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Ultrasonic Velocity and Density measurements of lithium Chloride in different compositions of lactose at different temperatures

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ABSTRACT

The ultrasonic velocity (U) and density (ρ) measurements have been carried out for lithium chloride in 2, 4, 6 wt. % lactose at different temperatures i.e. 303.15, 308.15, 313.15 and 318.15K. These measurements have been performed to evaluate some important acoustical parameters like adiabatic compressibility (β), change (Δβ) and relative change ($\Delta\beta/\beta_o$) in adiabatic compressibility, acoustic impedance (Z), intermolecular free length (L_f), Wada's constant (W), relative association (R.A.), relaxation time (τ). The variation of these parameters with respect to the concentration of the solute has been explained on the basis of solute-solvent and solute-solute interactions.

Keywords: Ultrasonic velocity, adiabatic compressibility, relaxation time, lactose, lithium chloride and water system.

INTRODUCTION

A survey of literature [1-15] indicates that acoustical parameters are useful in understanding the nature and strength of molecular interactions in the liquid mixtures. Ultrasonic energy is used in medicine, engineering, agriculture, defence and industry. In chemical industries ultrasonic energy is found useful in studying the chemical processes and in synthesis of chemical substances. Recently an ultrasonic wave has been extensively used to determine the ion-solvent interactions in aqueous solutions containing electrolytes. A number of researchers have studied acoustical properties of solutions containing alkali metal chlorides. In solution of ionic solute the attraction between the solute and solvent is of ion-dipole type. When electrolyte is dissolved in solvent it causes volume contraction due to interactions between ions and solvent molecules and therefore other acoustical parameters may be affected. In this paper, an attempt has been made to measure various parameters such as adiabatic compressibility (β), change (Δβ) and relative change ($\Delta\beta/\beta_o$) in adiabatic compressibility, acoustic impedance (Z), intermolecular free length (L_f), Wada's constant (W), relative association (R.A.), relaxation time (τ). These acoustical parameters provide qualitative information about the physical nature and strength of the molecular interactions in the liquid mixtures. During the last two decades, the ultrasonic study of the carbohydrates in aqueous electrolytic medium has gained much importance in assessing the nature of molecular interaction present in the mixture. The study of the carbohydrates / saccharides has become a subject of increasing interest because of the multidimensional, physical, biochemical and industrially useful properties of these compounds [16-19], in addition to their importance to the food pharmaceutical and chemical industries, the simple saccharides have received considerable attention for their ability to protect biological macromolecules [20]. In recent years, the study of acoustical properties of aqueous mixed electrolytic solutions has been found to be useful in understanding the specific ion-ion and ion-solvent interaction in solutions. Such studies on binary electrolytes have been made by many researchers [21-22]. Most of the biochemical processes occur in aqueous solutions. So, studies on the thermodynamic properties of lithium chloride in multi component solvent system is important. Studies involving density and ultrasonic velocity measurements are important for elucidation of ion–solvent, ion–ion and solute–solvent interactions in the mixed solvent systems. Multi–component solvent mixtures are of great practical importance in many industrial processes. Therefore in the present investigation, ultrasonic velocities, densities of lithium chloride in 2, 4, 6 wt. % lactose at different temperatures (i.e. 303.15K – 318.15K) have been carried out.

MATERIALS AND METHODS

Water used for solutions had specific conductance in the range 0.1- 1.0 x $10^{-6}\ \Omega^{-1}cm^{-1}$. Lithium chloride and lactose (Anala R) were dried over anhydrous calcium chloride for more than 48h and used as such. All the solutions were prepared by weight and conversion of molality to molarity was done by using the standard expression [23]. The concentration range of lithium chloride in 2, 4 and 6 wt. % of lactose was 0.01 to 0.12 m. The density and ultrasonic velocity was measured with the help of DSA (Density and Sound Analyser) 5000, Anton Paar, GmbH, Garz, Austria.

Theory and Calculations: Using the measured data, some acoustical parameters such as adiabatic compressibility (β), change (Δβ) and relative change in adiabatic compressibility ($\Delta\beta/\beta_o$), acoustic impedance (Z), intermolecular free length (L_f), Wada's constant (W), relative association (R.A.), relaxation time (τ) were studied and evaluated by using the standard equations:

Adiabatic compressibility (β) $= \dfrac{1}{U^2\rho}$ (1)

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

Change in adiabatic compressibility (Δβ) = $(\beta-\beta_o)$ (2)

Where β and β_o are the adiabatic compressibility of solution and solvent respectively.

