Ultrasonic Behaviour of Binary Mixtures Containing Stearates and Acetone

[1]r. Kavitha , [2]s. Jayakumar, [3]r. Uma

[1,3.] Research scholar, Department of Chemistry, Pachaiyappa's College, Chennai – 30.
[2]. Assoc Prof., Department of Physics, Vivekananda college, Mylapore, Chennai – 04.

Abstract

The ultrasonic velocity measurements along with density and viscosity in the binary mixtures of zinc stearate - acetone and calcium stearate - acetone at 303 K are studied. It is used to evaluate the different thermo acoustical parameters along with the excess properties. The experimentally determined velocities have been compared with theoretically estimated values obtained using different empirical theories and relations. The results are utilized to compare the relative merits of these theories and relations in terms of percentage of variation.

Keywords: Stearates, stabilizer, solvent, molecular interaction, excess properties.

1. Introduction

Many attempts have been undertaken to assess the association or generally speaking, the structuredness of the solvents [1]. Ion – solvent interaction is always attractive because the solvent molecules can orient their dipoles in the direction which results in minimum potential energy [2]. For many purposes, it is necessary to know the volumes and compressibilities of the solutions relative to their corresponding values at infinite dilution. The determination of such quantities requires the extrapolation of experimental data in very dilute solutions [3]. A stabilizers such as zinc stearate and calcium steartate is highly required in pharmaceutical and PVC industries. The determination of such quantities requires the extrapolation of experimental data in very dilute solutions. Zinc stearate $(C_{18}H_{35}O_2)_2Zn$ and calcium stearate $(C_{17}H_{34}COO)_2Ca$ are the stabilizers used and acetone is used as a solvent. It is the most powerful mold release agent among all metal soaps. It contains no electrolyte and has a hydrophobic effect. Its main application areas are the plastics and rubber industry where it is used as a releasing agent and lubricant which can be easily incorporated. The results have been discussed in terms of molecular interactions. The values of ultrasonic velocity (U), density (ρ) and viscosity (η) for the pure components is given in Table 1. From the experimental values, a few acoustical parameters such as adiabatic compressibility (β), acoustical impedance (Z), molar sound velocity (R), Wada's constant (W), molar volume (V_m), free volume (V_f), intermolecular free length (L_f), internal pressure (π), absorption coefficient (α/f^2) viscous relaxation time (ι), degree of intermolecular attraction (α), excess ultrasonic velocity (U^E), excess adiabatic compressibility (β^E) , excess acoustical impedance (Z^E), excess free length (L_f^E) and excess molar volume (V_m^E) were derived over the entire mole fraction range. Ultrasonic velocities have also been evaluated theoretically with the help of Impedance relation, Nomoto relation, Van Dael & Vangeel relation and Junjie relation. The suitability of these theories and equations were checked by comparing theoretical values of ultrasonic speeds with the values obtained experimentally. Literature survey showed that no measurements have been previously reported for the mixtures reported in this paper.

2. Materials and Methods

The chemicals used were of analytical grade and obtained from E.Merck company. Thermostatically controlled well-stirred water bath whose temperature was maintained to ±0.01 K accuracy was used for all the measurements. Binary mixtures were prepared by weighing in airtight bottles, the possible uncertainty in the concentration is estimated to be less than ±0.0001. Densities of pure components and their mixtures were determined by using a 1×10^{-5} m^3 double arm pycnometer. The density values from triplicate replication at the temperature of 303 K were reproducible within $\pm 2 \times 10^{-2}$ kg m^{-3}. The uncertainty in density and excess molar volume values were found to be $\pm 4 \times 10^{-2}$ kg m^{-3} and $\pm 0.001 \times 10^{-6}$ m^3 mol^{-1} respectively. Ostwald's viscometer having capacity of about 15 ml and the capillary having a length of about 90 mm and 0.5 mm internal diameter has been used to measure the flow times of pure liquids and liquid mixtures and it was calibrated with benzene (density ≈ 0.8738 g cm^{-3}) and doubly distilled water (density ≈ 0.9970 g cm^{-3}) at 303 K. The flow time of pure liquids and liquid mixtures were repeated for five times. The uncertainty of viscosity was $\pm 0.005 \times 10^{-3}$ m Pas. Speed of sound was measured by using a variable path, single crystal interferometer. (United scientific company, India), working at 2 MHz frequency. The interferometer was calibrated using toluene. Measurement of speed of sound through medium was based on the accurate determination of the wavelength of ultrasonic waves of known frequency produced by quartz crystal in the measuring cell. The interferometer cell was filled with the test liquid, and water was circulated around the measuring cell from a thermostat. The uncertainty was estimated to be 0.1ms^{-1}.

