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DENSITIES, VISCOSITIES AND SPEED OF SOUND AND OTHER ACOUSTIC PARAMETERS OF L. ALANINE IN AQUEOUS ALCOHOLS AT DIFFERENT TEMPERATURES

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ABSTRACT

Density, speed of sound and viscosity measurements have been made for L- alanine and other amino acids in ethanol-water and isopropyl alcohol-water co-solvents at the temperatures 303.15K,308.15K and 313.15K having the Concentration of amino acids in the range of 0.01 to 0.10 mol litre. These measurements have been used to evaluate some important parameters Such as isentropic Compressibility, Specific acoustic impedance, intermolecular free- length, molar Sound velocity, Apparent molal compressibility (φk) , Specific viscosity, reduced and relative viscosity and Some other parameters for the Same Concentrations and temperature range. These parameters have been discussed in the terms of Solute- Solvent interactions .The ultrasound velocity increases on increasing Concentration of electrolyte.

Keywords: Ultrasonic velocity, isentropic compressibility, L.Alanine.

INTRODUCTION

As amino acids have both a primary amino group and Carboxylic group these Chemicals can undergo most of the reactions associated with these functional group. These include nucleophilic addition, amide bond formation and imine formation for the amine group and esterification, amide bond formation and decarboxylation for the Carboxylic group. The multiple Side chain of amino acids Can also undergo Chemical reactions. As both the amine and carboxylic acid groups of amino acids can react to form amide bonds, One amino acid molecule Can react with another and become joined through an amide linkage. This polymerization of amino acids give formation proteins, these Condensation reactions yield the newly form peptide bond and a molecule of water. Peptides are Synthesized by a variety of reactions. One of the most used in solid Phase peptides, Synthesis which uses the aromatic oxime derivatives of amino acids as activated units. These are added in Sequence on to the growing peptide chain. Amino acids in aqueous solutions are ionized and can act as acids or bases due to formation of Zwitter ion (H_3N-CH(R)-coo-). The Knowledge of acid – base properties of amino acids is extremely important in understanding many properties of Proteins. Besides above the biological System Consists of 70% Water and hence the Study of interactions of these amino acids have become significant in aqueous protein solution, the amino acid residues of a Poly-peptide chain interact through a non Covalent interactions with each other and with Surrounding water molecules[1-2]. Investigations of the physiochemical properties of the Denatured State of protein are required to identify and characterize the Contribution of various nonbonding interactions between different functional groups of protein and protein- Solvent interactions which are the driving forces for a biological process. As Proteins are the complex molecules, the task of direct interpretation of studies of protein becomes difficult. Hence the approach to Study model Compounds Such as amino acids, peptides and their derivatives, which mimic Some of their Structural aspects, is pre requisite which provides the means to understand these intermolecular involved in the Complex protein System[3] The study of ultrasonic leads to a better understanding of the nature of interactions between the Solute and Solvent. In recent years these have been an increasing interest in the Study of non electrolytic Components in aqueous and non aqueous Solutions[4].

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The Physical properties of dilute aqueous solutions of non electrolytes depends that the Solute is a water-Structure breaker or maker. The influence of small quantity of amino acids on hydrogen bonded structure of water in the solution of water and ethanol and water isopropyl alcohol mixture and in the solution of water is quite different from that in the absence of amino acids in order to study the nature of molecular interactions in the above Solutions. Ultrasonic Velocity, density and viscosity Studies work Carried out in aqueous Solutions of Ethanol and isopropyl alcohol Containing L-alanine. These results have been discussed in terms of various interactions operating in these systems.

EXPERIMENTAL

The Ultrasound Velocities of the Solutions were measured with a multi frequency ultrasonic interferometer of model F-81 which is manufactured by m/s Mittal enterprises New Delhi. Quartz crystal have different frequency and have the accuracy of about $\pm$0 .05% the average of ten readings was treated as a final value of Ultrasound Velocities. The temperature around the cell was controlled with in ± 0.01k by Circulating the water from thermostat manufactured by Scientific instrument Company limited. It consists of 230 V and 2000 watts type D.B.S. It contains a motor which is manufactured by Rami Udyog. Bombay, 230 Volts, type 183, RP.M 1800.

