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Study of Bulk Modulus, specific heat ratio and relaxation strength of $MgCl_2$ in aqueous solution of glycine at different temperature.

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ABSTRACT

The monumental function of Glycine is as forerunner to proteins it is building block to the numerous natural product. Ultrasonic velocity, viscosity and density of MgCl2 in aqueous glycine solution are determine with the help of ultrasonic velocity meter, Ostwald's viscometer and weighing balance with density bottle. This experimental data accommodate to derive other parameter namely Relaxation strength (r), Specific heat ratio (ϒ) and Bulk modulus (K) at temperature 288.15K and 293.15K. Thus the variation of such parameter with respect to molarities has been explained on the basis of solute- solvent interaction and structure forming tendency of solute in solvent. On varying temperature the different acoustical and thermo-dynamical parameter shows the variation. This indicates that there is presence of intermolecular interaction of systems.

Keywords: Magnesium Chloride, Relaxation Straight, Bulk Modulus, Specific Heat Ratio.

INTRODUCTION

Ultrasonic is multifaceted nondestructive technique and useful to find various physical properties. From last few decades ultrasonic technique is used in determining the molecular interaction and investigation of physiochemical properties. Further ultrasonic technique is very useful tool to determine acoustical, thermo dynamical as well as transport properties of liquid system [1] .

Ultrasonic study on amino acids with aqueous solution of electrolyte provides useful information to understanding the behavior of liquid system.

Many researchers have used ultrasonic technique to investigate the ion solvent interaction in aqueous solution containing electrolytes.[2,3] In the present paper we have used technique for the better understanding of molecular interaction of some solution. The velocity, viscosity, density of glycine in aqueous MgCl2 are measured at 288.15K and 293.15K over the large amount of concentration range.[4]

METHODOLOGY

The experiment was carried out at 288.15K and 293.15K which was maintained by constant temperature water bath has been used to circulated water through the double walled measuring cell made up of steel containing the experimental solution at desire temperature. A digital ultrasonic interferometer was used to determine the ultrasonic velocity of solution. The viscosity of the liquid was measured by Oswald's viscometer which was fabricated by selecting different dimension of the bulk and the capillary. The recent time of the liquid between the viscometer marks is measured using an electronic digital timer. Also measure the flow of water from mark. The weight of empty bottle is measured with the help of weighing balance also measure the weight of density bottle with solution. By putting the value in the formula the density was determine. The other acoustical parameters were determined with the help of ultrasonic velocity, viscosity and density.

Defining relations

By using experimental data of velocity, viscosity and density the various thermodynamic parameters are evaluate by using the following formula.

1.Relaxation strength(r): $\mathbf{r = 1 - \left(\frac{U}{U_{\infty}}\right)^2}$

Where U is velocity of solution and U_{∞} is constant =1600 m/sec.

2.Bulk modulus (K): $\mathbf{K = U^2 \rho}$

Where U is velocity and ρ is density of solution.

3.Specific heat ratio (ϒ): $\Upsilon = \frac{17.1}{T^{4/9} \times \rho^{1/3}}$

RESULTS AND DISCUSSION

variation of experimental measured value of velocity, density, viscosity and various thermo-acoustic parameters of MgCl2 in aqueous glycine solution at different concentration as well as different temperature are tabulated in the table (1), (2), and (3) respectively.

Ultrasonic velocity is an important parameter used to find the Relaxation strength and Bulk modulus. The increase in ultrasonic velocity as shown in fig.(a) with rise in concentration at different temperature shows that the presence of intermolecular interaction among the solute-solute and solute-solvent molecular component.[5] The increase in ultrasonic velocity with rise in temperature for the present system confirmed the greater molecular association between the component of solute and solvent. Hence ultrasonic velocity increases with rise in temperature.

