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ACOUSTICAL INVESTIGATION OF L- VALINE AT 295.15K TEMPERATURE

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Abstract:
The ultrasonic velocity (U), density (ρ) and viscosity (η) values for L- Valine in aqueous potassium bromide solution for several concentration of amino acid at room temperature (295.15 K). From this experimental result, derived acoustical parameters such as the adiabatic compressibility (β), acoustic impedance (Z), free length (L_f), Surface Tension (σ) Molar volume (Vm), 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, adiabatic compressibility, acoustic impedance, free length, Surface Tension , Molar volume.

1. Introduction

Ultrasonic studies may throw more light on the molecular interaction to know the behavior of biological macromolecules in aqueous solution. Ultrasonic is the application of ultrasound can be use for medical imaging, detection, measurement and cleaning bio-technology [1], polymers [2-5] detergents. At higher power levels, ultrasonic is useful for changing the chemical property of substances. Ultrasonic viscosity and its parameters provide valuable information regarding the shape and size of the molecules. The variation of ultrasonic velocity and absorption in inorganic, organic and organometallic binary system has been used to access the molecular interaction in these systems [6, 7].

Ultrasonic study on amino acids with aqueous solution of electrolytes and non-electrolytes provides useful information in understanding the behaviour of liquid systems. Amino acids and peptides are the fundamental structure units of proteins, dipeptide, certain types of hormones and many other compounds of biological relevance. Amino acids are building blocks of proteins and they exhibit both acidic and basic properties. The amino acids in aqueous solution are useful model for understanding the thermodynamic behaviour of proteins, especially in determining the polar group contributions to the biopolymers. Most of the studies on amino acids have been carried out in pure and mixed aqueous solution [8-10].

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.

2 .Materials And Methods

The amino acid L-Valine and the solvent potassium bromide of various concentrations are mixed together. The liquid mixtures of various concentrations were prepared by taking AR grade chemicals as such without further purifications. Stock solutions of aqueous sodium bromide were prepared in doubly distilled water and were 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 ultrasonic velocity in liquid mixture has been measured using ultrasonic interferometer working at frequency 2MHz. The density is measured using a specific gravity bottle of capacity 10ml. The viscosities of solutions are measured using an Ostwald's viscometer which is calibrated with double mark. The flow of solutions was measured using stop watch. All the precautions were taken to minimize the possible experimental error.

For the derivation of several acoustical or physical parameters the following defining relations are used:

*Molar volume: $\mathbf{V_m = M_{eff.}/\rho}$ .....(1)

* Adiabatic compressibility is given by: $\boldsymbol{\beta} = \frac{1}{U^2\rho}$ .....(2)

* Acoustic impedance is given by: $\mathbf{Z = U\ \rho}$ .....(3)

* Free length is given by: $\mathbf{L_f = \frac{K}{U\,\rho^{1/2}}}$ .....(4)

*Surface Tension: $\boldsymbol{\sigma = 6.3*10^{-4}(\rho U^{3/2})}$ .....(5)

3 .Result And Discussion

From the graph, it is found that the experimental values of ultrasonic velocity, density and viscosity increases with increase in solute concentration at room temperature (295.15 K). The values of parameters such as, adiabatic compressibility and free length which are decreases with increase in solute concentration and acoustic impedance are increases with increases in solute concentration. The increase in acoustic impedance this is attributed to the effective solute solvent interaction. The increase in value of acoustic impedance with molarity indicates the tightening of molecules at higher concentration. The increase in ultrasonic velocity (U) in these solutions may be attributed to the cohesion brought about by ionic hydration.

Density (ρ) is a measure of solvent-solvent and ion solvent interactions. Increase of density with concentration indicates the increase in solvent-solvent and solute- solvent interactions. Increase in density with concentration is due to the shrinkage in the volume which in turn is due to the presence of solute molecules.

The values of density and viscosity of L-Valine vary with increase in concentration of solutions. The increasing trend of viscosity with increase in mole fraction of the amino acids indicates the existence of molecular interactions in these mixtures [11]. The change in structure of solvent or solution is a result of hydrogen bond formation or dissociation of solute. That is hydrogen bond forming or dissociation properties can thus be correlated with change in density and viscosity [12].