The adiabatic compressibility (ßs) was calculated by the equation

$$ß = 1/\rho U^2 \qquad (1)$$

Where ρ is the density of mixture and U is the ultrasonic velocity of the mixture.

The acoustical impedance (Z) was calculated by the equation,

$$Z = \rho U \qquad (2)$$

The molar sound velocity (R) was calculated by the equation

$$R = (M_{eff} / \rho)\, U^{1/3} \qquad (3)$$

The molar compressibility or Wada's constant (W), was calculated by the equation

$$W = (M / \rho)\, ß^{-1/7} \qquad (4)$$

The intermolecular free length (L_f) was calculated by the equation

$$L_f = k\, ß^{1/2} \qquad (5)$$

Where $K = 1.98 \times 10^{-6}$, the Jacobson constant (Jacobson 1952).

The Free volume was calculated by the equation

$$V_f = (M_{eff}\, U/K\eta)^{3/2} \qquad (6)$$

Where $K = 4.28 \times 10^9$ for all liquids which is a temperature independent constant.

The internal pressure was calculated by the equation

$$\pi = \{bRT / (V^2\ V_f)^{1/3}\} \qquad (7)$$

b is a packing factor, R is a gas constant, V_f is free volume and T is temperature.

The absorption coefficient was calculated by the equation

$$(\alpha/f^2) = (8\pi^2\eta/3\rho U^3) \qquad (8)$$

The viscous relaxation time was calculated by the equation

$$\iota = (4\eta/3\rho U^2) \qquad (9)$$

The degree of intermolecular attraction (α) was calculated by the equation

$$\alpha = (u^2 / u^2_{im}) - 1 \qquad (10)$$

Where $u^2_{im} = 1/ \{(x_1M_1 + x_2M_2)(x_1/M_1u_1^2 + x_2/M_2u_2^2)\}$

The U^E, $ß^E$, Z^E, L_f^E, and V_m^E were derived over the entire mole fraction range by using the general equation

$$A^E = A - (X_i A_1 + (1-X_i) A_2) \qquad (11)$$

Where A is the corresponding parameters (U, ß, Z, L_f, and V_m) of binary mixture and A_1 and A_2 are the corresponding pure component values.

The sound velocity can be correlated with the relation called Impedance relation which is represented as

$$U_{IM} = (X_1Z_1 + X_2Z_2) / (X_1\rho_1 + X_2\rho_2) \qquad (12)$$

where X, Z, ρ denote the mole fraction, acoustic impedance and density of the component respectively.

Nomoto derived an empirical formula for the sound velocity in binary mixture. It is given by the equation

$$U_{NR} = [R/V]^3 = \left\{ \frac{(X_1R_1 + X_2R_2)}{(X_1V_1 + X_2V_2)} \right\}^3 \qquad (13)$$

Where X, R, V denote the mole fraction, molar sound velocity and molar volume at temperature T of the component. The acoustical behaviour of binary mixture was studied in detail by Van deal etal. The expression for sound velocity (U_{IMR}) of binary mixtures can be obtained from equation

$$U_{IMR} = \left\{ \frac{[1/(X_1M_1 + X_2M_2)]}{[X_1/M_1U_1^2 + X_2/M_2U_2^2]} \right\}^{1/2} \qquad (14)$$

Where X, M and U are the mole fraction, molecular weight and sound velocity of component.