Thermometer made is western Germany which is used to measure the temperature and can measure the temperature difference of 0.01^0C.

Density measurement were reformed with a pre Calliborated Bicapillary pycknometer. The accuracy of the density measurements was upto $\pm$ 0.0001 gm/cm^3. Viscosities were measured using an ubbelohde type Capillary viscometer. Which was calliborated with doubly distilled water de-ionised water at three temperatures. The efflux time was measured using an electronic watch with a resolution of 0.01sec. An average of four or five readings reproducible with in 0.15 was used as final efflux time The uncertainty in the measured viscosities was $\pm$ 0.005 cp. The ultrasonic Parameters Such as molar Sound Velocity (R) apparent molal Compressibility (φk), isentropic compressibility (β_s), specific acoustic impedance (Z), Specifics Viscosity ($\acute{\eta}_{sp}$) and reduced viscosity ($\acute{\eta}_{red}$) were computed in these Solutions using the described standard Formulae[5]. Some of the formulae used as molar sound velocity –

$$R = M/\rho .V\ 1/3 \tag{1}$$

Apparent molal Compressibility

$$\varphi K = 1000/C.\rho\ (\rho.\beta s^0 - \beta s.\rho)+\beta s.\ \ m/\rho_o \tag{2}$$

Isentropic Compressibility

$$\beta_s = 1/v^2.\ \rho \tag{3}$$

Specific acoustic impedance

$$Z = v.\rho \tag{4}$$

Relative association

$$R = \frac{\overline{M}}{\rho} \times V^{1/3} \tag{5}$$

Where M = (n_1 m_1 + n_2 m_2 /n_1 + n_2) is effective molecular weight. Where n_1 and n_2 are the number of moles of solvent and solute and m_1 and m_2 are their molecular weight respectively. ρ and ρ_o are the densities of solution and solvent and V and V^o are their Ultrasonic Velocities respectively. βs and βs^o are the Isentropic Compressibility of Solution and Solvent and C is the Concentration of Solute in mole/ Litre.

In the Present work the Chemicals L- alanine, ethanol and propanol-2 were used of AR (BHD) quality, E mark grade and these Compounds were again purified and made anhydrous by temperature Controlling.

Even the solution of different Concentrations were made by using double distilled water and alcohols

RESULTS AND DISCUSSION

Ultrasonic Velocity and density Varied with the Concentration of amino acid (L – alanine) in the Solution of 50% ethanol and 50% water and also in the Co-Solvent of 50% propanol-2 and 50% water the Variation of data's are shown in the Table No. 1 and 2.

It can be seen from these datas that the Ultrasound Velocities of Solutions increases with increasing the Concentration of L- alanine in the Solution of L-alanine with water Ethanol Co-Solvent and as well as in the Solution of L-alanine in water- propanol – 2 Co- Solvent as different temperatures. The Values of Ultrasound Velocity for Same Sample decreases on increasing temperature this trend of Variation of Ultrasound Velocity also observed for other amino acids.

The Viscosity and reduced viscosity are given for the Samples of L- alanine with Ethanol – water Co-solvent and propanol -2- water Co Solvents is tabulated in the table no. 3 and4 and the Values of molar Sound Velocity and isentropic Compressibility is given in the table no. 5and6. The Values of specific acoustic impedance and Apparent molal Compressibility (φK) are given the table (7and8).

