ULTRASONIC STUDY OF MOLECULAR INTERACTION IN LIQUID MIXTURE Ethanol + Ethylamine + Butyric Acid AT DIFFERENT TEMPERATURE

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ABSTRACT

The Ultrasonic Velocity (U), Density (ρ), viscosity (η) have been measured for ternary liquid mixtures containing Ethanol + Ethylamine + Butyric acid at different temperatures. Adiabatic compressibility (βa) have been computed using standard relations. The results have been discussed in terms of molecular interactions.

Keywords: *Molecular interactions; Liquids mixtures; Ethylamine; Butyric acid; Ultrasonic velocity.*

Introduction

In recent years, Ultrasonic technique has become a powerful tool for studying the molecular behaviour of liquid mixture. This is because of its ability of characterizing physico- chemical behaviour of liquid medium. The study of properties of liquid and their mixtures find direct application in chemical and biochemical industries Ultrasonic velocity and related thermodynamic parameters help us for characterizing thermodynamic and physico - chemical aspects of liquid mixtures such as molecular interaction [14] and molecular structure.

The present paper deals with the measurement of density (ρ), ultrasonic velocity (U), Viscosity (η) and using them excess parameters such as adiabatic compressibility(βa) have been calculated.

Materials

In the present investigation density, viscosity and ultrasonic velocity are measured for ternary system containing Ethanol + Ethylamine + Butyric acid at four different temperature 298K, 303K, 308K, 313K. The chemicals used were of AR grade, obtained from Merch, (Mumbai) with purity of 99.5%. The ternary liquid mixture was prepared at room temperature. Samples were prepared by mixing the component liquids in volume proportion.

Methods

Density

The density of liquid mixture with different proportion are measured on electronic balance with precalibrated 10ml specific gravity bottle.The measured density was calculated using formula

$$\rho_2 = (\omega_2/\omega_1)\ \rho_1$$

where ω_1 = weight of distilled water
ω_2 = weight of experimental liquid
ρ_1 = density of water

Viscosity

Viscosity of liquid mixtures are measured using Ostwald's viscometer immersed in temperature controlled water bath. Using digital stopwatch, time of flow (t) was determined. The viscosity was calculated using the formula

$$\eta_2 = \eta_1\ (t_2/t_1)\ (\rho_2/\rho_1)$$

where η_1 = Viscosity of water
t_1 = flow time of water,
ρ_1 = density of water
η_2 = viscosity of liquid mixture
t_2 = flow time of liquid mixture
ρ_2 = density of liquid mixture

Ultrasonic velocity

The sound velocities of liquid mixtures have been measured using ultrasonic interferometer (Model F-81, Mittal enterprises, New Delhi) working at 2 MHz frequency.The liquid mixture is filled in measuring cell with quartz crystal and then micrometer was fixed keeping temperature constant. The total distance (d) travel by micrometer for n=10, was read. The wavelength (λ) was determined according to following equation.

$$\lambda = 2d/n$$

The sound velocity (U) of solvent and solutions were calculated from wavelength and frequency (F) according to equation

$$U = f\lambda$$

Adiabatic Compressibility

The adiabatic compressibility is the fractional decrease of volume per unit increase of pressure, when no heat flows in or out. It is calculated from speed of sound (U) and density (ρ) of the medium by using the equation of Newton Laplace

$$\beta a = 1/U^2\rho$$

Results & Discussion

Table-1 Values of Density (ρ) ,Viscosity (η) ,Ultrasonic Velocity (U) and Adiabatic Compressibility (βa) of Ethanol+Ethylamine+Butyric acid at 298 K

Sr. no.	Mole Fraction of Ethylamine	Mole Fraction of Butyric acid	Density (ρ) gm/cc	Viscosity (η) Cp	Ultrasonic Velocity(U) m/sec	Adiabatic Compressibility (βa) x10^{-11} cm^2/dyne
			298 K			
1	0.5123	0	0.8167	1.5605	1321	7.0128
2	0.4532	0.0434	0.8443	2.2269	1351	6.4878
3	0.3901	0.0899	0.8398	2.9732	1345	6.5746
4	0.3229	0.1394	0.8674	5.3049	1332	6.4899
5	0.2506	0.1925	0.864	4.2806	1313	6.713
6	0.1732	0.2494	0.8498	2.8227	1260	7.4065
7	0.0899	0.3107	0.8483	2.1268	1219	7.9243
8	0	0.377	0.8449	1.4783	1187	8.3964