Junjie derived an empirical formula for the sound velocity in binary mixture. It is given by the equation

$$U_{jun} = \left\{ \frac{(X_1V_1 + X_2V_2)}{(X_1M_1 + X_2M_2)^{1/2}} \left[\frac{X_1V_1}{\rho_{1U1}^{2}} + \frac{X_2V_2}{\rho_{2U2}^{2}} \right]^{-1/2} \right\} \qquad (15)$$

Where X, V, M, ρ denote the mole fraction, molar volume, molecular weight and density of the components.
The percentage deviation of the experimental velocity from the theoretical value is given by the equation

$$\text{Percentage deviation in velocity} = \frac{U_{Theo} - U_{Expt}}{U_{Theo}} \times 100 \qquad (16)$$

3. Results and Discussion

The ultrasonic velocity, density and viscosity data for the pure components at 303 K are given below:

Table 1

Comparison of density, ultrasonic velocity and viscosity data at 303 K

Component	U m/s	ρ Kg/m^3	η X 10^{-1} Nsm^{-2}
Zinc stearate	1404	1133	-
Calcium stearate	1310	1145	-
Acetone	1138	786	3.73

Table 2 gives the measured and acoustic parameters such as ultrasonic velocities (U), density (ρ), viscosity (η), adiabatic compressibility (ß), acoustical impedence (Z), molar sound velocity (R), molar compressibility (W), molar volume (V_m), free volume (V_f), Table 3 gives the thermodynamic properties like intermolecular free length (L_f), internal pressure (π), absorption coefficient (α/f^2), viscous relaxation time (ι), degree of intermolecular attraction (α), Table 4 gives the excess parameters like excess ultrasonic velocity (U^E), excess adiabatic compressibility ($ß^E$) , excess acoustical impedance (Z^E) , excess free length (L_f^E), excess molar volume (V_m^E), Table 5 gives the theoretical values of ultrasonic velocity calculated from Impedance, Nomoto, Van Dael & Vangeel and Junjie's relation along with the experimental ultrasonic velocity and percentage deviation for the binary mixtures zinc stearate - acetone and calcium stearate - acetone over the entire composition range at 303 K.

The ultrasonic velocity values (U) increases linearly with increase in stearate concentration in addition of acetone. Increase in ultrasonic velocity values may be due to decrease in space between chains inside the structure of components, thus it may be attributed to increase in cross linking between chains which consequently cause increase in rigidity of the molecules. When kinetic elements of adjacent chains have high mobility, cross linkages prevent the moving part of adjacent chains increase effectiveness of intermolecular interaction. This may result in a growth in the modulus of elasticity of stearates and ultrasonic velocity with increase in cross linkage factor [4]. In both Zn. St – ACE and Ca. St – ACE systems, aliphatic ketones used are strongly polar molecule with large dipole moment. Specific interaction between polar molecules leads to dipolar alignment forms α multimer and molecular interaction is found to be very less which may be due to the presence of weak dipole – induced dipole interaction between them. It depends upon polarity, increase in polarity due to the high electronegativity increases molecular motion leading to solute – solvent interaction [5]. This also reveals the absence of disruption of like molecular association by the component on one another and absence of strong dipole – dipole interaction between unlike molecules. Comparatively, interaction between aliphatic and aromatic molecules is quite stronger than aliphatic – aliphatic and aromatic – aromatic molecules. The density values (η) increases with increase in stearate concentration predicting the presence of greater molecular interaction between the components. The viscosity values (η) increases with increase in stearate concentration [6].

Table 2 : Measured and acoustic parameters of binary mixtures at 303 K

Co nc of stearate	ms^{-1}	Kgm^{-3}	η / 10^{-1} N sm^{-2}	**β / 10^{-10} Kg^{-1}ms^{-2}**	**Z / 10^{6} Kg m^{-2}s^{-1}**			V$_m$ / 10^{-1} **m^{3}mole^{-1}**	V$_f$ / 10^{-7} **m^{3}mole^{-1}**
				zinc stearate – acetone					
0.01	1172	792.32	2.84	9.19	0.92	0.78	1.44	0.738	4.24
0.02	1176	798.64	2.99	9.05	0.93	0.78	1.44	0.738	3.98
0.03	1184	804.96	3.15	8.86	0.95	0.78	1.45	0.737	3.77
0.04	1188	811.28	3.30	8.73	0.96	0.78	1.45	0.737	3.56
0.05	1200	817.6	3.46	8.49	0.98	0.78	1.45	0.736	3.40
0.06	1372	823.92	3.62	6.45	1.13	0.82	1.51	0.736	3.93
0.07	1404	830.24	3.78	6.11	1.17	0.82	1.52	0.735	3.85
0.08	1406	836.56	3.95	6.05	1.18	0.82	1.52	0.735	3.65

