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EFFECT OF SODIUM CHLORIDE ON AMINO ACID AT DIFFERENT TEMPERATURE

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Abstract:

The ultrasonic velocity (U), density (ρ), and viscosity (η) measurements have been carried out for L- Arginine in aqueous sodium chloride for several concentration of amino acid at different temperature. From these experimental results, derived thermodynamical parameters such as the adiabatic compressibility (β), acoustic impedance (Z), free length (L_f), internal pressure (P_i) have been computed by using the standard relations. The results are used to establish the nature of solute-solute and solute-solvent interactions. The results are discussed in terms of structure-making or structure-breaking effect of amino acids in the mixture.

Keyword: Ultrasonic velocity, density, viscosity, amino acid and acoustic parameters.

Introduction

Ultrasonic technique has been employed successfully to observe the dynamic equilibrium between multiple isomeric form of molecules and arrive at more complete kinetic description of chemical and structural reaction whose relaxation time are comparable to the period of the ultrasonic wave. Ultrasonic studies may throw more light on the molecular interaction to know the behaviour of biological macromolecules in aqueous solution. It is the key to solve the critical problems with the role and interaction of these substances in living organisms.

Ultrasonic study on amino acid with aqueous solution of electrolytes and non-electrolytes provides useful information in understanding the behaviour of liquid system, intermolecular and intra-molecular association, complex formation and related structural changes. Interaction of proteins with their surrounding environment plays an important role in their conformational characteristics. These interactions are mainly those between the protein molecules and the solvent ions. Most of these interactions, such as hydrogen bonding and electrostatic interactions have non-covalent nature. The study of these interactions provides important insight into the conformational stability and folding or unfolding behaviour of globular proteins[1]. The effect of electrolytes on the structure and function of protein and nucleic acids in terms of their structure-making or breaking property has been studied by number of researchers [2-5].

Amino acids are the structural units (monomers) that make up proteins. They join together to form short polymers chains called peptides or longer chains called either polypeptides or proteins. Amino acids belong to an important family of bio molecules, which serve primarily as basic building blocks of proteins. Because proteins are large complex molecules , direct study of protein-electrolyte interactions is difficult. It is therefore useful to investigate the interaction of model compounds such as amino acids, peptides, and their derivatives that constitute part of the protein structures[6-9].

Materials and Methods

The amino acid L-Arginine and the solvent of the salt sodium chloride whose molecular weight 58.44 are mixed together of various concentration. The liquid mixtures of various concentrations were prepared by taking AR grade chemicals as such without further purifications. Stock solution of aqueous sodium chloride was prepared in doubly distilled water and was used as solvent for the preparation of solute solutions. All the solutions were stored in special air tight bottles to avoid the exposure of solutions to air and evaporation. By using an electronic digital balance we were weighted all the solutions.

The density is measured by using a specific gravity bottle of capacity 10 ml. The measurement of ultrasonic velocity at a frequency of 2MHz at different concentrations and temperatures has been measured by using ultrasonic interferometer. The viscosity of the solutions was measured by using an Ostwald Viscometer. Time required for flow of solution was measured by using a racer digital stopwatch. An average of three reading has taken as the final value of time. These experimental results have been used to calculate adiabatic compressibility, acoustic impedance, free length etc. as a function of solute concentration and temperature with the help of standard formulae.

Adiabatic compressibility (β) is given by, $\beta = \frac{1}{U^2 \rho}$ ………… (1)

Acoustic impedance (Z) is given by, $Z = U\,\rho$ ………… (2)

Free length is given by, $L_f = \frac{K}{U\,\rho^{1/2}}$ …….. (3)

Internal Pressure is given by, $P_i = bRT * (K\eta\,/c)^{1/2} * (d^{2/3}\,/\,Meff^{7/6})$ ……….. (4)