Density is important parameter to find value of specific heat. From fig.(b) it observe that the density increases with increase in concentration of MgCl2 is due to association between the solute and solvent molecule and decreases with rise in temperature.[6-8] From the graph(c) it is observe that viscosity increases with increase in concentration. It is found that, viscosity decreases as the temperature of the system increases this will happen because of temperature increases, the kinetic energy of molecule increases which diminishes the viscosity medium.[9]

Bulk modulus mainly depends on the speed of sound. Figure (d) indicates that the bulk modulus increase with raise in temperature. [10] Bulk modulus is the reciprocal of adiabatic compressibility. The values of bulk modulus increases with increase in concentration in MgCl2.

Figure (e) shows the variation of specific heat ratio at different concentration and temperature. It shows that specific heat ratio decreases with increase in both concentration as well as temperature.[11,12] specific heat ratio depend on density.

Table-1: Utrasonic velocity (U) at 288.15K and 293.15 K temprature respectivly

Concentration mol kg^{-1}	**Ultrasonic Velocity(U)(m/s)**	
	288.15k	**293.15k**
0.0	1495.020	1507.872
0.2	1503.759	1518.533
0.4	1512.416	1524.533
0.6	1520.749	1533.032
0.8	1529.993	1539.147
1	1535.472	1547.169
1.2	1543.456	1554.649
1.4	1549.033	1561.570
1.6	1561.570	1573.669
1.8	1562.835	1587.916
2	1575.597	1589.224

Table-2: Utrasonic density (ρ) at 288.15K and 293.15 K temprature respectivly

Concentration mol kg^{-1}	**Density (kg/m^3)**	
	288.15k	**293.15k**
0.0	959.417	972.9232
0.2	965.6255	980. 9789
0.4	974.3049	989.8825
0.6	975.6303	992.2331
0.8	989.0516	994. 9798
1	992.222	997.7782
1.2	994.757	1000.776
1.4	1004.428	1009.122
1.6	1005.175	1013.330
1.8	1008.165	1018.826
2	1010. 963	1020.660

Table-3: Utrasonic viscosity (η) at 288.15K and 293.15 K temprature respectivly.

Concentration mol kg^{-1}	**Viscosity (kg/ms)**	
	288.15k	**293.15k**
0.0	0.001097	0.001086
0.2	0.001245	0.001122
0.4	0.001355	0.001263
0.6	0.001359	0.001272
0.8	0.001403	0.001346
1	0.001432	0.001387
1.2	0.001459	0.001404
1.4	0.001507	0.001438
1.6	0.001535	0.001443
1.8	0.001664	0.001527
2	0.001859	0.001755

Table- 4: Bulk Modulus (K) at 288.15K and 293.15K temperature respectively.

Concentration mol kg^{-1}	**Bulk modulus (Nm^{-2})**	
	288.15k	**293.15k**
0.0	214437	221211
0.2	218356	229442
0.4	223091	231933
0.6	225400	235201
0.8	231524	237426
1	237047	240755
1.2	239120	243898
1.4	240483	248076
1.6	245548	252305
1.8	247176	257358
2	253008	258192

Table- 5: Specific heat ratio (γ) at 288.15K and 293.15K temperature respectively.

Concentration mol kg^{-1}	**Specific heat ratio**	
	288.15k	**293.15k**
0.0	0.13990	0.13819
0.2	0.13960	0.13777
0.4	0.13917	0.13722
0.6	0.13914	0.13703
0.8	0.13849	0.13629
1	0.13773	0.13609
1.2	0.13781	0.13562
1.4	0.13788	0.13525
1.6	0.13766	0.13488
1.8	0.13742	0.13470
2	0.13711	0.13399

Table- 6: Relaxation Strength(r) at 288.15K and 293.15K temperature respectively.