The surface tension values go on increasing with increase in solute concentration. Solute such as ionic salts usually increases the surface tension of aqueous solutions above the value of pure water and in such solutions the surface layers are poorer in that solute.

The decreasing molar volume in the system indicates the presence of solute-solvent interaction. The magnitude of molar volume concluded that strong molecular association present.

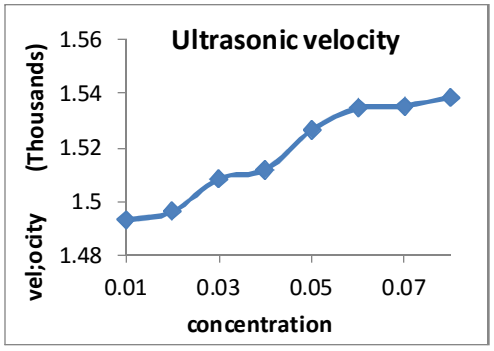
Table1: Ultrasonic velocity, density, viscosity and Adiabatic compressibility of L-Valine in aqueous solution of potassium bromide at 295.15K.

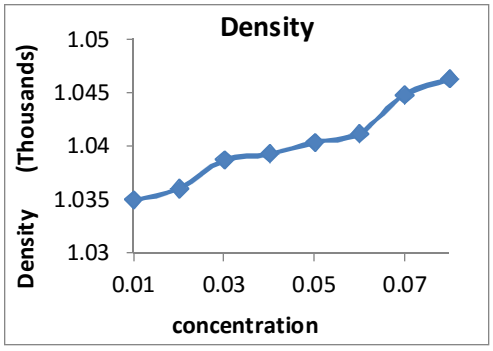
Conc.m	Velocity m/s	Density $\rho/(*10^3 Kg/m^3)$	Viscosity $\eta/(*10^{-3}\ NSm^{-2})$	Adiabatic compressibility $\beta/(*10^{-10}m^2/N)$
0.01	1493.06	1.03489	0.81992	4.3346
0.02	1496.32	1.03601	0.82927	4.3110
0.03	1508.57	1.03865	0.83139	4.2305
0.04	1511.83	1.03926	0.84036	4.2098
0.05	1526.53	1.04033	0.84123	4.1249
0.06	1534.69	1.04120	0.84193	4.0777
0.07	1535.51	1.04481	0.85338	4.0593
0.08	1538.77	1.04625	0.85456	4.0366

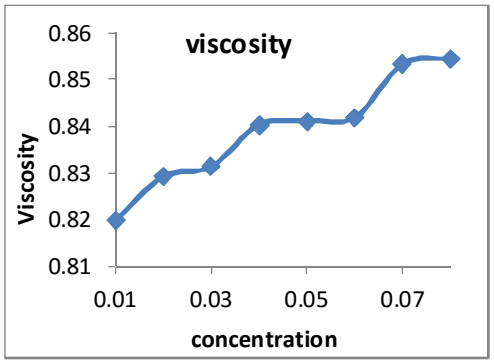
Table2: Acoustic impedance, free length, surface tension, molar volume of L-Valine in aqueous solution of potassium bromide at 295.15K.

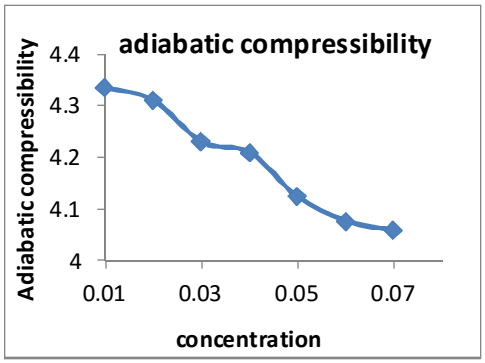
Conc.m	Acoustic impedance $Z/(*10^6 Kgm^{-2}s^{-1})$	Surface tension $\sigma/(*10^4\ N/m)$	Free Length $L_f/(*10^{-10}m)$	Molar Volume $V_m/(10^{-3}m^3/mole)$
0.01	1.545152	3.7614	0.412231	18.126
0.02	1.550202	3.7778	0.411110	18.109
0.03	1.566876	3.8340	0.407253	18.065
0.04	1.571184	3.8487	0.406256	18.057
0.05	1.588094	3.9090	0.402137	18.039
0.06	1.597919	3.9437	0.399831	18.026
0.07	1.604316	3.9605	0.398927	17.966
0.08	1.609938	3.9786	0.397808	17.944

