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Study of Adiabatic Compressibility and Excess Adiabatic Compressibility in Ternary Liquid Mixtures of Alcohol + Triethylamine + Acetic Acid

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ABSTRACT

The acoustical parameters like density, viscosity and ultrasonic velocity have been measured experimentally for the ternary liquid mixture of alcohol, tri-ethylamine and acetic acid at three different temperatures 30o, 35o and 40o. The samples were prepared by mixing the components in volume proportion. From the measured parameters adiabatic compressibility and excess compressibility have been calculated. Non linear behaviour of the parameters gives the assurance of presence of molecular interaction.

Keywords: Molecular Interaction, Ternary Liquid Mixture, Adiabatic Compressibility, Excess Adiabatic Compressibility

I. INTRODUCTION

The study of molecular interaction in binary and ternary liquid mixtures plays an important role in the study of development of molecular science. Since long, thermodynamic and transport properties of liquid mixtures have been used to study the departure of real liquid mixture behaviour from ideal one[1-4]. Acoustical parameters are important to understand different kinds of association, the molecular packing, molecular motion and various types of intermolecular interactions and their strength. Generally due to the presence molecular interaction the variation of acoustical and other properties is nonlinear. The sign and magnitude of the nonlinear deviation from their ideal values of velocity, adiabatic, temperature are generally ascribed to the difference in molecular size and strength of interaction between unlike molecules [5-7].

II. THEORY

The adiabatic compressibility is the fractional decrease of volume per unit increase of pressure, when no heat flows in or out. These changes are related to the compressibility of the medium by thermodynamic relation;

$$U^2 = \left(\frac{\partial P}{\partial \rho}\right)_S$$

So that

$$\frac{1}{U^2} = \rho.[1/\rho\left(\frac{\partial \rho}{\partial P}\right)_s] = \rho.\beta_a$$

and then

$\beta_a = 1/(U^2 \rho)$ ...(1)

Where, 'ρ' stands for density of liquid and 'β_a'is adiabatic compressibility. Thus, from experimental measurement of 'U' and 'ρ' we can calculate adiabatic compressibility.

The Excess adiabatic compressibility β_a^E for the ternary mixture were calculated by using following equation,

$\beta_a^E = \beta_{a\ mix} - (\beta_{a1}f_1 + \beta_{a2}f_2 + \beta_{a3}f_3)$ ...(2)

III. METHOD AND MATERIAL

In the present work density was measured by using density bottle (corning made certified 10 ml). Stopper is used in order to avoid evaporation of chemicals. Weight of bottle was taken by monopan balance (model no. K15) supplied by, K-Roy and Company, Varanasi. Its capacity is 100 gm with sensitivity of 0.01 mg. For the measurement of viscosity Ostwald viscometer was used. During measurement prepared sample was poured in to the viscometer and the time taken by the liquid sample to fall down from higher mark to lower mark and a crystal controlled interferometer, model No. M8 15 supplied by Mittal enterprises, New Delhi, was used for determination of ultrasonic velocity. Measurements are made at frequency 2 MHz. Density viscosity and ultrasonic velocity were measured at three different temperatures.