Relative change in adiabatic compressibility = $(\Delta\beta/\beta_o)$ (3)

Acoustic impedance (Z) = Uρ (4)

Intermolecular free length (L_f) = $K\beta^{1/2}$ (5)

Wada's constant (W) = $\dfrac{M}{\rho}\beta^{-1/7}$ (6)

Relative association (R.A.) = $\left(\dfrac{\rho}{\rho_o}\right)\left(\dfrac{U_o}{U}\right)^{1/3}$ (7)

Relaxation time (τ) = $\dfrac{4\eta}{3\rho U^2}$ (8)

RESULTS AND DISCUSSION

The experimental values of density (ρ), ultrasonic velocity (U), adiabatic compressibility, change and relative change in adiabatic compressibility for different molal compositions of lithium chloride in 2, 4, 6 wt. % lactose at different temperatures (i.e.303.15K-318.15K) are shown in Table-I.

The density increases with increase in concentration of lithium chloride in all the systems under investigation and the same decreases with a rise in temperature. But, however, the ultrasonic velocity values found to be increasing with increase in concentration of lactose, aqueous solutions of lithium chloride, and also with increase in temperature. Molecular association is thus responsible for the observed increase of ultrasonic velocities in these mixtures. The increase in ultrasonic velocity in these solutions may be attributed to the cohesion brought about by the ionic hydration. Further, the decrease in density and increase in velocity with rise in temperature indicate decrease in intermolecular forces due to increase in thermal energy of the system [24].

It is clear from the Table-I that the values of adiabatic compressibility (β) decreases with increase in the solute content as well as with the rise in temperature. Such a decrease in adiabatic compressibility observed in the present system, generally, confirms the conclusions drawn from the velocity data. The increasing electrostrictive compression of water around the molecules may result in a large decrease in the compressibility of the solutions. The decrease in β is due to the increase in electrostriction compression of solvent around the molecules which results in a large decrease in the compressibility of solutions [25]**.** The compressibility decreases with decrease in hydrogen bond strength among solvent molecules. The behavior of compressibility depicts the existence of interaction between solute and solvent molecules in which the structural arrangement in the neighbourhood of solutes is considerably affected. The sample plots of β Vs m for LiCl in 2% lactose at different temperatures is shown in fig (I). The negative values of change in adiabatic compressibility ($\Delta\beta$) and relative change in adiabatic compressibility ($\Delta\beta/\beta_o$) are due to solute-solvent interactions [26-27] .Such an increase in $\Delta\beta$ and $\Delta\beta/\beta_o$ values with increase in concentration may be attributed to an overall increase in the cohesive forces in the solution [28]. These cohesive forces may be due to the interactions in the solution. The acoustic impedance (Z) of all the systems is found to increase with increase in the concentration of lithium chloride in 2, 4, 6 wt.% lactose . The sample plots of Z Vs m for LiCl in 2% lactose at different temperatures is shown in fig (II). This is in agreement with the theoretical requirements as U and ρ both increases with increase in the concentration of the solute. This increase of Z values with solute concentration can be attributed to the effective solute-solvent interactions. A similar type of behavior has been obtained for tetra alkyl ammonium and alkali metal salts in methanol + chloro benzene mixtures [29].

Intermolecular free length (L_f) was obtained from adiabatic compressibility (β) using equation [30]:

Intermolecular free length (L_f) = $K\beta^{1/2}$

Where K is the temperature dependent constant (= $(93.875 + 0.375T) \times 10^{-8}$) [31]. It is clear from table that ultrasonic velocity (U) increases and intermolecular free length (L_f) decreases with increase in concentration of lithium chloride in 2, 4, 6 wt.% lactose at 303.15,308.15,313.15,318K . In general U and L_f have been reported to vary as the inverse of each other as in the present systems [32-33]. The decrease in the value of L_f with the increase in molality indicates the presence of significant ion-solvent interaction between solute and solvent molecules due to which the structural arrangement in the neighbourhood of constituent ions is considerably affected [34]. The sample plots of L_f Vs m for LiCl in 2% lactose at different temperatures is shown in fig (III).