The Viscosity of solutions for the given Sample increases with increase in the Concentration of electrolyte. the Variation with the Concentration of the electrolyte and Change in temperature agreed with kumar, S[6] and the Variation of densities, Viscosities of the present work also agreed with Singh et.al[7] The ultrasound Velocity in the Solution of Ethyl alcohal and isopropyl alcohol with water increases with the addition of amino- acids when amino acids and other electrolyte are dissolved, the water Structure is disturbed initially followed by the structural reorganization leaving the molecules enclosily fitting in the helical Cavities.[8] When the amino acids are dissolved in aqueous solutions of alcohols the Cations H_3N^+ and anions – Coo^- are formed , the water molecules are attacked to the ions strongly by the electrostatic forces which introduce a greater Cohesion in the Solution the Cohesion in these generally increases with the increase of amino acid Concentration. The increased association observed in these Solutions, may also be due to water Structure enhancement brought by the increasing electrostriction in the presence of ethanol and propanol-2. The electrostriction effect which brings about the Shrinkage in the Volume of Solvent, Caused by the Zwitter ionic portion of the amino acid, is increased in mixed Solvent as Compared to that in pure water. This effect is similar to the result of A Srinivasa Rao.[9] The decrease in the isentropic Compressibility, observed in aqueous C_2H_sOH and CH_3 CH(OH) CH_3 Solutions with H_2N.CH (CH_3) COOH. In the Present Study Confirms that Conclusion drawn in the Velocity Studies, the importance of the interactions of the water molecule in biological Structures can not be overemphasized. The Structure and Function of Biological molecules are directly linked with its aqueous medium. Water molecules constitute an integral part of the Protein Structure and interaction of the Protein with the water molecule decides the Conformations of the residues, which are on the Surface of the Protein molecules. The interaction has an important role in Protein folding. Ordered water molecules also mediate protein ligand interaction. Water molecule band to active Sites are Found to reduce the entropy or activation when replaced by the ligands. Water bridges between Carbonyl Oxygen atoms and NH_3^+ Protons of different peptides lead to formation of linkages that stabilize the Protein ligands and Protein- Protein interfaces. Water molecule provide necessary plasticity to the Protein molecules which is essential for its internal dynamics and thus for its biological activity. In the molecular recognition process in enzymes and binding proteins, optimization energy of mutual hydrogen bonded networks between proteins, water and ligands plays an important role. The linear results of Density and ultrasound Velocity have also been reported for glucose in binary aqueous Solution of mannose, maltose and raffinose by Pal. A. and Chauhan, N.[10] Linear result for molar Volume for the electrolyte in aqueous Solution of alcohols also shown by Parmar M Land Guleria M.K.and others[11-13] The results are also agreed with Kumar. P. et. al.[14] the physicochemical behaviour of liquid mixtures is also studied by R. Mehra and Gaur A.K. [15] and the results agreed with the present work.

Table-1: Ultrasound velocity and density of L.Alanine in alcohol - Water Co- Solvent at 303.15K, 308.15K and 313.15K ± 0.05°C.

Ultrasound Velocity (m/sec)				Density . (gm/ml)		
Con. (mol/lit)	303.15K	308.15K	313.15K	303.15K	308.15K	313.15K
0.01	1526	1518	1510	0.9227	0.9155	0.9081
0.02	1528	1520	1512	0.9232	0.9160	0.9085
0.03	1530	1522	1514	0.9237	0.9165	0.9090
0.04	1532	1524	1516	0.9242	0.9170	0.9095
0.05	1534	1526	1518	0.9247	0.9175	0.9100
0.06	1536	1528	1520	0.9252	0.9180	0.9105
0.07	1538	1530	1522	0.9257	0.9185	0.9110
0.08	1540	1532	1524	0.9262	0.9190	0.9115
0.09	1542	1534	1526	0.9267	0.9195	0.9120
0.10	1544	1536	1528	0.9272	0.9200	0.9125