0.09	1408	842.88	4.12	5.98	1.19	0.82	1.53	0.734	3.48
0.1	1412	849.2	4.29	5.91	1.20	0.82	1.53	0.734	3.32
calcium stearate – acetone									
0.01	1216	792.04	2.97	8.54	0.963	0.79	1.46	0.738	4.19
0.02	1368	798.12	3.12	6.70	1.09	0.82	1.51	0.738	4.69
0.03	1376	804.2	3.27	6.57	1.11	0.82	1.51	0.737	4.44
0.04	1380	810.28	3.43	6.48	1.12	0.82	1.51	0.737	4.20
0.05	1382	816.32	3.59	6.41	1.13	0.82	1.51	0.736	3.98
0.06	1384	822.4	3.75	6.35	1.14	0.82	1.52	0.736	3.77
0.07	1388	828.48	4.05	6.27	1.15	0.82	1.52	0.735	3.41
0.08	1520	834.56	4.21	5.19	1.27	0.84	1.56	0.735	3.72
0.09	1576	840.6	4.38	4.79	1.32	0.85	1.57	0.734	3.74
0.1	1582	846.68	4.96	4.72	1.34	0.85	1.58	0.734	3.15

Table 3 : Thermodynamic parameters of binary mixtures at 303 K

Conc of stearate	**L_f / 10^{-11} M**	**π / 10^{6} atm**	**α/f^2 / 10^{-12} $m^{-1}s^{2}$**	**ι / 10^{-10} s**	**α / 10^{-1} m**
zinc stearate – acetone					
0.01	6.01	3.81	5.85	3.48	0.676
0.02	5.97	3.89	6.05	3.61	0.820
0.03	5.91	3.97	6.19	3.72	1.04
0.04	5.86	4.04	6.38	3.85	1.18
0.05	5.78	4.11	6.44	3.92	1.48
0.06	5.04	3.92	4.48	3.11	5.11
0.07	4.90	3.95	4.33	3.08	5.92
0.08	4.88	4.02	4.47	3.18	6.06
0.09	4.85	4.09	4.60	3.29	6.21
0.1	4.82	4.15	4.71	3.38	6.40
calcium stearate – acetone					
0.01	5.80	3.82	5.48	3.38	1.49
0.02	5.13	3.69	4.01	2.78	4.63
0.03	5.08	3.75	4.11	2.87	4.90
0.04	5.05	3.83	4.24	2.96	5.07
0.05	5.02	3.90	4.38	3.07	5.21
0.06	5.00	3.97	4.52	3.17	5.34
0.07	4.97	4.11	4.80	3.38	5.53
0.08	4.52	4.00	3.78	2.91	8.73
0.09	4.34	3.99	3.50	2.80	10.3
0.1	4.31	4.23	3.89	3.12	10.5

Table 4 : Excess parameters of binary mixtures like U^E, $ß^E$, Z^E,$L_f{}^E$ and $v_m{}^E$ at 303 K

Conc of stearate	**U^E ms^{-1}**	**β^E / 10^{-10} $Kg^{-1}ms^{-2}$**	Z^E / 10^5 Kg $m^{-2}s^{-1}$	L_f^E / 10^{-12} m	$V_m{}^E$ / 10^{-3} m^3mole^{-1}
zinc stearate – acetone					
0.01	34	-0.63	0.336	-2.03	-0.412
0.02	38	-0.76	0.437	-2.46	-0.823
0.03	45	-0.95	0.571	-3.08	-1.23
0.04	49	-1.07	0.673	-3.49	-1.64
0.05	61	-1.31	0.841	-4.29	-2.05
0.06	233	-3.35	2.33	-11.7	-2.46
0.07	265	-3.69	2.68	-13.0	-2.87
0.08	266	-3.75	2.78	-13.3	-3.28
0.09	268	-3.80	2.88	-13.5	-3.69
0.1	272	-3.88	2.99	-13.8	-4.09
calcium stearate – acetone					
0.01	78	-1.28	0.682	-0.420	-0.390
0.02	230	-3.12	1.96	-1.08	-0.781
0.03	238	-3.25	2.11	-1.13	-1.17
0.04	241	-3.33	2.22	-1.16	-1.56
0.05	243	-3.39	2.31	-1.19	-1.95
0.06	245	-3.46	2.41	-1.21	-2.34
0.07	249	-3.53	2.52	-1.24	-2.73
0.08	381	-4.61	3.71	-1.69	-3.12
0.09	437	-5.00	4.26	-1.87	-3.50
0.1	443	-5.07	4.41	-1.90	-3.89

