw more light on the molecular interaction to know the behaviour of solute and solvent molecules in liquid mixtures and solutions. Acoustical parameters such as adiabatic compressibility (βa), intermolecular free length (Lf), Acoustic Impedance (Z) and relaxation time (τ)for n- Hexanol in 1,4 Dioxanewere calculated from ultrasonic velocity and effect of concentration on molecular interaction was predicted.

Keywords :- concentration, n- Hexanol, 1,4Dioxane, molecular, ultrasonic.

INTRODUCTION :

Ultrasonic measurements are very useful in the study of molecular interaction which plays an important role in the development of molecular science. The study of thermodynamic properties of binary mixtures provides opportunities for adjustment of observable properties which provides an experimental background for intermolecular interaction in the binary mixture. The nature of molecular interaction of the system can be determined by the propagation of ultrasonic waves. The ultrasonic wave propagation in the medium affects its physical properties[1-4].

The quantities such as ultrasonic velocity, density, viscosity are the important parameters which are required for the ultrasonic non-destructive technique of material characterization [4-6].In the present work ultrasonic velocity, density and viscosity values are measured in binary liquid mixtures of n-Hexanol with 1-4 Dioxane at 303K over entire range of mole fraction. By using these data, the parameters adiabatic compressibility (β_a), intermolecular free length (L_f), Acoustic Impedance (Z) and relaxation time (τ)are calculated.

MATERIAL AND METHOD :

The ultrasonic velocity, density and viscosity in binary liquid mixtures for n – Hexanol in 1-4 Dioxane been measured for different concentration at 303K.

Velocity Measurement

The ultrasonic velocity (U) in binary liquid mixtures for n – Hexanol in 1-4 Dioxane been measured using an ultrasonic interferometer (Mittal type, Model F-81) working at 2MHz frequency and at temperature 303K. The accuracy of sound velocity was $\pm 0.1 ms^{-1}$. An electronically digital operated constant temperature water bath has been used to circulate water through the double walled measuring cell made up of steel containing the

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experimental solution at the desired temperature.

Density measurement

The density of pure liquid and liquid mixture was determined using pycknometer by relative measurement method with an accuracy of ± $0.1 Kgm^{-3}$. The mixture bottle was immersed in the temperature-controlled system with the bath water.

Viscosity Measurement

The Ostwald viscometer 10ml ± $0.01 Ns^{-1} m^{-2}$ was used for measurement of viscosity of flowing time with the accuracy of ± 0.1 was determined using a digital stop watch.

The parameters such as adiabatic compressibility (β_a), intermolecular free length (L_f), Acoustic Impedance (Z) and relaxation time (τ)are calculated by using the followingrelation (1- 4).

$\beta_a = (U^2 \rho)^{-1}$ ..... (1)

$L_f = K_T \beta a^{1/2}$ ..... (2)

$Z = U\rho$ ..... (3)

$\tau = 4/3\ \eta\ \beta_a$ ..... (4)

RESULTS AND DISCUSSION :

The measured values such as ultrasonic velocity (U), density (ρ) and viscosity (η) of 1,4Dioxane with n-Hexanoland calculated parameters adiabatic compressibility (βa), free length (L_f), free volume (V_f) and acoustical impedance (Z) parameters for 1,4 Dioxane with n-Hexanolare given in Table 1. It is clearly revealsthat all measured parameters, sound velocity, density decreases and viscosity are increasing for increasing concentrationofn-Hexanol. The ultrasonic velocity studies carried out in the present investigation reveal that the velocity varies with concentration due to the solute – solvent interactions through molecular association.

Table-I shows that, Ultrasonic velocity and density decreases with concentration of n-Hexanolin 1,4Dioxane at temperature 298K.The viscosity increases in the system, suggesting thereby more dissociation between solute and solvent molecules [7-9].

From the Table-I, the adiabatic compressibility (β_a) and free length (L_f) increases with increase of mole fraction of the n- Hexanol. This may lead to the presence of specific molecular interaction between the molecules of the liquid mixture. Acoustic impendence decreases with increase of concentration of n- Hexanol in 1,4 Dioxane in the system .The relaxation time(τ) increases with increase in concentration of the system .The relaxation time is of the order of 10^{-12} sec is due to structural relaxation process it suggested that the molecules gets dissociated[8-12].

CONCLUSION :

The ultrasonic velocity, density.viscosity of n-Hexanol in 1-4 Dioxane are measured and other related parameters were calculated. The existence of molecular interaction in solute-solvent is favoured in the system, confirmed from the U, ρ, η, βa, L_f, Z and τ data. The variation in ultrasonic velocity (U), density (ρ) and viscosity (η) and other related thermodynamic parameters such as βa, L_f, Zand τ at various concentrations and at 303K temperature in the n- Hexanol in 1-4 Dioxane shows the variation -linear. Strong intermolecular interactions are confirmed in the systems investigated. This provides useful information about solute solvent interactions in the mixture as existing in the liquid system.

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Table 1.Measured (Ultrasonic velocity (U), density (ρ) and viscosity (η) and calculated(adiabatic compressibility (βa), free length (L_f), free volume (Vf) and acoustical impedance (Z) parameters for 1,4Dioxane with n-Hexanol.

Mole fraction of n-Hexanol in 1,4 Dioxane	U (m/s)	ρ (kg/m^3)	η*10^{-3} (CP)	βa *10^{-10} (Pa^{-1})	L_f *10^{-10} (m)	Z*10^6 (kg/m^2s)	τ*10^{-12} (s)
0	1321.60	1031.00	1.1043	5.5531	0.4850	1.3625	0.8176
0.1	1310.20	1001.40	1.1444	5.8172	0.4964	1.3120	0.8876
0.2	1306.00	976.30	1.1596	6.0052	0.5044	1.2750	0.9284
0.3	1301.00	949.20	1.1685	6.2242	0.5135	1.2349	0.9697
0.4	1296.40	924.70	1.1845	6.4345	0.5221	1.1987	1.0162
0.5	1288.56	898.60	1.3052	6.7023	0.5328	1.1579	1.1663
0.6	1286.28	894.50	1.4245	6.7569	0.5350	1.1505	1.2833
0.7	1286.00	880.00	1.5655	6.8712	0.5395	1.1316	1.4342
0.8	1280.000	866.50	1.7263	7.0438	0.5462	1.1091	1.6213
0.9	1276.000	842.00	1.9515	7.2943	0.5559	1.0743	1.8979
1.0	1268.000	818.90	2.5196	7.5950	0.5672	1.0383	2.5515

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