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Ultrasonic Studies on Halide Doped Amino Acids

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ABSTRACT

Amino acids are very small bio molecules with all average molecular weight of about 135 daltons. Proteins are polymers of amino acids. Amino acids are important and they can be classified into three groups; polar, non polar and charged. Amino acids have salt like character. For athletes or anyone who practices regular strenuous physical activity, IsoLeucine supplements are recommended. Although there are foods that contain this amino acid, people who are extremely active and exercise heavily need more IsoLeucine in their bodies to repair and protect muscle tissues. Internal pressure in a liquid system is measure of intermolecular cohesive forces and confirms the presence of solute –solvent interactions. The density and speed of L-iso in aqueous concentrated NaBr, NaCl, KBr (5%, 10%, 15%) at T= 303K have been measured. These parameters are used to calculate the internal pressure (πi). Here the KBr aqueous solution having very high solute solvent interaction than the NaBr and NaCl aqueous solution, because K^+ ion is a structure breaking ion which interact to the end group of the amino acid (COO^-) Hence it is found that the present study shows there is variation in the internal pressure of the three halides.

Key words: Alkali Halide, Amino Acids, Ultrasonic, Internal Pressure.

INTRODUCTION

Isoleucine (abbreviated as Ile or I) is an α-amino acid with the chemical formula $HO_2CCH(NH_2)CH(CH_3)CH_2CH_3$. It is an essential amino acid, which means that humans cannot synthesize it, so it must be ingested. With a hydrocarbon side chain, isoleucine is classified as a hydrophobic amino acid. Together with threonine, isoleucine is one of two common amino acids that have a chiral side chain. Four stereoisomers of isoleucine are possible, including two possible diastereomers of L-isoleucine. However, isoleucine present in nature exists in one enantiomeric form, (2*S*,3*S*)-2-amino-3-methylpentanoic acid. Amino acids are the basic building blocks of proteins and peptides. The development of experimental measurements and modelling of thermodynamic properties of amino acids are used in their separation, concentration and purification. Most of the amino acids are soluble in water; hardly few are appreciably soluble in non aqueous organic solvents. Literature survey shows that electrolytes can influence the solubility behaviour of amino acids. Remarkable experiments and theoretical works have been reported on thermodynamics of amino acids in aqueous salt solution. Most of the papers explain the electrolyte solution of some amino acids. In this paper, we present results, the system consisting of L-isoleucine in aqueous NaBr,KCl, KBr at different concentration (like 0.02,0.04,0.06,0.1) at constant temperature 303K.

The main objective of this paper is the study of density, viscosity, velocity and internal pressure of amino acids in aqueous solution. Internal pressure of a liquid system is a measure of inter molecular cohesive force and confines the presence of solute- solvent interactions.

MATERIALS AND METHODS

L-isoleucine (AR Grade) was obtained and used without further treatment and the alkali halides used were also of AR Grade. The solutions were prepared on a molality basis. The specific conductivity of the water was used less than 18×10^{-6} /ohm/cm. The concentration of L-isoleucine was in the range of 0.02, 0.04, 0.06, 0.08, 0.10 mol/kg while the salt varied from 5%, 10%, and 15% mol/kg.

The density of the solutions ρ were measured, with the help of a specific gravity bottle with 5ml capacity is cleaned well and dried and filled with reference liquid (conductivity water). The weight of the reference liquid is determined as Ww with an accuracy of ± 0.1 mg [model: SHIMADZUAX -200].

The viscosities of the solution were measured using an Ostwald viscometer (10 ml capacity). The speed of sound (velocity) υ, were measured using an ultrasonic interferometer [model: F81] supplied by M/S.Mittal Enterprises, NewDelhi, having a frequency 3MHz with an overall accuracy of $\pm 2 ms^{-1}$ has been used for velocity measurements. The temperature was kept constant to ± 0.05 K using a constant temperature bath.

