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Excess parameters of glycine in aqueous sodium chloride

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ABSTRACT

The density, viscosity and speed of sound have been measured for the systems (1M NaCl +1M Glycine) at different volume fraction and at different temperatures 298.15, 303.15and 308.15K. The excess acoustic parameters such as excess ultrasonic velocity, excess adiabatic compressibility, excess acoustic impedance, excess intermolecular free length and excess relative association have been calculated for the solution. The results are interpreted in terms of molecular interactions.

Key words: Glycine, sodium chloride, ultrasonic velocity, excess parameters, intermolecular attraction.

INTRODUCTION

Excess thermodynamic parameters have been found to be highly useful in elucidating solute-solvent interactions in aqueous solutions and binary mixtures.Thermodynamic excess functions are found to be very sensitive towards mutual interactions between component molecules of the liquid mixture. The sign and the extent of deviation of these functions from ideality depend on the strength of interactions between unlike molecules **[1-3]**.

Excess parameter play a vital role in assessing the compactness due to molecular arrangement and the extent of molecular interactions in the liquid mixtures through charge transfer, dipole-induced dipole and dipole-dipole interactions**[4]**,interstitial accommodation and orientational ordering **[5]**, leading to more compact structure making. Derived parameters from ultrasonic velocity measurement and the corresponding excess functions provide qualitative information regarding the nature and strength of interactions in liquid mixtures **[6-8].**

Glycine is a colorless, sweet-tasting crystalline solid of high melting point behaves like a salts. It melts at 232^{0}C. It is readily soluble in water, but insoluble in alcohol and ether, commonly found in proteins. It is unique among the proteinogenic amino acids in that it is not *chiral*. It can fit into ***hydrophilic*** or ***hydrophobic*** environments, due to its two hydrogen atom side chain. In (NaCl + Glycine), it may be presumed that the interactions may be taking place as : ion-dipolar or hydrophilic group interactions between the ions of sodium and chlorine (Na^+, Cl^-) and NH_3^+,COO^-,OH groups of Glycine**[9]**. These interactions compressively introduce the cohesion into solution under investigation.

Ultrasonic velocities, densities and viscosities have been measured for binary liquid systems as (1M NaCl + 1M Glycine) at 2MHz frequency and at 298.15,303.15and 308.15K .From these data, excess thermodynamic parameters such as ultrasonic velocity(U^E),adiabatic compressibility (β_a^E), intermolecular free length (L_f^E), acoustic impedance(z^E) and relative association (R_A^E) have been estimated using standard relations. The results have been analyzed on the basis of variations in thermodynamic excess parameters.

MATERIALS AND METHODS

The chemicals used were of AR grade and dried over anhydrous $CaCl_2$ in desiccators before use. All solutions were prepared in deionized and distilled water (degassed by boiling), having specific conductivity ~10^{-6} Scm^{-1}. The aqueous solution of Glycine and NaCl was prepared by weighing the all chemicals on a digital balance with an accuracy of ± 1 x 10^{-4} g. Solutions of required liquid mixture were prepared by changing volume fraction (X) of glycine. The solutions were kept in the special air tight and were used within 12 hrs. to minimize decomposition due to bacterial contamination.

Ultrasonic velocity was measured by a single crystal interferometer (F-81, Mittal Enterprises, and New Delhi) operating at frequency of 2 MHz. The source of ultrasonic waves was a quartz crystal excited by a radio frequency oscillator placed at the bottom of a double jacketed metallic cylinder container. The cell was filled with the desired solution and water at constant temperature was circulated in the outer jacket. The cell was allowed to equilibrate for 30 min prior to making the measurements. The interferometer was calibrated against the ultrasonic velocity of water used at T=298.15K.The present experimental value is 1497.59 ms^{-1} which is in good agreement with literature value[7] 1496.69 ms^{-1} and accuracy in the velocity measurement is =-1.0 ms^{-1}.

Table1: Variation of thermodynamic parameters at different volume fraction (x) and different temperatures for the system (1MNaCl+1MGlycine) at 2 MHz.