Table-2: L. Alanine + Isopropyl Alcohal + Water

Ultrasound Velocity (m/sec)				Density . (gm/ml)		
Con. (mol/lit)	303.15K	308.15K	313.15K	303.15K	308.15K	313.15K
0.01	1464	1457	1452	0.9174	0.9070	0.9010
0.02	1466	1459	1454	0.9176	0.9074	0.9015
0.03	1468	1461	1456	0.9178	0.9079	0.9119
0.04	1470	1463	1458	0.9181	0.9084	0.9024
0.05	1472	1465	1460	0.9183	0.9088	0.9028
0.06	1474	1467	1462	0.9185	0.9093	0.9032
0.07	1476	1479	1464	0.9187	0.9098	0.9036
0.08	1478	1471	1466	0.9190	0.9102	0.9040
0.09	1480	1473	1468	0.9192	0.9107	0.9044
0.10	1482	1475	1470	0.9194	0.9112	0.9048

Table-3: Viscosity(η) and reduced viscosity η_{red} of L. Alanine in Alcohol – Water Co Solvent at 303.15K , 308.15K and 313.15K ± 0.05°C.
L. Alanine + Ethanol + Water

Viscosity (c.p)				Reduced Viscosity . (η_{red})		
Con. (mol/lit)	303.15K	308.15K	313.15K	303.15K	308.15K	313.15K
0.01	1.1969	1.0342	0.8808	0.4532	0.4955	0.4905
0.02	1.2025	1.0392	0.8852	0.4616	0.4907	0.4962
0.03	1.2082	1.0444	0.8896	0.4672	0.4955	0.4981
0.04	1.2138	1.0495	0.8940	0.4679	0.4955	0.4991
0.05	1.2195	1.0547	0.8980	0.4699	0.4975	0.4997
0.06	1.2250	1.0595	0.9030	0.4685	0.4923	0.5038
0.07	1.2308	1.0645	0.9075	0.4711	0.4914	0.5052
0.08	1.2365	1.0695	0.9130	0.4720	0.4907	0.5077
0.09	1.2420	1.0745	0.9166	0.4737	0.4901	0.5083
0.10	1.2479	1.0795	0.9211	0.4733	0.4896	0.5088

Table-4: L .alanine + propanol -2 + water

Viscosity η (c.p)				reduced viscosity. (η_{red})		
Con. (mol/lit)	303.15K	308.15K	313.15K	303.15K	308.15K	313.15K
0.01	1.7830	1.5566	1.3486	0.3037	0.3287	0.3273
0.02	1.7883	1.5618	1.3533	0.3009	0.3319	0.3384
0.03	1.7939	1.5671	1.3577	0.3056	0.3351	0.3597
0.04	1.7992	1.5724	1.3627	0.3037	0.3367	0.3448
0.05	1.8047	1.5777	1.3674	0.3049	0.3372	0.3451
0.06	1.8100	1.5829	1.3721	0.3037	0.3373	0.3459
0.07	1.8162	1.5881	1.3767	0.3002	0.3370	0.3454
0.08	1.8205	1.5935	1.3812	0.3016	0.3383	0.3440
0.09	1.8260	1.5988	1.3857	0.3025	0.3387	0.3430
0.10	1.8314	1.6041	1.3902	0.3026	0.3390	0.3422

Table-5: Molar sound velocity and Isentropic compressibility of L–alanine in Alcohol - water Co–solvent at 303.15K , 308.15K and 313.15K ± 0.05°C.

L .alanine + Ethanol + water

Molar sound Velocity (m/see)				Isentropic Compressibility (β_s/cm^2/dyne x10^{12})		
Con. (mol/lit)	303.15K	308.15K	313.15K	303.15K	308.15K	313.15K
0.01	399.52	401.96	404.52	46.54	47.40	48.29
0.02	399.72	402.17	404.78	46.39	47.25	48.15
0.03	399.83	402.37	404.99	46.25	47.10	47.99
0.04	400.13	402.58	405.20	46.10	46.95	47.84
0.05	400.34	402.79	405.40	45.95	46.80	47.68
0.06	400.54	402.99	405.61	45.81	46.65	47.64
0.07	400.74	403.20	405.82	45.67	46.50	47.39
0.08	400.95	403.40	406.03	45.52	46.36	47.24
0.09	401.15	403.61	406.24	45.38	46.22	46.08
0.10	401.35	403.81	406.44	45.24	46.07	46.94