TABLE 1

Conc	Velocity				Density				Viscosity			
	293^{O}K	288^{O}K	283^{O}K	278^{O}K	293^{O}K	288^{O}K	283^{O}K	278^{O}K	293^{O}K	288^{O}K	283^{O}K	278^{O}K
0.01	1536.695	1525.283	1504.345	1491.553	1.0247	1.0352	1.0389	1.0684	1.1383	1.2414	1.3883	1.4747
0.02	1539.147	1526.362	1506.707	1493.284	1.0319	1.0404	1.0446	1.0691	1.1463	1.2580	1.4167	1.5288
0.03	1539.533	1526.642	1508.028	1495.020	1.0357	1.0415	1.0483	1.0751	1.1505	1.2698	1.4322	1.5374
0.04	1539.761	1527.362	1510.824	1497.340	1.0399	1.0421	1.0631	1.0766	1.1656	1.2705	1.4736	1.5502
0.05	1540.991	1527.824	1512.008	1500.835	1.0414	1.0422	1.0759	1.0767	1.1673	1.2706	1.4914	1.5717
0.06	1543.456	1529.993	1514.976	1502.003	1.0421	1.0481	1.0769	1.0774	1.1785	1.3092	1.5249	1.5835
0.07	1544.692	1531.207	1516.167	1504.345	1.0435	1.0485	1.0778	1.0804	1.1905	1.3307	1.5370	1.6093
0.08	1545.930	1531.815	1517.359	1507.695	1.0438	1.0501	1.0780	1.0816	1.1909	1.3537	1.5480	1.6111

At temperature 293°K, 288°K, 283°K, 278°K.

TABLE 2

Acoustic Parameters at temperature 293°K

Concentration	Adiabatic compressibility	Acoustic Impedance	Free Length	Internal Pressure
0.01	4.1326	1.5747	0.4025	0.9188
0.02	4.0907	1.5882	0.4005	0.9253
0.03	4.0737	1.5945	0.3996	0.9290
0.04	4.0560	1.6012	0.3988	0.9375
0.05	4.0437	1.6048	0.3982	0.9385
0.06	4.0281	1.6084	0.3974	0.9425
0.07	4.0163	1.6119	0.3968	0.9476
0.08	4.0087	1.6136	0.3964	0.9473

TABLE 3

Acoustic Parameters at temperature 288°K

Concentration	Adiabatic compressibility	Acoustic Impedance	Free Length	Internal Pressure
0.01	4.4496	1.5789	0.4035	0.9530
0.02	4.4657	1.5880	0.4022	0.9621
0.03	4.4687	1.5899	0.4019	0.9670
0.04	4.4670	1.5917	0.4016	0.9673
0.05	4.4648	1.5923	0.4014	0.9671
0.06	4.4773	1.6036	0.3997	0.9845
0.07	4.4719	1.6055	0.3993	0.9922
0.08	4.4753	1.6086	0.3989	1.001

TABLE 4

Concentration	Adiabatic compressibility	Acoustic Impedance	Free Length	Internal Pressure
0.01	4.2534	1.5629	0.4083	0.9996
0.02	4.2169	1.5739	0.4066	1.0125
0.03	4.1946	1.5809	0.4055	1.0198
0.04	4.1209	1.6062	0.4019	1.0431
0.05	4.0656	1.6268	0.3992	1.0571
0.06	4.0459	1.6315	0.3983	1.0683
0.07	4.0361	1.6341	0.3978	1.0725
0.08	4.0291	1.6357	0.3974	1.0759

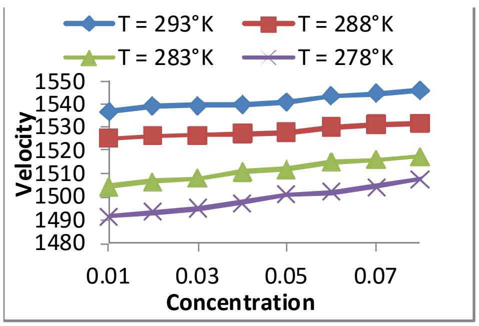
Acoustic Parameters at temperature 283°K

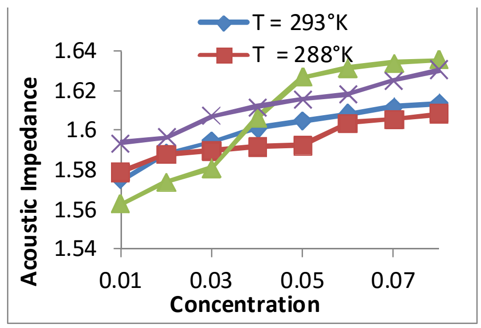
TABLE 5

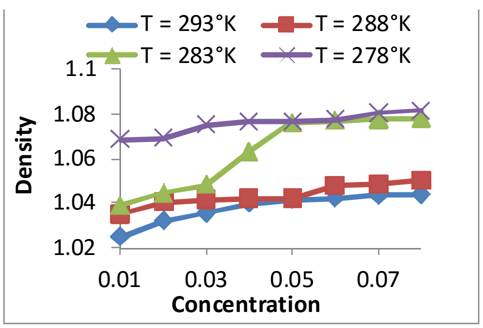
Acoustic Parameters at temperature 278°K