Wada's constant (W) has been calculated by standard equation [35]:

Wada's constant (W) = $\dfrac{M}{\rho}\beta^{-1/7}$

It has been found that the values of Wada's constant (W) decreases with increase in concentration of solute and increases with increase in temperature. To obtain a firm impact of interactions in solutions, relative association (R.A.) was calculated by following relation [36]:

Relative association (R.A.) = $\left(\dfrac{\rho}{\rho_o}\right)\left(\dfrac{U_o}{U}\right)^{1/3}$

where ρ_o and Uo are the density and ultrasonic velocity of solvent respectively. Relative association is influenced by two factors (i) breaking up of the associated solvent molecules on addition of solute in it and (ii) the solvation of solute molecules. The former leads to decrease and later to increase of relative association. In the present study, the values of (R.A.) increases with increase in solute concentration showing significant ion-solvent interactions which increase with increase in solute concentration [37]. The dispersion of ultrasonic waves in system contains information about the characteristic time of relaxation process that causes the dispersion [38]. The relaxation time was calculated by following relation [39-41]:

Relaxation time (τ) = $\frac{4\eta}{3\rho U^2}$

where η is viscosity.

The relaxation time decreases with increase in temperature. The sample plots of τ Vs m for LiCl in 2% lactose at different temperatures is shown in fig (IV).

Table-I: Density (ρ), ultrasonic velocity (U), adiabatic compressibility (β), change (Δβ) and relative change in adiabatic compressibility (Δβ/β$_o$) for Lithium chloride in 2, 4 and 6 wt. % Lactose at different temperatures (i.e. 303.15, 308.15, 313.15 and 318.15K).

Molality (m)	ρ x 10^{-3} (Kg m^{-3})	U (ms^{-1})	β x10^{-07} (Pa^{-1})	-Δβx 10^{-09} (Pa^{-1})	-Δβ/β$_o$ x 10^{-3}
Lithium chloride in 2% aqueous Lactose					
Temperature = 303.15K					
0.00	1.0030	1514.98	4.3441	-	-
0.01	1.0033	1515.61	4.3391	0.5038	1.1598
0.02	1.0036	1516.22	4.3343	0.9799	2.2557
0.04	1.0041	1517.38	4.3254	1.8656	4.2946
0.06	1.0046	1518.5	4.3171	2.6982	6.2112
0.08	1.0050	1519.59	4.3092	3.4872	8.0274
0.10	1.0053	1520.6	4.3020	4.2084	9.6876
0.12	1.0056	1521.69	4.2945	4.9561	11.4088
Temperature = 308.15K					
0.00	1.0013	1525.36	4.2923	-	-
0.01	1.0016	1526.01	4.2873	0.4950	1.1532
0.02	1.0019	1526.52	4.2833	0.8984	2.0931
0.04	1.0024	1527.61	4.2751	1.7210	4.0095
0.06	1.0028	1528.6	4.2676	2.4621	5.7360
0.08	1.0032	1529.69	4.2599	3.2387	7.5454
0.10	1.0036	1530.69	4.2528	3.9502	9.2032
0.12	1.0039	1531.77	4.2454	4.6887	10.9237
Temperature = 313.15K					
0.00	0.9994	1534.23	4.2508	-	-
0.01	0.9997	1534.94	4.2456	0.51427	1.2098
0.02	0.9999	1535.47	4.2416	0.91847	2.1607
0.04	1.0005	1536.37	4.2346	1.6191	3.8090
0.06	1.0009	1537.38	4.2272	2.3593	5.5504
0.08	1.0013	1538.38	4.2200	3.0782	7.2416
0.10	1.0017	1539.28	4.2135	3.7281	8.7704
0.12	1.0020	1540.27	4.2067	4.4123	10.3801
Temperature = 318.15K					
0.00	0.9973	1541.64	4.2192	-	-
0.01	0.9975	1542.35	4.2141	0.5604	1.1994
0.02	0.9978	1542.81	4.2105	0.8651	2.0505
0.04	0.9983	1543.71	4.2036	1.5559	3.6878
0.06	0.9987	1544.62	4.1968	2.2313	5.2886
0.08	0.9991	1545.61	4.1898	2.9365	6.9599
0.10	0.9995	1546.51	4.1834	3.5784	8.4814
0.12	0.9998	1547.41	4.1771	4.2072	9.9717
Lithium chloride in 4% aqueous Lactose					
Temperature = 303.15K					
0.00	1.0106	1520.97	4.2775	-	-
0.01	1.0109	1521.66	4.2722	0.5297	1.2384
0.02	1.0112	1522.31	4.2672	1.0276	2.4024
0.04	1.0118	1523.56	4.2577	1.9783	4.6250
0.06	1.0124	1524.71	4.2490	2.8556	6.6758
0.08	1.0129	1525.81	4.2406	3.6901	8.6267
0.10	1.0134	1526.89	4.2325	4.4999	10.5200
0.12	1.0139	1527.92	4.2248	5.2693	12.3185
Temperature = 308.15K					
0.00	1.0089	1531.17	4.2278	-	-
0.01	1.0092	1531.8	4.2230	0.4811	1.1379