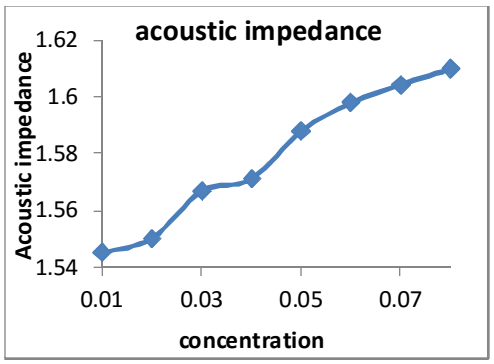
Variation of Ultrasonic velocity and their allied parameters with L-Valine in aqueous potassium bromide at temperature 295.15K

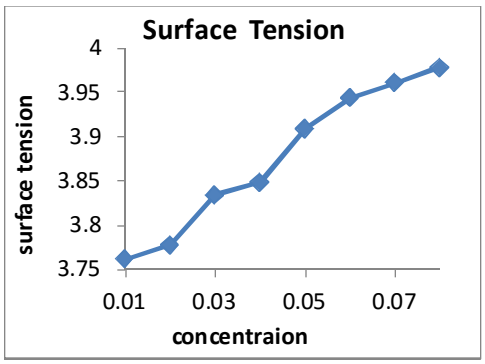


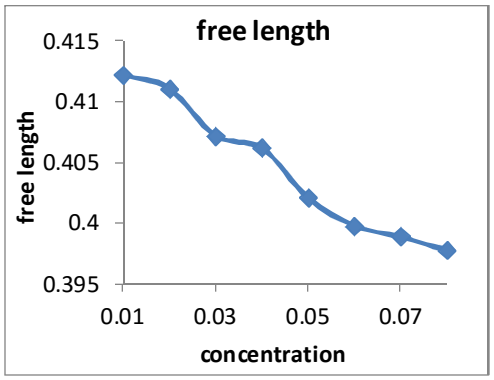


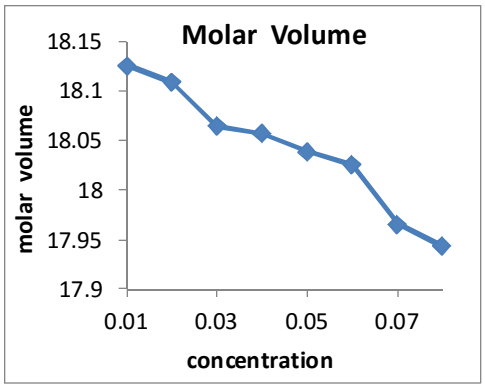












4 .Conclusions

Ultrasonic velocity, density, viscosity have been measured for L-Valine in aqueous sodium bromide solution at 295.15 K on the basis of the observations, it is conclude that an appreciable existence of solute- solvent and solute-solute interaction present in the system with varying degrees and the presence of ion-solvent or solute-solvent interaction resulting in attractive forces promote the structure-making tendency while ion-ion or solute-solute interactions resulting in dipole-dipole, dipole-induced dipole and electrostrictive forces enhance the structure-breaking properties of amino acids. L-Valine shows stronger ion-solvent interaction it is evident that L- Valine behaves as a good structure-maker.

The decrease in the values of adiabatic compressibility with increase in the solute concentration may be due to the occupation of the interstitial spaces of water by the solute molecules thereby making the medium less compressible. The surface tension values go on increasing with increase in concentration of the electrolytes in aqueous solutions. This leads to the conclusion that multi charged electrolytes under study can be said to be negatively absorbed at the surface.

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