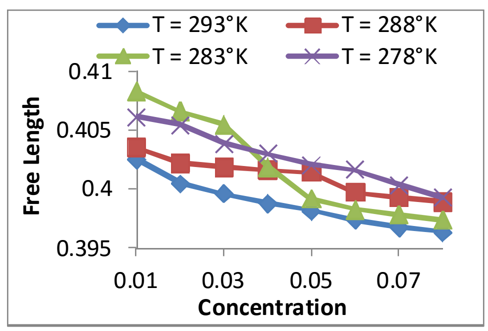
Concentration	Adiabatic compressibility	Acoustic Impedance	Free Length	Internal Pressure
0.01	4.2072	1.5936	0.4061	1.0355
0.02	4.1947	1.5965	0.4055	1.0540
0.03	4.1616	1.6073	0.4039	1.0601
0.04	4.1429	1.6120	0.4030	1.0646
0.05	4.1232	1.6159	0.4021	1.0705
0.06	4.1142	1.6183	0.4016	1.0744
0.07	4.0899	1.6253	0.4004	1.0840
0.08	4.0673	1.6307	0.3993	1.0840

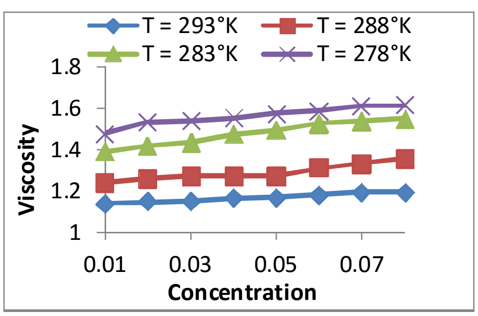
For ultrasonic velocity, density, viscosity and acoustic parameters at temperatures 293°K, 288°K, 283°K, 278°K.

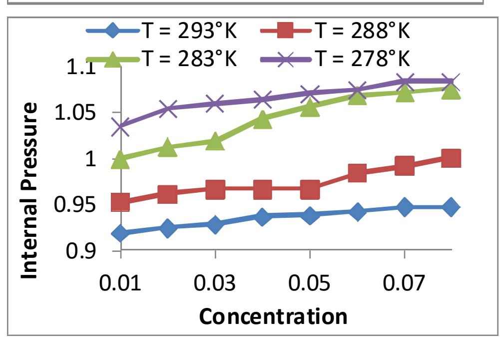


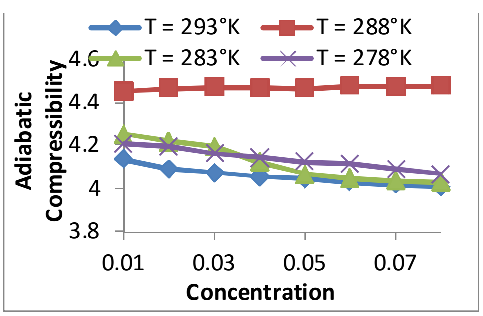












Result and Discussion

From the graph, it is found that the experimental values of ultrasonic velocity, density, viscosity increases with increase in solute concentration and also increases with increase in temperature. The values of parameters such as, adiabatic compressibility and free length which are decreases with increase in solute concentration and acoustic impedance and internal pressure are increases with increases in solute concentration.

The increase in ultrasonic velocity values of L-Arginine in aqueous sodium chloride solution may be attributed to the overall increase of cohesion brought about by solute-solute, solute-solvent and solvent-solvent interaction in solution. The increase in the values of density may be attributed to the increases in hydrophilic interactions [3] and increase of density with concentration indicates the increase in solvent-solvent and solute-solvent interactions. The increasing trend of viscosity with increase in mole fraction of the amino acids indicates the existence of molecular interactions in these mixtures [4].

The increase in value of acoustic impedance with molality indicates the tightening of molecules at higher concentration. As the concentration increases, the molecules come closer, thereby decreasing the intermolecular free length and hence internal pressure increases.

The decrease in adiabatic compressibility values with rise in temperature in all the systems under study may be explained in terms of the changes occurred in water structure around Zwitterions and ions [10].

Conclusions

In the present work, ultrasonic velocity, density, viscosity have been measured for amino acid L-Arginine in aqueous sodium chloride solution at different temperature on the basis of the observations, it is concluded that the presence of ion-solvent interaction result in the structure making property while ion-ion interaction is responsible for structure-breaking tendency of amino acid. The decrease in the values of adiabatic compressibility with increase in the solute concentrations may be due to the occupation of the interstitial spaces of water by the solute molecules thereby making the medium less compressible.

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