Table – 6: L .alanine + Propanol -2 + water

Con. (mol/lit)	303.15K	308.15K	313.15K	303.15K	308.15K	313.15K
0.01	482.97	487.73	490.42	50.86	51.94	52.64
0.02	483.72	488.01	490.64	50.71	51.77	52.47
0.03	483.35	488.23	490.92	50.51	51.60	52.30
0.04	484.05	488.45	491.15	50.40	51.43	52.13
0.05	484.43	488.73	491.42	50.26	51.27	51.96
0.06	484.80	488.95	491.70	50.11	51.10	51.80
0.07	485.18	489.17	491.98	49.96	50.93	51.63
0.08	485.50	489.44	492.26	49.81	50.77	51.47
0.09	485.88	489.66	492.53	49.67	50.61	51.31
0.10	486.25	489.88	492.81	49.52	50.44	51.15

Table-7: Specific acoustic impedance and Apparent molal Compressibility φk of L- alanine in Ethanol water Co - Solvent at 303.15K , 308.15K and 313.15K ± 0.05°C.
L . alanine + Ethanol + water

Specifice accustic impedence ($z*10^{-5}$c.g.s); Apparent molal compressibility (“φk” cm^2/dyme*10^9)

Con. (mol/lit)	303.15K	308.15K	313.15K		303.15K	308.15K	313.15K
0.01	1.4080	1.3897	1.3712		-222.41	-216.66	-210.95
0.02	1.4106	1.3923	1.3736		-223.12	-217.36	-211.59
0.03	1.4132	1.3949	1.3762		-223.82	-218.05	-212.27
0.04	1.4158	1.3975	1.3788		-224.53	-218.74	-212.94
0.05	1.4184	1.4001	1.3813		-225.24	-219.43	-213.62
0.06	1.4211	1.4027	1.3840		-225.95	-220.13	-214.30
0.07	1.4237	1.4053	1.3865		-226.66	-220.85	-214.98
0.08	1.4263	1.4079	1.3891		-227.37	-221.52	-215.66
0.09	1.4289	1.4105	1.3917		-228.08	-222.22	-216.35
0.10	1.4316	1.4131	1.3943		-228.80	-222.92	-217.04

Table-8: Specific acoustic impedance and Apparent molal Compressibility φk of L- alanine in propanol-2 water Co - Solvent at 303.15K , 308.15K and 313.15K ± 0.05°C.
L . alanine + Proponal -2 + water

Con. (mol/lit)	303.15K	308.15K	313.15K		303.15K	308.15K	313.15K
0.01	1.3430	1.3216	1.3082		-202.43	-195.51	-192.02
0.02	1.3452	1.3238	1.3107		-203.03	-196.54	-192.66
0.03	1.3473	1.3264	1.3131		-203.83	-197.18	-193.27
0.04	1.3496	1.3289	1.3157		-204.25	-197.83	-193.92
0.05	1.3517	1.3314	1.3180		-204.85	-198.46	-194.53
0.06	1.3538	1.3339	1.3204		-205.45	-199.11	-195.15
0.07	1.3560	1.3565	1.3228		-206.05	-199.76	-195.77
0.08	1.3582	1.3589	1.3252		-206.68	-200.40	-196.40
0.09	1.3604	1.3414	1.3276		-207.38	-201.05	-197.02
0.10	1.3625	1.3440	1.3300		-207.89	-201.71	-197.64

Specific acoustic impedance ($z*10^{-5}$c.g.s); Apparent molal compressibility (“φk” cm^2/dyme*10^9)