Table 5 Experimental Velocities And Theoretical Velocities Along With The Percentage Deviation Of Binary Mixtures At 303 K

Conc of stearate	Ultrasonic velocity U /ms^{-1}					% Deviation			
	EXPT	**Imp**	**Nom**	**VDV**	**Junjie's**	**Imp**	**Nom**	**VDV**	**Junjie's**
					zinc stearate – acetone				
0.01	1172	1138	1139	1134	1138	-2.962	-2.863	-3.327	-2.958
0.02	1176	1139	1141	1131	1139	-3.288	-3.092	-4.018	-3.279
0.03	1184	1139	1142	1127	1139	-3.965	-3.670	-5.064	-3.951
0.04	1188	1139	1143	1123	1139	-4.290	-3.899	-5.756	-4.271
0.05	1200	1139	1145	1120	1140	-5.318	-4.828	-7.163	-5.292
0.06	1372	1140	1146	1116	1140	-20.384	-19.717	-22.908	-20.346
0.07	1404	1140	1147	1113	1140	-23.161	-22.371	-26.166	-23.115
0.08	1406	1140	1149	1109	1141	-23.307	-22.409	-26.736	-23.251
0.09	1408	1141	1150	1106	1141	-23.452	-22.448	-27.304	-23.388
0.1	1412	1141	1151	1103	1141	-23.773	-22.662	-28.052	-23.698
					calcium stearate – acetone				
0.01	1216	1138	1139	1134	1138	-6.837	-6.773	-7.188	-6.847
0.02	1368	1138	1140	1131	1138	-20.172	-20.030	-20.962	-20.194
0.03	1376	1139	1141	1127	1138	-20.855	-20.642	-22.045	-20.887
0.04	1380	1139	1141	1124	1138	-21.187	-20.903	-22.774	-21.228
0.05	1382	1139	1142	1121	1138	-21.343	-20.991	-23.323	-21.393
0.06	1384	1139	1143	1117	1139	-21.499	-21.078	-23.872	-21.557
0.07	1388	1139	1144	1114	1139	-21.831	-21.342	-24.600	-21.896
0.08	1520	1139	1145	1111	1139	-33.396	-32.788	-36.852	-33.475
0.09	1576	1140	1145	1107	1139	-38.288	-37.584	-42.306	-38.377
0.1	1582	1140	1146	1104	1139	-38.792	-38.012	-43.262	-38.889