0.02	1.0095	1532.41	4.2183	0.9439	2.2326
0.04	1.0101	1533.59	4.2094	1.8330	4.3356
0.06	1.0106	1534.72	4.2010	2.6807	6.3408
0.08	1.0112	1535.81	4.1929	3.4933	8.2627
0.10	1.0117	1536.9	4.1848	4.2955	10.1602
0.12	1.0121	1537.95	4.1771	5.0664	11.9837
Temperature = 313.15K					
0.00	1.0070	1539.84	4.1882	-	-
0.01	1.0073	1540.47	4.1835	0.4705	1.1235
0.02	1.0076	1541.07	4.1790	0.9185	2.1932
0.04	1.0081	1542.22	4.1705	1.7750	4.2381
0.06	1.0087	1543.32	4.1623	2.5922	6.1894
0.08	1.0092	1544.38	4.1544	3.3772	8.0635
0.10	1.0097	1545.41	4.1468	4.1366	9.8768
0.12	1.0102	1546.41	4.1395	4.8724	11.6336
Temperature = 318.15K					
0.00	1.0043	1547.02	4.1607	-	-
0.01	1.0046	1547.67	4.1559	0.47464	1.1408
0.02	1.0049	1548.28	4.1514	0.9220	2.2159
0.04	1.0054	1549.43	4.1430	1.7682	4.2498
0.06	1.0059	1550.52	4.1350	2.5707	6.1787
0.08	1.0065	1551.56	4.1273	3.3371	8.0207
0.10	1.0070	1552.56	4.1199	4.0733	9.7900
0.12	1.0074	1553.49	4.1130	4.7654	11.4534
Lithium chloride in 6% aqueous Lactose					
Temperature = 303.15K					
0.00	1.0182	1527.17	4.2109	-	-
0.01	1.0186	1527.84	4.2058	0.5063	1.2024
0.02	1.0189	1528.48	4.2010	0.9871	2.3441
0.04	1.0195	1529.56	4.1926	1.8219	4.3267
0.06	1.0201	1530.55	4.1849	2.5910	6.1531
0.08	1.0206	1531.64	4.1768	3.4002	8.0747
0.10	1.0211	1532.82	4.1684	4.2454	10.0821
0.12	1.0215	1533.81	4.1611	4.9764	11.8179
Temperature = 308.15K					
0.00	1.0165	1537.11	4.1636	-	-
0.01	1.0168	1537.88	4.1581	0.5472	1.3141
0.02	1.0172	1538.42	4.1540	0.9625	2.3117
0.04	1.0177	1539.42	4.1462	1.7367	4.1712
0.06	1.0183	1540.41	4.1387	2.4917	5.9846
0.08	1.0188	1541.41	4.1312	3.2403	7.7824
0.10	1.0193	1542.41	4.1238	3.9782	9.5546
0.12	1.0198	1543.4	4.1166	4.7021	11.2933
Temperature = 313.15K					
0.00	1.0146	1545.57	4.1260	-	-
0.01	1.0149	1546.29	4.1209	0.5101	1.2364
0.02	1.0152	1546.84	4.1167	0.9232	2.2376
0.04	1.0158	1547.74	4.1096	1.6317	3.9546
0.06	1.0163	1548.73	4.1022	2.3762	5.7591
0.08	1.0168	1549.64	4.0953	3.0673	7.4341
0.10	1.0173	1550.63	4.0880	3.7936	9.1944
0.12	1.0178	1551.63	4.0808	4.5149	10.9426
Temperature = 318.15K					
0.00	1.0124	1552.56	4.0978	-	-
0.01	1.0127	1553.35	4.0924	0.5404	1.3188
0.02	1.0130	1553.89	4.0884	0.9430	2.3012
0.04	1.0136	1554.71	4.0818	1.6013	3.9077
0.06	1.0141	1555.61	4.0749	2.2912	5.5912
0.08	1.0146	1556.51	4.0681	2.9721	7.2528
0.10	1.0151	1557.51	4.0608	3.6964	9.0204
0.12	1.0156	1558.32	4.0547	4.3134	10.5260

Table-II: Acoustic impedance (Z), intermolecular free length (L_f), Wada's constant (W), relative association (R.A.), relaxation time (τ) for Lithium chloride in 2, 4 and 6 wt. % Lactose at 303.15K