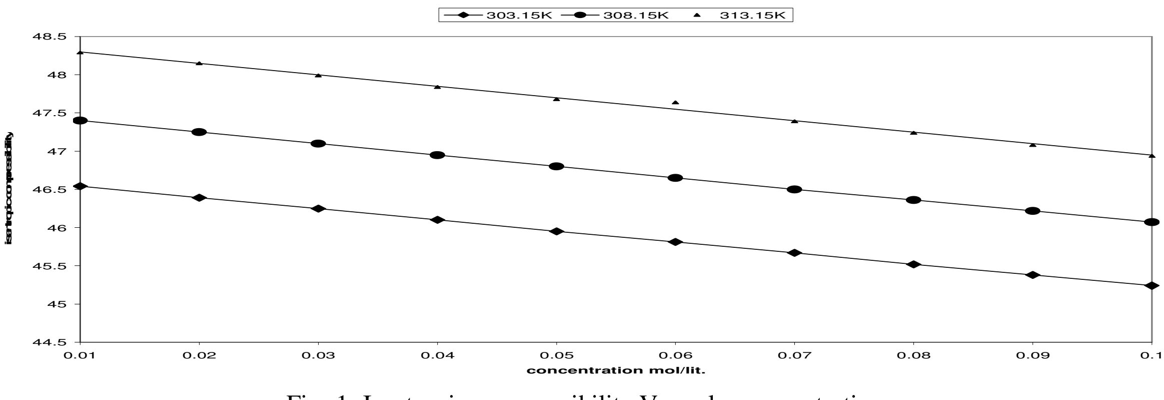

Fig.-1: Isentropic compressibility Vs molar concentration

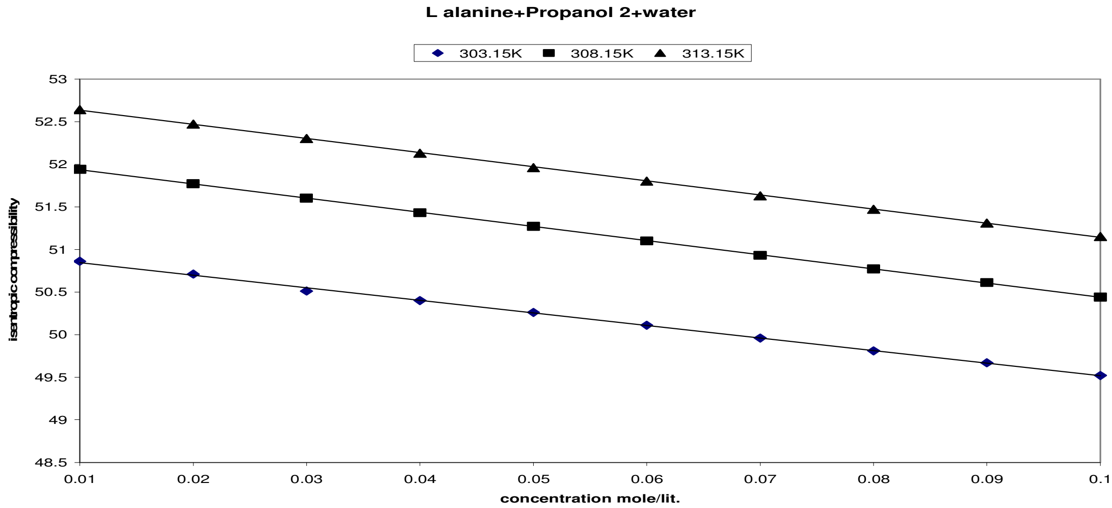

Fig.-2: Isentropic compressibility Vs molar concentration

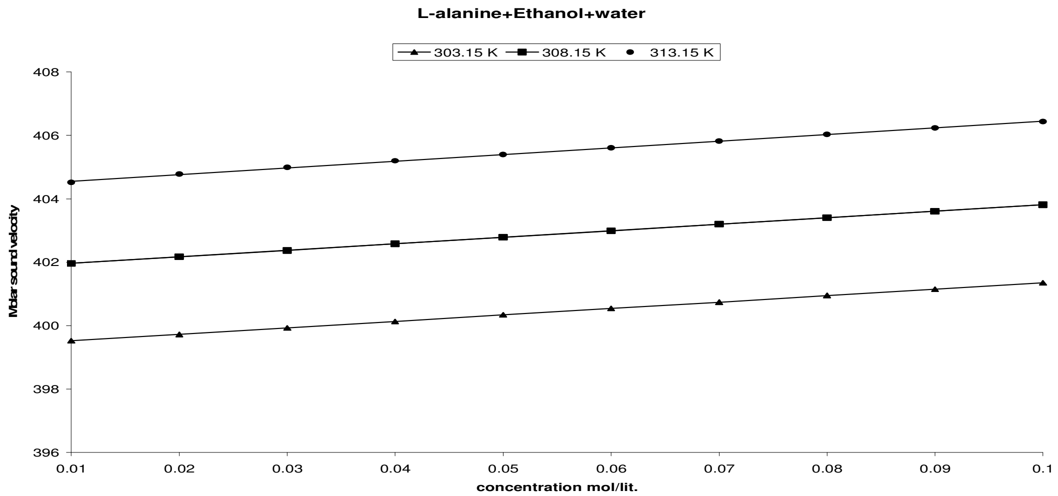

Fig.-3: Molar sound velocity Vs molar concentration

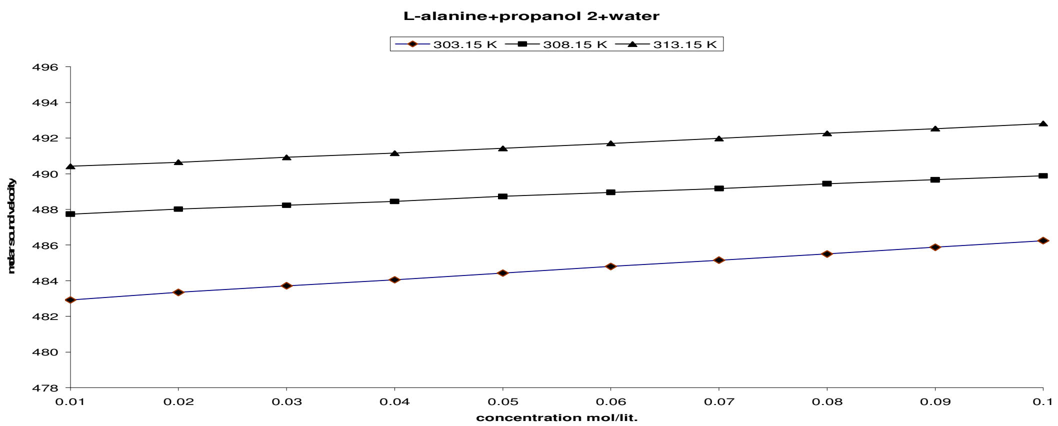

Fig.-4: Molar sound velocity Vs molar concentration

Depending on the Polarity of side Chain amino acids vary in their hydrophilic or hydrophobic Character. These Properties are important in protein Structure and Protein – Protein interactions. The importance of the Physical properties of the Side Chain Come from the influence, this has on the amino acid residues interaction with other Structures, both with in a Single Protein and between Proteins. The distribution of hydrophilic amino acids determines the tertiary Structure of the Protein and their Physical location on the outside Structure of the Proteins influences their quaternary Structure.

CONCLUSION

The new measurements of density (ρ) viscosity (η) and ultrasound velocity at 303.15, 308.15 and 313.15 K are reported for L- alanine in aqueous solutions of ethanol and propanol-2 in the present work. Various parameters have been calculated using the experimental data. On the basis of these data we conclude that the destabilization of amino acids in aqueous alcohol is not merely due to electrical effect of aqueous alcohols by virtue of it's lower dielectric constant but largely due to dehydration of amino acids in aqueous alcohols by overlap of Co-sphere of hydration zone and the observation reflect that the solute. solvent interaction are predominant over the solute- solute interaction for the L- alanine in ethanol water and propanol-2- water Co- solvents.

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