Table-2 Values of Density(ρ), Viscosity(η), UltrasonicVelocity (U) and Adiabatic Compressibility (βa) of Ethanol+Ethylamine+Butyric acid 308 K

Sr. no.	Mole Fraction of Ethylamine	Mole Fraction of Butyric acid	Density (ρ) gm/cc	Viscosity (η) Cp	Ultrasonic Velocity (U) m/sec	Adiabatic Compressibility (βa) x10^{-11} cm^2/dyne
			308 K			
1	0.5123	0	0.8024	1.2502	1309	7.2626
2	0.4532	0.0434	0.8289	1.7957	1322	6.8954
3	0.3901	0.0899	0.8268	2.3636	1324	6.8942
4	0.3229	0.1394	0.8582	3.9051	1339	6.4902
5	0.2506	0.1925	0.8518	3.2505	1306	6.8756
6	0.1732	0.2494	0.8323	2.4818	1235	7.8697
7	0.0899	0.3107	0.8263	1.738	1219	8.1348
8	0	0.377	0.8182	1.2412	1138	9.4335

Table-3 Values of Density (ρ) ,Viscosity (η) ,Ultrasonic Velocity (U) and Adiabatic Compressibility (βa) of Ethanol+Ethylamine+Butyric acid at 303 K

Sr. no.	Mole Fraction of Ethylamine	Mole Fraction of Butyric acid	Density (ρ) gm/cc	Viscosity (η) Cp	Ultrasonic Velocity (U) m/sec	Adiabatic Compressibility (βa) $x10^{-11}$ cm^2/dyne
			303K			
1	0.5123	0	0.8136	1.3401	1320	7.0538
2	0.4532	0.0434	0.8421	1.9068	1333	6.6798
3	0.3901	0.0899	0.8364	2.5726	1337	6.6802
4	0.3229	0.1394	0.8684	4.7684	1323	6.575
5	0.2506	0.1925	0.8619	3.5449	1299	6.8743
6	0.1732	0.2494	0.8481	2.6624	1260	7.4214
7	0.0899	0.3107	0.8432	1.9096	1227	7.8683
8	0	0.377	0.8379	1.3392	1164	8.8056

Table-4 Values of Density (ρ) ,Viscosity (η) ,Ultrasonic Velocity (U) and Adiabatic Compressibility (βa) of Ethanol+Ethylamine+Butyric acid at 313 K

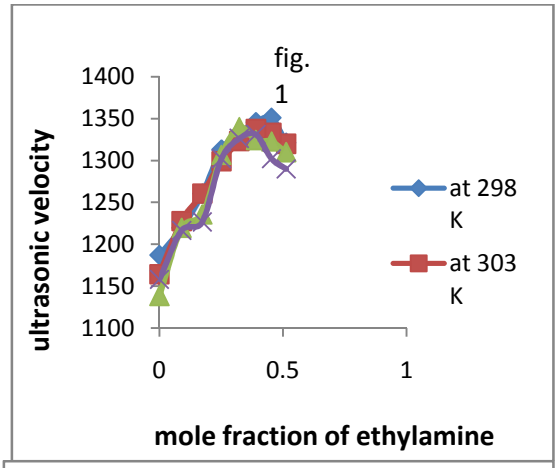
Sr. no.	Mole Fraction of Ethylamine	Mole Fraction pf Butyric acid	Density (ρ) gm/cc	Viscosity (η) Cp	Ultrasonic Velocity (U) m/sec	Adiabatic Compressibility (βa) x10-11 cm2/dyne
			313K			
1	0.5123	0	0.8083	1.0739	1290	7.4342
2	0.4532	0.0434	0.8346	1.5423	1302	7.0655
3	0.3901	0.0899	0.8333	2.0081	1331	6.7723
4	0.3229	0.1394	0.8653	3.2173	1326	6.5685
5	0.2506	0.1925	0.859	2.6885	1302	6.865
6	0.1732	0.2494	0.839	2.1198	1226	7.9205
7	0.0899	0.3107	0.8324	1.4906	1216	8.1149
8	0	0.377	0.83	1.1076	1158	8.9809