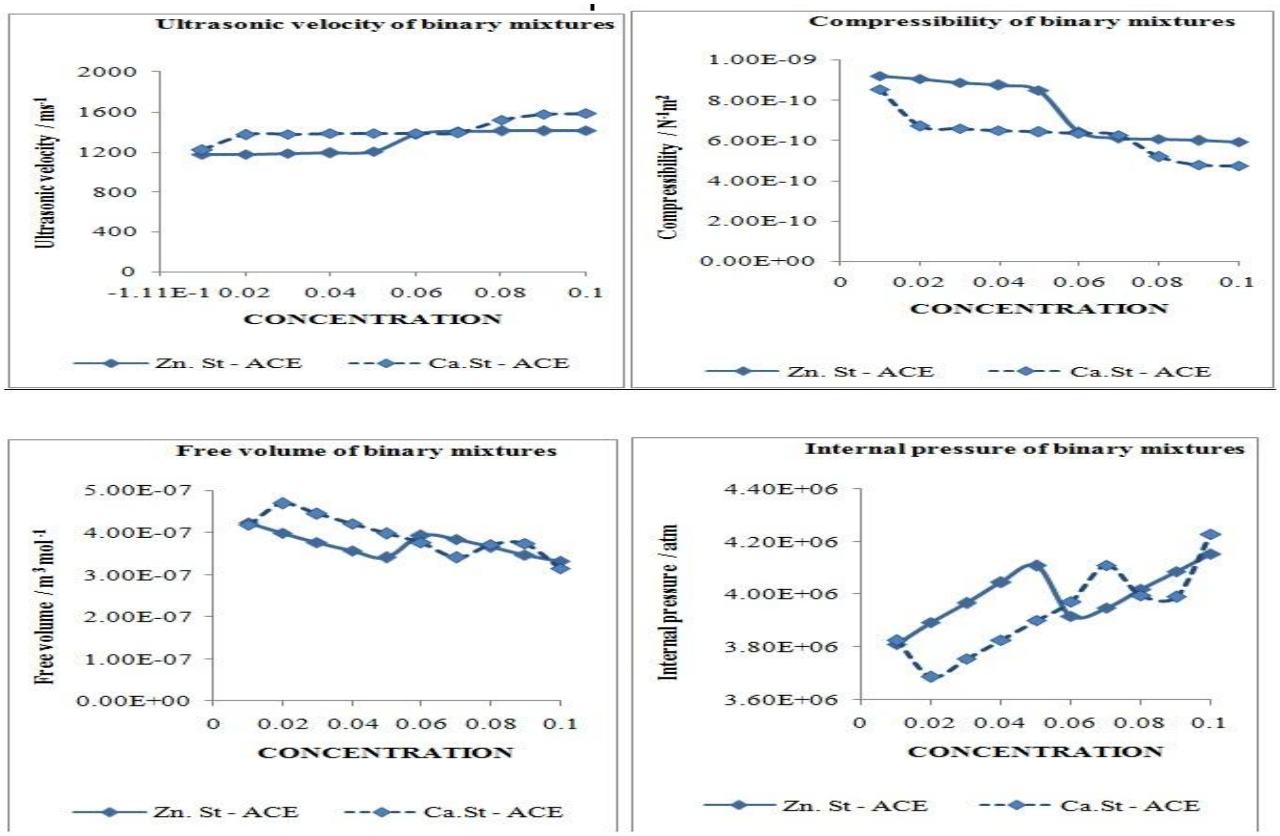

Fig. 1 Computed parameters of Zn. St – ACE and Ca. St – ACE at 303 K

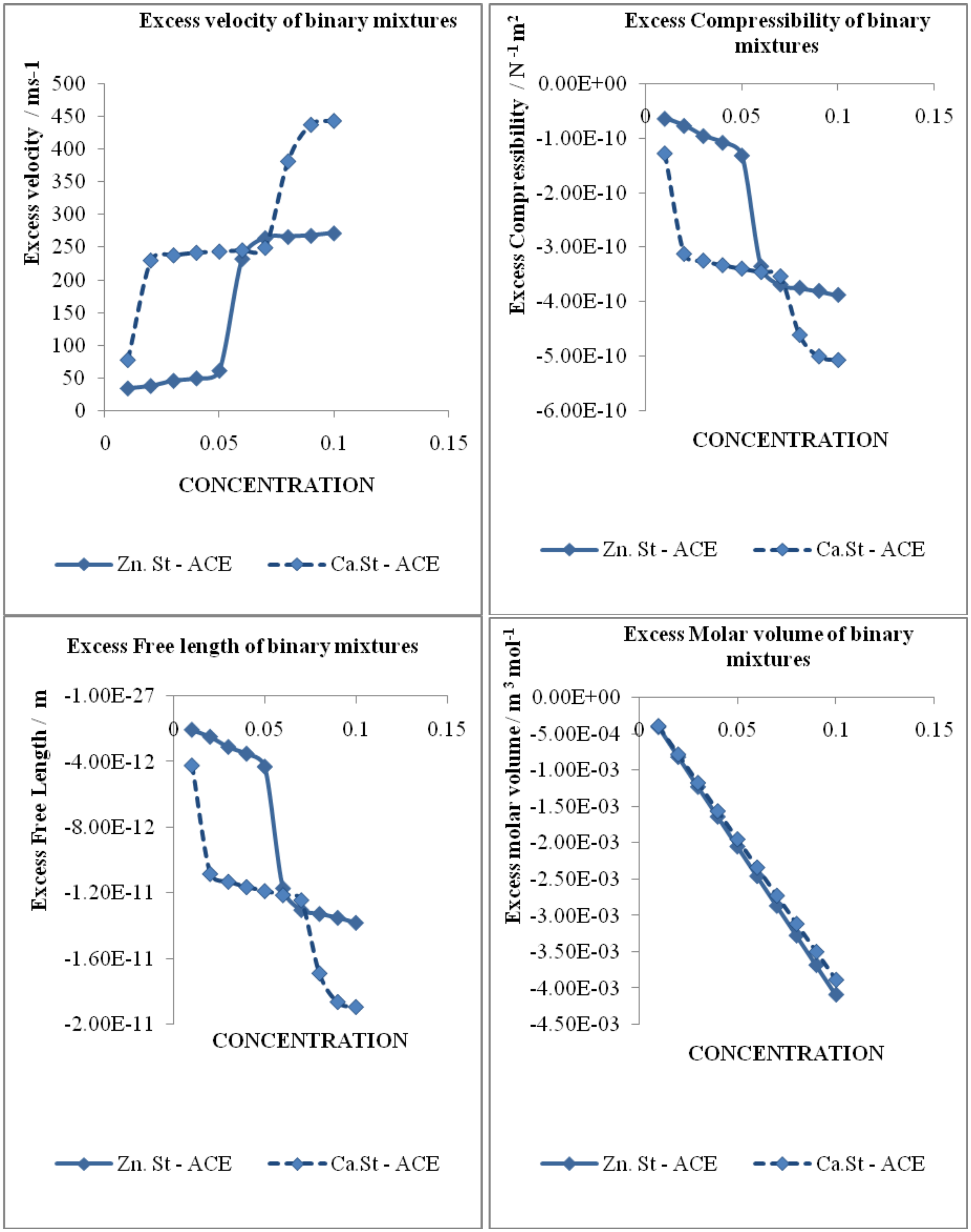

Fig. 2 Excess parameters of Zn. St – ACE and Ca. St – ACE at 303 K

The adiabatic compressibility (β) exhibits an exact reverse trend as that of ultrasonic velocity [7] for both the binary mixtures studied. The available solvent molecules for the next incoming component get decreased and every solvent has a limit for the compression as limiting compressibility value. The compressibility of solvent is greater than that of solution and it decreases with increase in concentration of solution. Solvents examined were chosen to cover a wide range of adiabatic compressibility. In both Zn. St – ACE and Ca. St – ACE systems, non linear decrease trend is observed.

The trend in non linear variation indicates the presence of complex formation which may be due to strong solute – solvent interaction. The disruption of stearates by solvents and weak interaction between unlike molecules leave the binary mixtures more compressible. Acoustic impedance (Z) increases with increase in stearate concentration for Zn. St – ACE and Ca. St – ACE systems. This favours increase in intermolecular distance between stearate and solvent molecules making relatively wider gaps between the molecules and becoming the main cause of impediment in the propagation of ultrasonic waves. It confirms the presence of molecular association between solute – solvent molecules through intermolecular hydrogen bonding [8]. Rao constant (R) and Wada's constant (W) show linear variation and almost it is constant with increase in stearate concentration, indicating the presence of solute – solvent interaction in addition of acetone to stearates . Molar volume (V_m) decreases with increase in stearate concentration. For Ca. St – ACE system, free volume increase and decrease with increase in stearate concentration. Comparatively, Zn. St – ACE system free volume decrease and increase with increase in stearate concentration. The decrease in the free volume also confirms the increasing order of symmetry [9] except for the system, both being aliphatic or aromatic components. The increase in free volume suggests the packing of molecules become looser predicting the presence of weaker interaction among the molecules.