RESULTS AND DISCUSSION

The ultra sonic studies of amino acid/peptide+ water and amino acid +salt + water systems are useful to understand several bio chemical processes such as protein hydration, de naturation, aggregation etc. The thermodynamic equations have been successfully used for an accurate analysis of volumetric properties of pure and mixed electrolytes in aqueous and non-aqueous solutions up to high concentrations, temperatures and pressure.

The measured density (ρ), velocity (U), values are listed in table (1) , (2) and (3) for different concentration of L-isoleucine and electrolytes. This increasing value of density in these three systems indicates the increase in solvent-solvent and solute- solvent interaction.

In these three different solvent compositions have also been investigated to understand ion-solvent interactions in electrolyte systems [1] have repeated similar finding for L-isoleucine aqueous KCl, KNO_3 and K_2SO_4 salt.

Table (1), (2) and (3) shows the variation of viscosity with single temperature (303K) and three different solvent compositions (KCl,NaBr, NaCl) have also been investigated to understand ion-solvent interactions in electrolyte systems.

Table 1: Values of Density, Viscosity, Velocity, Free volume and Internal pressure in L-isoleucine in aqueous Sodium Bromide at 303 K

Molality m(mol/Kg)	Density (ρ) Kg/m^3			Viscosity $\eta x10^3$ Nsm^{-2}			Velocity U ms^{-1}			Free volume $V_f 10^8$ m^3/mol			Internal Pressure $\Pi i x10^{-6}$ N/m^2		
	NaBr + water			NaBr + water			NaBr + water			NaBr + water			NaBr + water		
	5%	10%	15%	5%	10%	15%	5%	10%	15%	5%	10%	15%	5%	10%	15%
0	1070.7	1110.9	1159.4	0.8179	0.8526	0.9118	1518	1535	1544	2.6851	2.3832	2.0279	2345	2584	2893
0.02	1072.5	1112.9	1161	0.8247	0.8601	0.9315	1523	1541	1554	3.4191	3.0271	2.5325	1938	2140	2412
0.04	1077.7	1113.9	1162	0.8417	0.8644	0.9368	1526	1551	1567	4.1274	3.7568	3.1424	1659	1812	2044
0.06	1078.5	1114.1	1162.9	0.8474	0.8745	0.9394	1531	1556	1574	4.9617	4.4801	3.7994	1435	1572	1766
0.08	1079.1	1115	1164	0.8546	0.8945	0.9441	1540	1566	1579	5.8551	5.1724	4.4765	1260	1391	1553
0.1	1079.9	1116.2	1164.9	0.8571	0.8968	0.9471	1543	1573	1585	6.8143	6.5169	5.291	1119	1164	1380

Table :2 Values of Density, Viscosity, Velocity, Free volume and Internal pressure in L-isoleucine in aqueous Potassium Bromide at 303 K

Molality m(mol/Kg)	Density (ρ) Kg/m^3			Viscosity $\eta x10^3$ Nsm^{-2}			Velocity U ms^{-1}			Free volume $V_f 10^8$ m^3/mol			Internal Pressure $\Pi i x10^{-6}$ N/m^2		
	KBr + water			KBr + water			KBr + water			KBr + water			KBr + water		
	5%	10%	15%	5%	10%	15%	5%	10%	15%	5%	10%	15%	5%	10%	15%
0	1071.7	1111.1	1155.3	0.8118	0.8068	0.8271	1516	1525	1530	2.7127	2.5722	2.3203	2325	2516	2757
0.02	1072.3	1113.4	1155.6	0.8186	0.8117	0.8313	1520	1532	1544	3.4804	3.2839	2.9792	1921	2087	2276
0.04	1072.9	1114.1	1155.9	0.8315	0.8258	0.8395	1523	1545	1553	4.2213	4.0097	3.6599	1636	1780	1934
0.06	1075.9	1114.8	1156.6	0.8329	0.836	0.847	1528	1549	1557	5.0716	4.7692	4.3717	1417	1545	1679
0.08	1076.3	1115.4	1157	0.8357	0.846	0.8605	1534	1551	1561	6.017	5.5559	5.0628	1244	1363	1446
0.1	1076.6	1116.7	1158.4	0.8422	0.8515	0.8712	1539	1554	1566	6.9419	6.9316	5.8104	1107	1144	1368