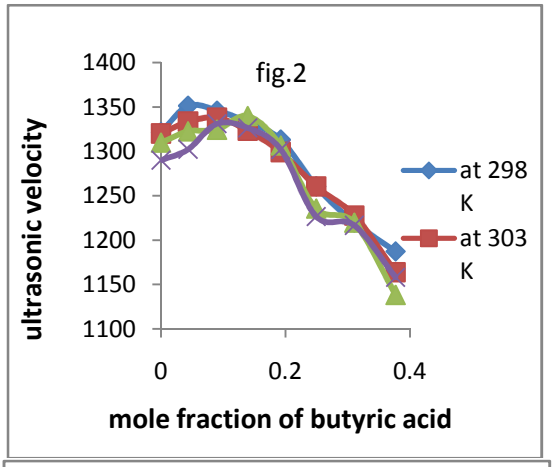
Table 1,2,3 and 4 provide the experimentally determined values of density (ρ), viscosity (η) and ultrasonic velocity (U) of ternary liquid mixture Ethanol + Ethylamine + Butyric acid at 298k, 308k, 303k and 313k. Adiabatic compressibility was calculated from ultrasonic velocity and density.

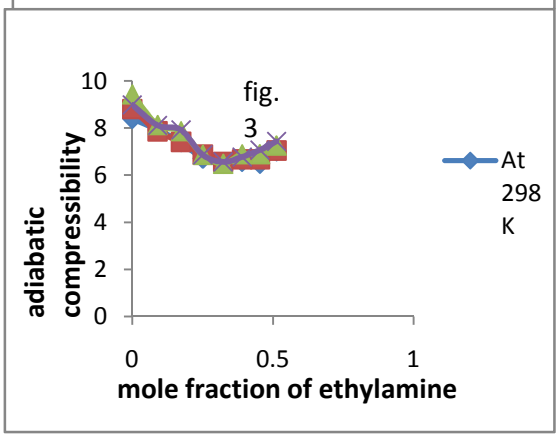
When concentration of Ethyl-amine at particular temperature decreases and concentration of Butyric acid increases the experimental density, viscosity and ultrasonic velocity first increases then decreases whereas adiabatic compressibility first decreases then increases. When temperature increases at fixed concentration of Ethyl-amine, density, viscosity and ultrasonic velocity decreases while adiabatic compressibility increases.

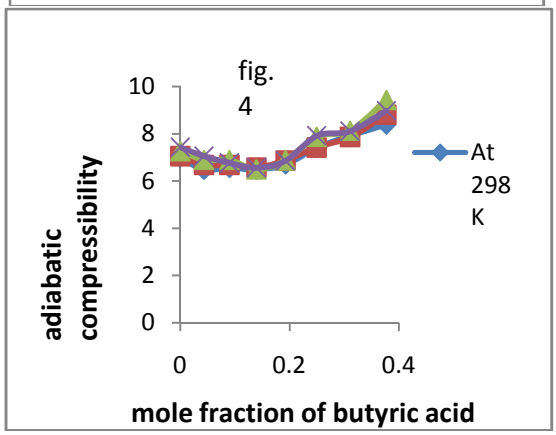
The plots of deviation in ultrasonic velocity against mole fraction at 298k, 303k, 308k and 313k are presented in fig (1) and fig (2).

The plots of deviation in adiabatic compressibility against mole traction at 298k, 303k, 308k and 313k are presented in fig (3) and fig (4).









Acoustical and thermodynamic properties are of great significance in studying the physico-chemical behaviour and molecular interactions of multi-component liquid mixtures. The molecular interactions existing in binary liquid mixture are discussed in terms of acoustical parameter.

Ultrasonic velocity as the speed in which sound propagates in certain material. It depends on material density and elasticity. Velocity is constant for given material. Ultrasonic velocity changes with change in concentration. This suggest powerful solute - solvent interactions

Density is an intensive property that increasing the amount of substance does not increase its density, rather it increases its mass. The density changes with change in concentration which results in change in number of particle in given region which leads to change in volume of solution.

Viscosity of solvent or solution is a measure of cohesiveness or rigidity present between either ions or ion-solvent or solution. The change in viscosity with concentration indicates that there exist a strong interaction between solute and solvent.

Adiabatic compressibility changes with change in concentration. This indicates existence of solute - solvent interactions. The change in adiabatic compressibility in liquid mixture indicates there is definite contraction on mixing and the variation is may be due to complex formation.

Hence in the present study there is existence of solute - solvent interaction which are discussed in above calculated acoustical parameters.

Conclusion

All the observations from present study leads to conclude that the non-liner variations of all the parameter measured from ternary liquid mixture indicates existence of interaction between the different molecules of the compounds in the mixture.

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