Vol.fr. (X)	**Sound velocity(U) m/s**	**Density(ρ) Kg/m^3**	**Viscosity (η)** N s m^{-2}
298.15K			
0.2	1601.20	1084.8	13.0591
0.4	1595.43	1076.4	12.1994
0.6	1579.90	1066.8	11.5941
0.8	1559.90	1060.4	11.4420
303.15K			
0.2	1609.80	1084.0	11.9289
0.4	1601.00	1065.6	11.1977
0.6	1583.10	1075.6	10.5736
0.8	1575.50	1059.6	10.4617
308.15K			
0.2	1609.10	1080.8	10.9030
0.4	1599.40	1073.6	10.1766
0.6	1585.50	1064.4	09.6606
0.8	1583.50	1057.6	09.5278

Table2: Variation of excess parameters at different volume fraction (x) and different temperatures for the system (1M NaCl+1M Glycine) at 2 MHz.

Vol.fr. X	**U^E m/s**	**β^E m^2N^{-1}**	**Z^E x10^6 Nm-^{2}**	**L_F^E A^0**	**R_A^E**
298.15K					
0.2	+60.42	-0.0049	+0.0012	+0.0012	+0.0004
0.4	+45.89	-0.0038	+0.0008	+0.0008	+0.0078
0.6	+30.07	-0.0010	+0.0002	+0.0002	+0.0011
0.8	+17.07	+0.0012	-0.0003	-0.0003	+0.0015
303.15K					
0.2	-02.68	+0.0138	+0.0027	+0.0008	+0.0053
0.4	+02.72	+0.0020	+0.0044	+0.0003	-0.9925
0.6	-00.62	+0.0204	+0.0025	+0.0011	+0.0048
0.8	-00.16	+0.0137	+0.0005	+0.0007	-0.037
308.15K					
0.2	+01.84	-0.0108	+0.0026	+1.0151	+0.0057
0.4	+03.37	-0.0186	+0.0044	+0.7660	+0.0054
0.6	+03.81	-0.0152	+0.0280	+0.5102	+0.0039
0.8	+01.30	+0.0001	-0.0005	+0.0254	+0.0049

The densities of the solutions were determined accurately using 25 ml specific gravity bottle and electronic balance and the accuracy in the density measurements is ± $1x10^{-4}$g.An average of triple measurements was taken into account. Sufficient care was taken to avoid any entrapment of air bubble. Viscosity was measured with pre-calibrated Ostwald type viscometer. The flow of time was measured by a digital stop watch capable of registering time accurate to ±0.1 S. An average of three or four sets of flow of times for each solution was taken for the purpose of calculation of viscosity and the accuracy of the viscosity measurement was ±0.5%.The experimental temperature was maintained constant by circulating water with the help of thermostatic water bath with an accuracy of temperature measurement ±0.1K.**[10].**