Concentration mol kg^{-1}	**Relaxation Strength (r)**	
	288.15k	**293.15k**
0.0	0.12691	0.11184
0.2	0.11668	0.09921
0.4	0.10648	0.09208
0.6	0.09661	0.08195
0.8	0.08559	0.07461
1	0.07903	0.06494
1.2	0.06943	0.05588
1.4	0.06269	0.047460
1.6	0.04746	0.03264
1.8	0.04591	0.01504
2	0.03027	0.013424

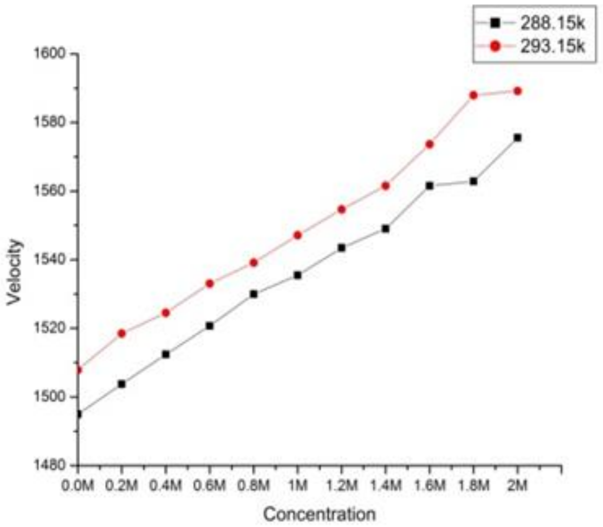

Fig. A

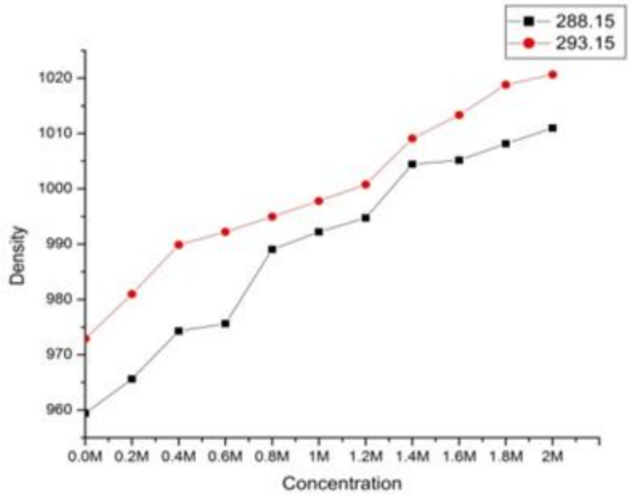

Fig. (b)

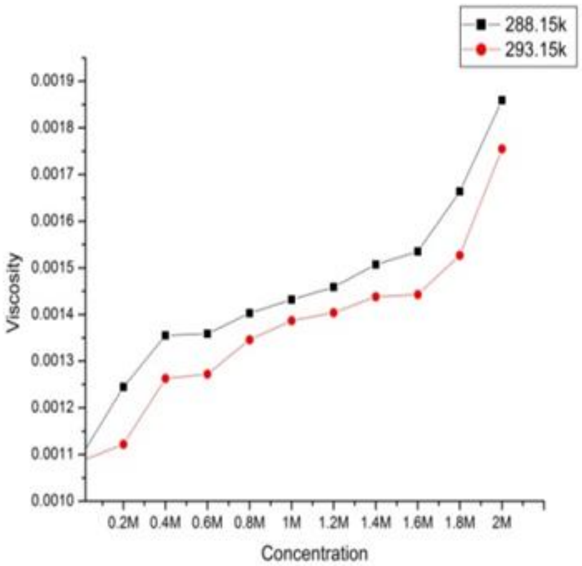

Fig. (c)