IV. RESULT AND DISCUSSION

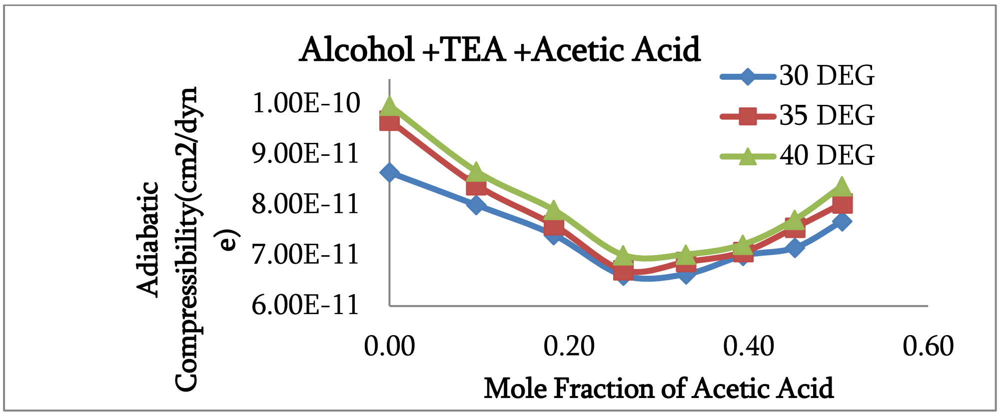

Fig. 1

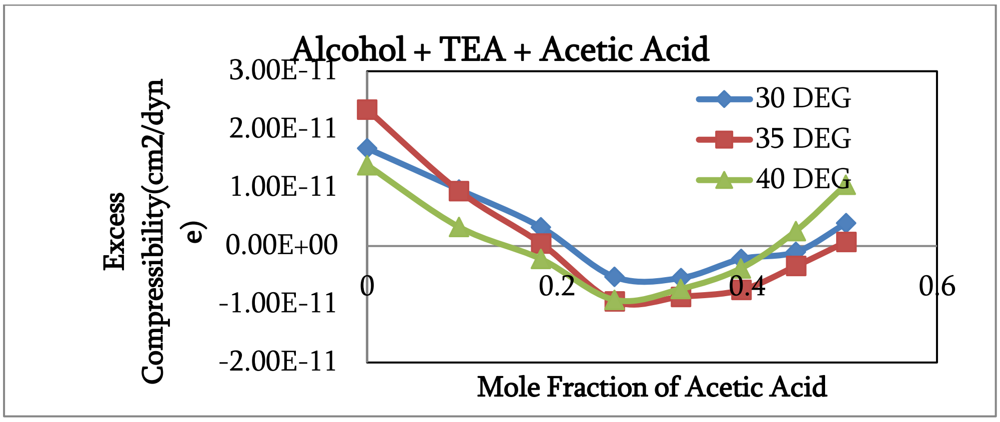

Fig. 2

Physically the decrease in adiabatic compressibility indicates that the component molecules are held close to each other. From Fig.1 the compressibility curves shows minimum at intermediate concentration of carboxylic acid. In general the alcohol molecules have both hydrophilic OH group which can attract polar molecules and hydrophobic hydrocarbon chain that can attract non polar values[8]. The minimum of compressibility shows that at this mole fraction the mixture is less compressible indicating hydrogen bond formation between acid and amine. Even though alcohols are self-associated liquids the addition of acid having more dipole moment (1.74 for Acetic acid) hydrophilic interaction increases giving rise to decrease in adiabatic compressibility. The donor acceptor interaction between carboxylic acid and amine seems to be mainly responsible for decrease values of compressibility. Further the increase in temperature increases adiabatic compressibility and decrease in ultrasonic velocity due to increase in molecular thermal motion. In order to understand the nature of molecular interactions between the components of the ternary liquid mixture, it is better to discuss the results in terms of excess parameters rather than their actual values. Curves of excess adiabatic β_a^E compressibility versus mole fraction of acetic acids are shown in Fig.2 The positive excess values of adiabatic compressibility (β_a^E), is the indication of weak interactions between molecules due to dispersive forces[9]. This suggests the rupture of the associated structure of alcohols that dominates the hydrogen bond interaction between like molecules of alcohol[10]. In the present case β_a^E values are positive on either ends where mole fraction of either carboxylic acid or amine is more. Comparatively higher values of compressibility at lower concentration of acid may be due to dissociation of alcohol molecules on account of breaking of hydrogen bonds. The positive values of β_a^E suggest the rupture of the associated structure at a smaller mole fraction of acid or amine molecules[10]. When their mole fractions become equal it is the hydrogen bond formation that dominates the other effects and this makes the β^E values negative. On either sides of minimum in β^E, mole fraction of either acid or amine is more leading to positive values of β^E. Similar results are found by J Edward Jayakumar et al[11].

V. CONCLUSION

In present investigation acoustical parameters like adiabatic compressibility and excess adiabatic compressibility have been calculated. From the graphical representation of acoustical parameters it is confirmed that there is presence of strong intermolecular interaction between the components of the mixture. The temperature variation of the ternary mixtures indicates that the strength of the intermolecular interaction decreases with rise in temperature.

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