The intermolecular free length (L_f) also follows the same trend as that of adiabatic compressibility in both binary systems. Free length is greater at low stearate concentration which may be due to solvent self association. As solvent density is not affected by association, one can deduce that the distance between the aggregate is greater than between the monomeric solvent molecules [10]. The decrease in free length with increase in ultrasonic velocity along with increase in stearate concentration increases intermolecular force between stearates and solvents. It strengthens the idea of molecular association in each system. The values indicates significant interaction between the components of the mixture through dipole – dipole interaction, dipole – induced dipole, hydrogen bonding etc., The internal pressure (π_i) values suggest the presence of inter – molecular interactions in addition of stearates to solvent. In Zn. St – ACE system, internal pressure increase at low concentration and decrease at high concentration. Comparatively, for Ca. St – ACE system, internal pressure decrease at low concentration and increase at high concentration. Non linear variation with both increased and decreased value suggests the presence of molecular association between unlike molecules. It predicts the existence of greater molecular interaction among the molecules in binary mixture. The absorption coefficient values (α/f^2) shows non linear increase and decrease trend in Zn. St – ACE and Ca. St – ACE systems. The values of relaxation time (τ) shows both increase and decrease data with increase in stearate concentration for Zn. St – ACE and Ca. St – ACE systems, viscous relaxation time increases at low concentration which may be due to increase in frictional resistance force and change in molecular area. As concentration increases, τ value decreases with decrease in available space between the molecules. Interaction parameter values (α) value increases with increase in stearate concentration for Zn. St – ACE and Ca. St – ACE systems, confirms the existence of molecular interaction between them [11].