Molality (m)	Z x 10^6 (Kg $m^{-2}s^{-1}$)	L_f x 10^{-09} (m)	W x 10^{-4} ($m^3mol^{-1}Pa^{1/7}$)	R.A	τ X 10^{-7} (s)
Lithium chloride in 2% aqueous Lactose					
Temperature = 303.15K					
0.00	1.5195	1.3680	3.4273	-	-
0.01	1.5206	1.3672	3.4267	1.0005	4.7861
0.02	1.5217	1.3665	3.4263	1.0009	4.7899
0.04	1.5236	1.3651	3.4255	1.0017	4.7951
0.06	1.5254	1.3637	3.4249	1.0024	4.7995
0.08	1.5271	1.3625	3.4244	1.0030	4.8032
0.10	1.5287	1.3614	3.4241	1.0036	4.8072
0.12	1.5302	1.3602	3.4239	1.0041	4.8104
Temperature = 308.15K					
0.00	1.5274	1.3721	3.4388	-	-
0.01	1.5285	1.3713	3.4384	1.0004	4.2661
0.02	1.5294	1.3707	3.4379	1.0008	4.2697
0.04	1.5312	1.3693	3.4371	1.0067	4.2746
0.06	1.5329	1.3682	3.4365	1.0022	4.2793
0.08	1.5346	1.3669	3.4606	1.0029	4.2830
0.10	1.5362	1.3658	3.4356	1.0034	4.2867
0.12	1.5378	1.3646	3.4354	1.0040	4.2899
Temperature = 313.15K					
0.00	1.5334	1.3777	3.4501	-	-
0.01	1.5345	1.3768	3.4497	1.0004	3.8035
0.02	1.5354	1.3762	3.4493	1.0008	3.8063
0.04	1.5371	1.3751	3.4484	1.0015	3.8113
0.06	1.5387	1.3738	3.4478	1.0021	3.8151
0.08	1.5404	1.3727	3.4473	1.0028	3.8189
0.10	1.5418	1.3716	3.4467	1.0033	3.8229
0.12	1.5434	1.3705	3.4464	1.0039	3.8264
Temperature = 318.15K					
0.00	1.5374	1.3847	3.4613	-	-
0.01	1.5386	1.3839	3.4609	1.0004	3.4668
0.02	1.5394	1.3833	3.4605	1.0008	3.4692
0.04	1.5410	1.3822	3.4596	1.0015	3.4734
0.06	1.5426	1.3811	3.4894	1.0021	3.4774
0.08	1.5442	1.3799	3.4584	1.0027	3.4809
0.10	1.5457	1.3788	3.4579	1.0033	3.4846
0.12	1.5471	1.3778	3.4574	1.0038	3.4887
Lithium chloride in 4% aqueous Lactose					
Temperature = 303.15K					
0.00	1.5370	1.3575	3.4090	-	-
0.01	1.5383	1.3566	3.4085	1.0005	4.8479
0.02	1.5394	1.3558	3.4080	1.0009	4.8511
0.04	1.5416	1.3543	3.4071	1.0018	4.8549
0.06	1.5436	1.3529	3.4062	1.0026	4.8579
0.08	1.5456	1.3516	3.4054	1.0034	4.8606
0.10	1.5474	1.3503	3.4046	1.0041	4.8628
0.12	1.5491	1.3491	3.4039	1.0048	4.8652
Temperature = 308.15K					
0.00	1.5448	1.3618	3.4204	-	-
0.01	1.5459	1.3610	3.4199	1.0005	4.3092
0.02	1.5470	1.3602	3.4194	1.0009	4.3120
0.04	1.5490	1.3588	3.4185	1.0017	4.3156
0.06	1.5510	1.3574	3.4176	1.0025	4.3186
0.08	1.5529	1.3561	3.4168	1.0035	4.3211
0.10	1.5548	1.3548	3.4160	1.0040	4.3233
0.12	1.5566	1.3537	3.4153	1.0047	4.3256
Temperature = 313.15K					
0.00	1.5506	1.3675	3.4315	-	-
0.01	1.5517	1.3667	3.4310	1.0004	3.8446
0.02	1.5528	1.3660	3.4305	1.0009	3.8467
0.04	1.5548	1.3646	3.4296	1.0017	3.8500