Fig1

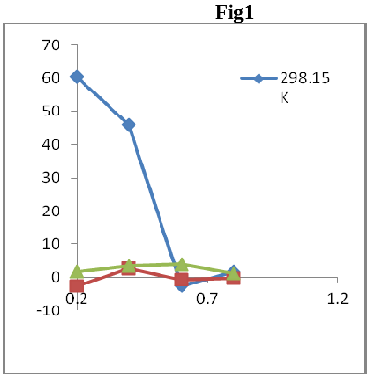

Fig2

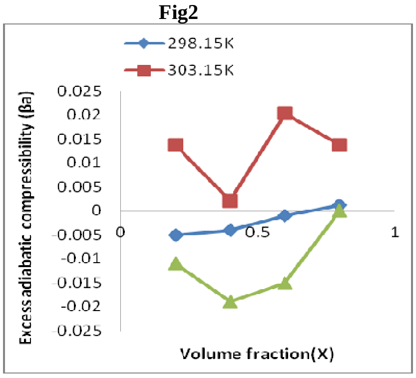

Fig3

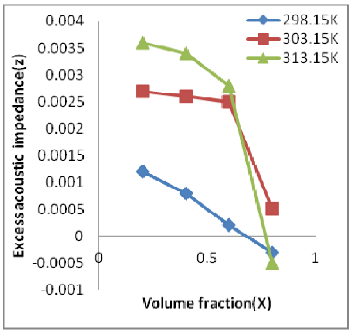

Fig4

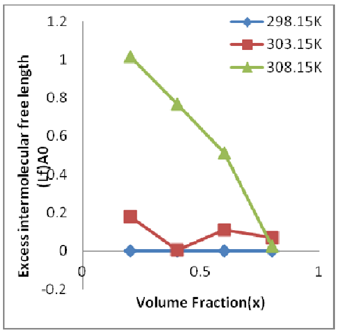

Fig5

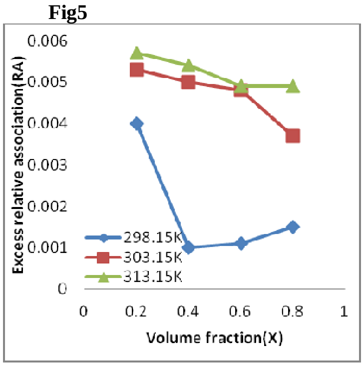

Fig.1.Plot of excess ultrasonic velocity (u^E) against volume fraction(X) for system (1M NaCl+1M Glycine) at 298.15, 303.15, 308.15K temperatures

Fig.2. Plot of excess adiabatic compressibility (β_a^E) against volume fraction (X) for system (1MNaCl+1MGlycine) at 298.15, 303.15, 308.15K temperatures.

Fig.3. Plot of excess acoustic impedance (z^E) against volume fraction (X) of system (1MNaCl+1MGlycine) at 298.15, 303.15, 308.15K temperatures.

Fig.4. Plot of excess intermolecular free length (L_f^E) against volume fraction (x)) for system (1MNaCl+1MGlycine) at 298.15, 303.15, 308.15K temperatures.

Fig.5. Plot of excess relative association (R_A^E) against volume fraction (X) for system (1M NaCl+1MGlycine) at 298.15, 303.15, and 308.15K temperatures.

RESULTS AND DISCUSSION

The ultrasonic velocity, density and viscosity of the liquid systems mentioned have been measured. Using these experimental data, other thermodynamic parameters such as adiabatic compressibility (β_a), intermolecular free length (L_f), acoustic impedance (z) and relative association (R_A) were investigated for four mole fractions of 1M Glycine at frequency 2 MHz and temperatures 298.15, 303.15 and 308.15 K.

For the electrolytic and amino acid liquid systems (1M NaCl + 1M Glycine), ultrasonic velocity (u), density (ρ) and the coefficient of viscosity (η) for various volume fractions of Glycine have been measured at a constant frequency of 2MHz to evaluate u, β_a, L_f, z and R_A. The experimental values of u, ρ, η are given in Table 1 and values of β_a, z, L_f, R_A have been calculated. Using these experimental and calculated data, excess parameters such as excess ultrasonic velocity (u^E), excess adiabatic compressibility (β_a^E), excess acoustic impedance (z^E), excess intermolecular free length (L_f^E), and excess relative association (R_A^E) have been computed. The values of excess parameters have been presented in Tables 2. The graphs plotted between excess parameters (along Y-axis) versus volume fraction (along X-axis) for the liquid system under study as shown in Fig. 1-5.

It is clear from Table2 that the values of u^E are positive at all increasing concentrations of solute except at x=0.2,at 303.15K for (1M NaCl + 1M Glycine) ,thereafter by increasing volume fractions of glycine in the liquid mixtures the values of excess ultrasonic velocity are decreasing. The positive values of β_a^E for the system suggest the presence of weak interaction between unlike molecules. The size of component molecules almost not equal, it is seen that their molecules do not pack well into each other's structures .This results in expansion of volume and hence positive β_a^E. The negative value of β_a^E suggests significant interaction between component molecules in the mixture forming donor –acceptor complex between carbonyl group and ions of electrolytes. As a result there is contraction in volume resulting negative values of β_a^E with volume fraction (X). The values of Excess acoustic impedance z^E are positive at all concentration of volume fractions except at X= 0.8 at all temperatures. The excess value of (L_f) being negative indicate a strong interaction between the electrolyte and glycine .The values of excess relative association (R_A^E) are positive for all concentration the system (1M NaCl+1M Glycine).

CONCLUSION

In glycine ionisable and acceptable groups are more; also glycine is neutral molecule because of its zwitterionic nature. Hence association with electrolyte is more. Glycine is structure maker in inorganic salt solution.

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