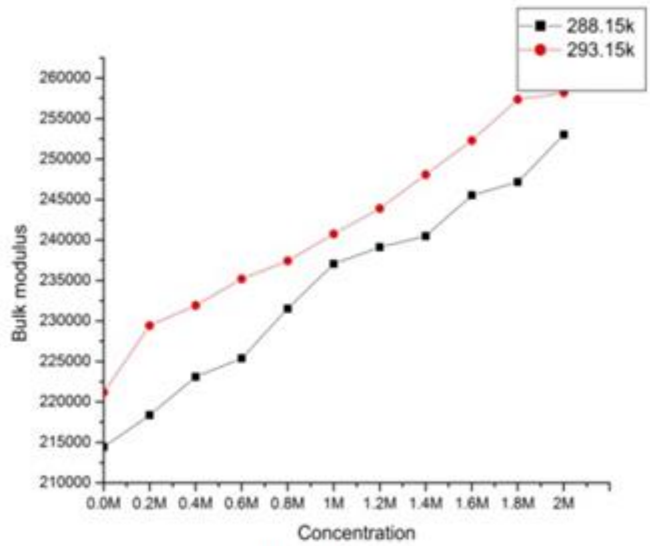

Fig. (d)

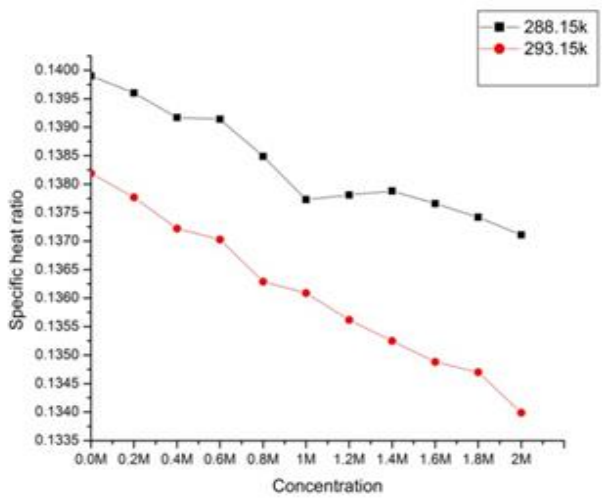

Fig. (e)

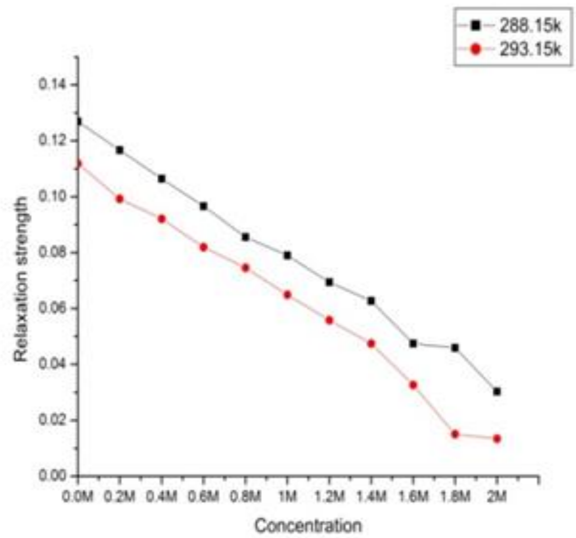

Fig. (f)

The relaxation strength is directly related to adiabatic compressibility. Relaxation strength increases with increase in concentration. Relaxation strength depends on the factor $1 - \frac{U}{U_{\infty}}$ where, U indicated ultrasonic velocity and U_{∞} is constant, has value 1600 m/s. As the ultrasonic velocity increases the relaxation strength also increases. [13-15] Decrease in value of relaxation strength with increase in concentration indicate solute-solvent interaction in the system as shown in fig. (f) Which suggest greater association between the molecule of MgCl2 and glycine.

CONCLUSION

The basic parameters, such as ultrasonic velocity. Density and viscosity of MgCl2 in aqueous glycine solution of different concentration and different temperature initially measured. It may be concluded that there exist of solute-solvent interaction in present system. Increase in the value of bulk modulus (K) and decrease in the value of rest parameter with rise in temperature confirms the presence of solute-solvent interaction in the system.

Conflicts of interest: The authors stated that no conflicts of interest.

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