Excess values may be affected by three factors, first factors explains the specific forces between molecules such as hydrogen bond, charge transfer complex, breaking of hydrogen bond and complexes shows large negative deviation. The second factor deals with the physical intermolecular forces, including electrostatic forces between charged particles and between a permanent dipole and so on induction forces between a permanent dipole and an induced dipole and force of attraction and repulsion between non polar molecules favouring physical intermolecular force shows both positive and negative deviation. The third factor deals with the structural characteristics of the component arising from geometrical fitting of one component into other structure due to the differences in size and shape of the components. The excess velocity shows positive deviations [12] which predict the weak interaction due to dispersion force. It shows non linear variation for Zn. St – ACE and Ca. St – ACE systems. Non linear variation shows specific intermolecular interaction between binary mixtures and the positive values predicts the strong association due to rupture of cohesion and growing adhesion leading to the formation of dipole – induced dipole interaction. The excess compressibility value depends upon two factors ie, first factor is increase in free length which may be due to loss of dipolar association, breaking up of hydrogen bonding, differences in size and shapes of the component. The second factor is the decrease in free length which is due to dipole – dipole interactions, hydrogen bonding association, complex formation, and interstitial accommodation of unlike molecules [13]. The first effect contributes to increase in the spacing between the molecules, such that ultrasound waves cover smaller distances in mixtures than in pure components. This would result in negative deviation of both excess compressibility and free length. The second effect contributes to decrease in the interspace between molecules and ultrasound waves which cover larger distances in the mixtures. This would result in positive deviation in ultrasonic velocity and negative deviation in compressibility and free length. For Zn. St – ACE and Ca. St – ACE systems, non linear trend is observed with respect to stearate concentration. It was reported that the positive deviation in excess impedance indicates the presence of strong interactions between component molecules in the mixture [46]. Excess molar volume shows negative deviation and linear decrease with increase in stearate concentration. Molar volume is slightly greater when calcium stearate is added to acetone than zinc stearate.

The experimental and theoretical velocities calculated by using various empirical relations are presented. The observed deviation of theoretical velocity from the experimental values should be rather treated as evidence of molecular interaction which takes place between stearates and acetone [14]. Deviation is larger in Van Dael and Vangeel relation which is due to the strengthening among unlike molecules. At all concentrations experimental ultrasonic velocity is found to be in good agreement with theoretical Nomoto velocity. It may be due to weak dipolar dispersive interaction between like molecules [56 - 58]. For Zn. St – ACE systems, deviation follows the order $U_{Vdv} > U_{Imp} > U_{Jun} > U_{Nom}$. However, for Ca. St – ACE systems, deviation follows as $U_{Vdv} > U_{Jun} > U_{Imp} > U_{Nom}$.

4. Conclusion

The present investigation measures ultrasonic velocity, density and viscosity of stearates with acetone at 303 K. It reveals the presence of weak and strong molecular interactions in the binary systems from the acoustic, thermodynamic and excess parameter values. It may be suggested that the strength of interactions between aliphatic molecule and aromatic component will be greater than that of aliphatic – aliphatic and aromatic – aromatic components. Based on the above consideration, Zn. St – ACE and Ca. St – ACE system shows weak dipole – induced dipole interaction. The reason is that, stearate and ketones are aliphatic in nature, so interaction is expected to be very less. Molecular interaction between the stabilizer and solvent used decreases in the order: Ca. St – ACE > Zn. St – ACE From the computed data, standard relations like Impedance relation, Nomoto relation, Van Dael and Vangeel and Junjie relation are calculated. The large deviation of ultrasonic velocity is found in Van Dael & Vangeel and Junjie relation and it is found to be least in Nomoto and Impedance relation.

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