0.06	1.5567	1.3633	3.4287	1.0024	3.8526
0.08	1.5586	1.3620	3.4279	1.0032	3.8552
0.10	1.5604	1.3607	3.4271	1.0039	3.8576
0.12	1.5622	1.3595	3.4263	1.0046	3.8601
Temperature = 318.15K					
0.00	1.5536	1.3751	3.4440	-	-
0.01	1.5547	1.3743	3.4436	1.0004	3.4975
0.02	1.5558	1.3736	3.4431	1.0009	3.4991
0.04	1.5578	1.3722	3.4422	1.0017	3.5015
0.06	1.5597	1.3708	3.4413	1.0024	3.5042
0.08	1.5616	1.3696	3.4405	1.0032	3.5070
0.10	1.5634	1.3683	3.4396	1.0039	3.5096
0.12	1.5651	1.3672	3.4388	1.0046	3.5126
Lithium chloride in 6% aqueous Lactose					
Temperature = 303.15K					
0.00	1.5550	1.3469	3.3909	-	-
0.01	1.5562	1.3461	3.3904	1.0005	4.9883
0.02	1.5574	1.3453	3.3899	1.0009	4.9914
0.04	1.5594	1.3439	3.3889	1.0017	4.9958
0.06	1.5612	1.3427	3.3880	1.0025	4.9991
0.08	1.5631	1.3414	3.3872	1.0032	5.0011
0.10	1.5651	1.3401	3.3865	1.0040	5.0020
0.12	1.5668	1.3389	3.3858	1.0047	5.0038
Temperature = 308.15K					
0.00	1.5626	1.3514	3.4021	-	-
0.01	1.5638	1.3505	3.4017	1.0005	4.3681
0.02	1.5648	1.3498	3.4012	1.0009	4.3709
0.04	1.5667	1.3486	3.4001	1.0017	4.3750
0.06	1.5686	1.3473	3.3992	1.0024	4.3780
0.08	1.5704	1.3461	3.3983	1.0032	4.3805
0.10	1.5722	1.3449	3.3976	1.0039	4.3827
0.12	1.5739	1.3437	3.3968	1.0046	4.3847
Temperature = 313.15K					
0.00	1.5681	1.3573	3.4100	-	-
0.01	1.5694	1.3565	3.4126	1.0005	3.8889
0.02	1.5704	1.3558	3.4121	1.0009	3.8912
0.04	1.5722	1.3540	3.4110	1.0016	3.8953
0.06	1.5740	1.3534	3.4100	1.0024	3.8981
0.08	1.5757	1.3522	3.4091	1.0031	3.9010
0.10	1.5776	1.3510	3.4083	1.0038	3.9031
0.12	1.5793	1.3499	3.4075	1.0045	3.9052
Temperature = 318.15K					
0.00	1.5718	1.3647	3.4238	-	-
0.01	1.5731	1.3638	3.4234	1.0005	3.5329
0.02	1.5741	1.3631	3.4229	1.0009	3.5348
0.04	1.5758	1.3620	3.4218	1.0016	3.5388
0.06	1.5776	1.3608	3.4208	1.0023	3.5419
0.08	1.5793	1.3597	3.4198	1.0030	3.5446
0.10	1.5811	1.3585	3.4190	1.0038	3.5467
0.12	1.5827	1.3575	3.4181	1.0044	3.5495