Table 3: Values of Density, Viscosity, Velocity, Free volume and Internal pressure in L-isoleucine in aqueous Sodium Chloride at 303 K

Molality m(mol/Kg)	Density (ρ) Kg/m^3			Viscosity $\eta x10^3$ Nsm^{-2}			Velocity U ms^{-1}			Free volume $V_f 10^8$ m^3/mol			Internal Pressure $\Pi i x10^{-6}$ N/m^2		
	NaCl + water			NaCl + water			NaCl + water			NaCl + water			NaCl + water		
	5%	10%	15%	5%	10%	15%	5%	10%	15%	5%	10%	15%	5%	10%	15%
0	1054.2	1089.3	1129.3	0.8337	0.9847	1.0794	1554	1604	1677	2.7035	2.0509	1.7822	2365	2720	2990
0.02	1054.3	1090.3	1130	0.8727	0.9918	1.1005	1566	1615	1681	3.274	2.6227	2.2187	1978	2241	2491
0.04	1055.4	1091.3	1130.2	0.8847	0.9934	1.118	1574	1623	1691	4.0101	3.2638	2.7019	1676	1892	2121
0.06	1055.9	1092.4	1130.7	0.8935	1.0029	1.1425	1585	1633	1693	4.8272	3.9206	3.1588	1445	1636	1853
0.08	1056.7	1093.1	1131.3	0.9274	1.0081	1.1457	1596	1640	1695	5.4641	4.6334	3.7248	1284	1435	1628
0.1	1057	1093.9	1131.7	0.9483	1.0194	1.1561	1624	1647	1712	6.3227	5.7637	4.3441	1142	1278	1446

Similar results were shown by several authors on LiCl, NaCl, KCL, RbCl and CsCl salts [2]. They have also observed that alkali metal ions do not change the water structure much.

Also the already conducted studies [3] shows that the strength of ion-solvent interactions decrease with increase in size of the ions but on the other hand the co-ordination number of the ion increase with increase in its size.

The values varied from NaCl>NaBr>KBr. According to the X-ray diffraction analysis and neutron scattering studies the co-ordination number of K^+ ion is 4. The K^+ is considered as weak structure breaking ion. The structure breaking ion causes an increase in the thermal motion of water molecules while the structure making ion such as Na^+ shows a contrary effect.

According to Samoilor [5] the surface density of the distribution of water molecules around an ion decrease with increase in ionic radius. The tables (1),(2) and (3) shows the variation of internal pressure and free volume with concentration. Internal pressure of a system is a measure of the intermolecular cohesive force. The values of the internal pressure and can be used to study the nature of molecular interactions can be used to study the nature of molecular interaction in liquids. In this study observed that the increase in internal pressure with L-isoleucine concentration confirms the formation of intermolecular hydrogen bonding between the aqueous salt solutions at all concentration.

CONCLUSION

Such behaviour lends support to the weak solute- solute and solute – solvent intermolecular inter ionic interactions in these systems. The solute –solute and solute-solvent interactions exists in the following order NaCl<NaBr<KBr.Some of the benefits of L-IsoLeucine include the regulation of blood sugar levels in the body, and producing hemoglobin. This amino acid is responsible for muscle recovery after exercise, and is important in metabolism for producing energy.L-IsoLeucine is also beneficial for preventing muscles wasting in individuals with debilitations. It is also essential for the production and maintenance of body proteins, and is involved in blood clot formation. IsoLeucine is necessary for nitrogen balance in adults, and for the healthy, normal growth of infants.

IsoLeucine is probably best known for its use in increasing endurance and helping heal and repair muscle tissue. Serious athletes and bodybuilders need this amino acid because of its ability to boost energy levels and help the muscles recover from strenuous exercise and other physical activities. Bodybuilding requires energy and endurance. By using IsoLeucine along with Valine and Leucine, the muscles fully recover after exercise. IsoLeucine is literally broken down within the muscle tissue to provide energy.

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