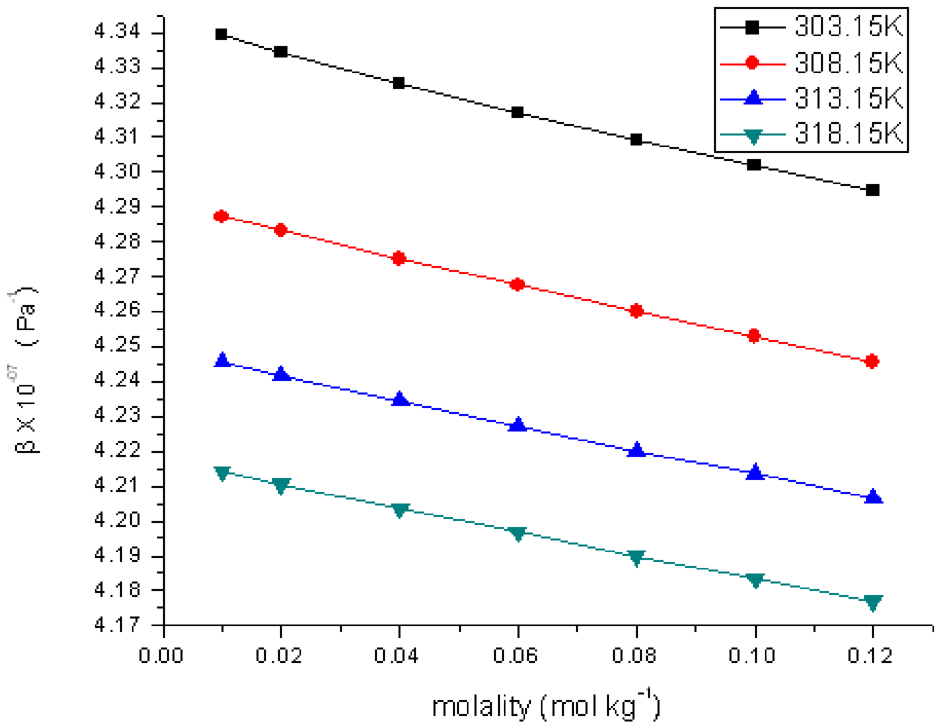

Fig I : Plots of β Vs m for LiCl in 2% lactose at different temperatures.

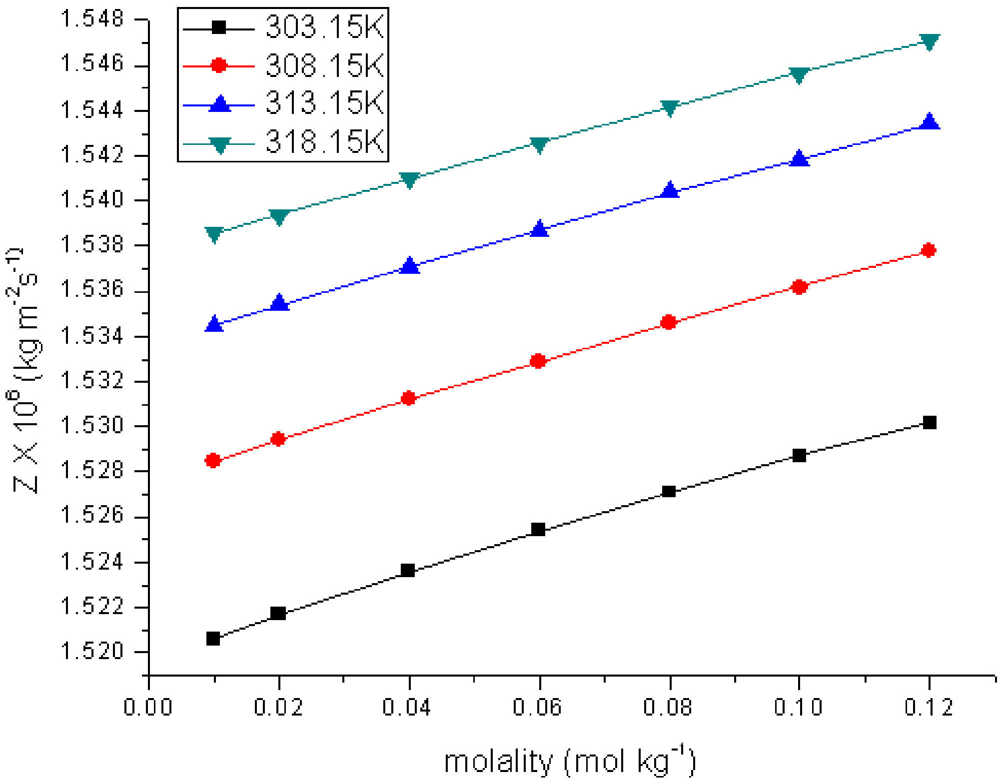

Fig II: Plots of Z Vs m for LiCl in 2% lactose at different temperatures.

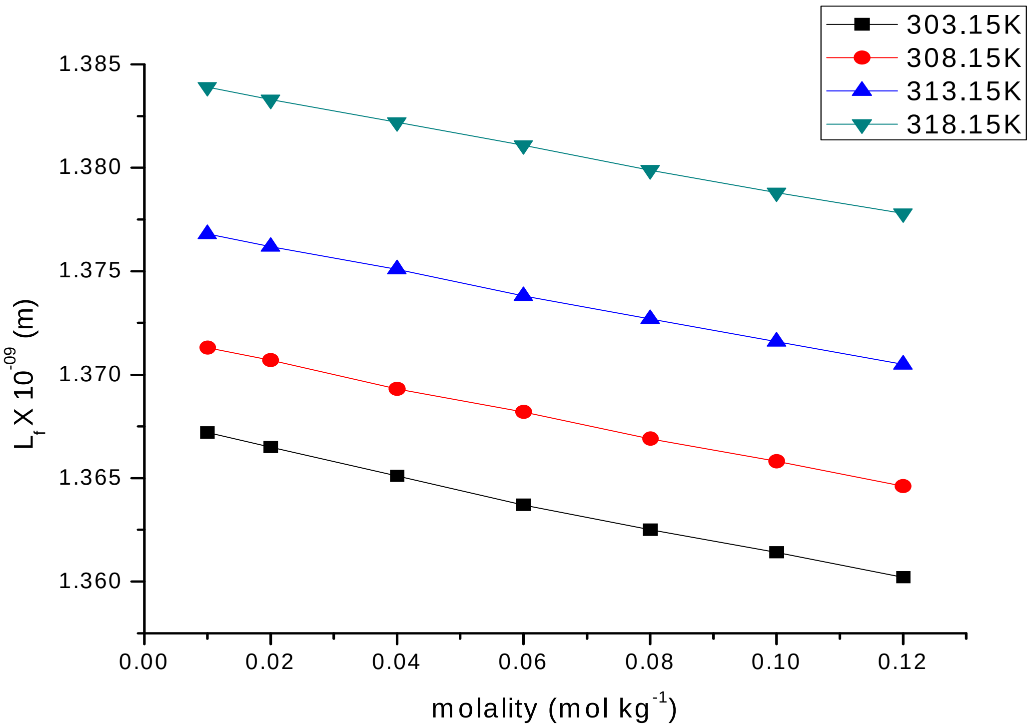

Fig III: Plots of L_f Vs m for LiCl in 2% lactose at different temperatures

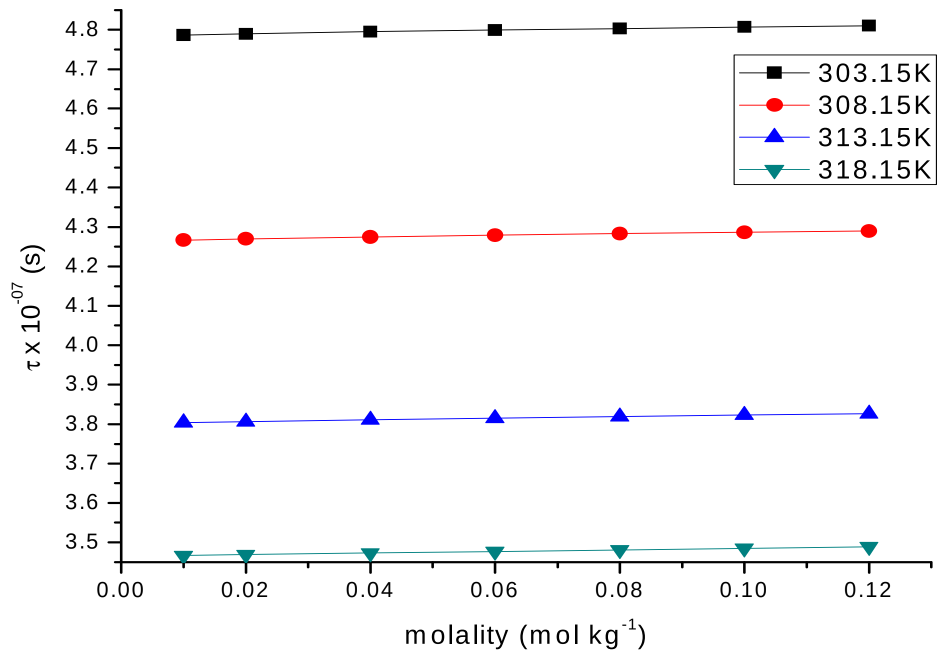

Fig IV: Plots of τ Vs m for LiCl in 2% lactose at different temperatures.

CONCLUSION

The observed trends and variations of thermo dynamical parameters with molar concentrations of lithium chloride provide useful information about the nature of intermolecular forces existing in the multi component system. The existence of ion-solvent (or) solvent – solvent interaction resulting in attractive forces promote the structure – making tendency, while ion-ion are solute – solute interaction resulting dipole-dipole, dipole induced dipole and electrostrictive forces enhance the structure – breaking properties of lithium chloride in 2, 4 and 6 wt. % lactose . There is appreciable existence of solute – solvent and solute – solute interactions present in the system. Hence it is evident that the ultrasonic velocity measurement in the given medium serves as a powerful probe in characterizing the physico-chemical properties of the medium.

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