Transport Properties Of Thiaminehydrochloridein Binary Aqueous Mixtures Of Galactose

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ABSTRACT : Structure proting and breaking capacity of thiamine hydrochloride in binary aqueous mixtures of galactose has been determined in the present study at four equidistant different temperatures by using different transport parameters.It has been found that thiamine hydrochloride acts as structure breaker in binary aqueous solutions of galactose and ion-solvent interactions increase with the increase in temperature.
KEYWORDS : Viscosity, relative viscosity, transport phenomenon, structure maker/breaker .

INTRODUCTION

In recent years, many advances have been made in the study of electrolyte solutions. The study of electrolyte solutions has been expanded in several directions. Aqueous electrolyte solution is a comprehensive coverage of properties of aqueous ionic solutions and solution equilibria. Electrolyte solutions historically set themselves apart from all the ordinary solutions [1-5]. Solubility depends on structural and chemical effects that lead mutual interactions between both solute and solvent. Ion-solvent interactions play a key role in determining the kinetics (rate of reaction) and equilibria of reaction involving electrolytes in solutions[6-10]. The structure of electrolyte solution can be inferred with the help of transport properties of the electrolytic solutions [11-15].

In the solution chemistry, ion-solvent and ion-ion interactions play an important role and the interactions between them are better understood in mixed solvents than in the pure solvents [16-20]. In pre or early formulation, selection of the most suitable solvent plays an important role and is based on the principle of “like dissolves like”. “Like dissolves like” is a rough but useful rule for predicting whether one substance will dissolve in another or not. Water is of course the most generally used solvent system in electrochemistry [21, 22]. Because of its several distinctive properties when compared with other solvents like high density, high thermal conductivity, large surface tension. The intermolecular attractive interactions are stronger in water than all other solvents [23-26].

Study of binary aqueous mixtures can be done with the help of transport properties. With the help of transport properties of the electrolytic solutions, the structure of the electrolyte solution can be detected. The structure making and structure breaking capacity is also determined by transport properties of electrolyte solutions. Transport properties are of course interesting in themselves because they control important reaction rates and also control number of reactions in humans. In this way, transport properties have industrial, biological and practical values [27-29].

Now a day, the knowledge of electrolytic solutions has increased immensely [28-30]. Interactions involving solute-solute and solute-solvent interactions are commonly found in different solution systems. To understand the nature of solute and solvent these interactions play an important role. They give knowledge about whether the solute enhances the structure or distort the structure of the solvent.

MATERIAL AND METHODS

The reagents used thiamine hydrochloride (M.W.=337.27g/mol), galactose (M.W.= 180.156) were of AR grade and purified as per standard procedures.

RESULTS AND DISCUSSION

The densities, viscosities and relative viscosities of thiamine hydrochloride in different binary aqueous solution of galactose (0.1, 0.2, 0.3) m at 303.15 K have been determined and are given in Table-1.

TABLE 1

DENSITIES, VISCOSITIES AND RELATIVE VISCOSITIES OF THIAMINE HYDROCHLORIDE IN DIFFERENT BINARY AQUEOUS SOLUTION OF GALACTOSE AT 303.15K

Molality m (mol Kg^{-1})	**Density $\rho \times 10^{-3}$ (kgm^{-3})**	**Viscosity η (cP)**	**Relative Viscosity η/η_0**
0.1m GALACTOSE			η_0= 0.8193**cP**
0.01	1.00982	0.82330	1.00488
0.03	1.01172	0.82967	1.01266
0.05	1.01359	0.83603	1.02042
0.07	1.01542	0.84238	1.02818
0.10	1.01811	0.85109	1.03880
0.2m GALACTOSE			η_0= 0.8407**cP**
0.01	1.01435	0.84472	1.00478
0.03	1.01624	0.85113	1.01241
0.05	1.01809	0.85754	1.02003
0.07	1.01990	0.86554	1.02955
0.10	1.02257	0.87431	1.03998
0.01	1.01435	0.84472	1.00478
0.3m GALACTOSE			η_0= 0.8572**cP**
0.01	1.02049	0.86124	1.00471
0.03	1.02235	0.86931	1.01412
0.05	1.02418	0.87737	1.02353
0.07	1.02596	0.88379	1.03102
0.10	1.02857	0.89421	1.04318

Values of relative viscosities for the solution of thiamine hydrochloride in different binary aqueous solutions of galactose at 303.15 K increase with the increase in concentration of thiamine hydrochloride. The concentration dependence of relative viscosity η_r of solution of the thiamine hydrochloride in different binary aqueous solutions of galactose can be represented by the Jones –Dole equation. The linear plots have been obtained between $(\eta_r - 1)/\sqrt{c}$ vs $\sqrt{c}$ for all the above mentioned salts in different composition of binary aqueous solution of galactose at 303.15K. A sample plot of ($\boldsymbol{\eta_r - 1)/\sqrt{c}}$ vs $\boldsymbol{\sqrt{c}}$ for thiamine hydrochloride in different composition of galactose is shown in Fig. 1.

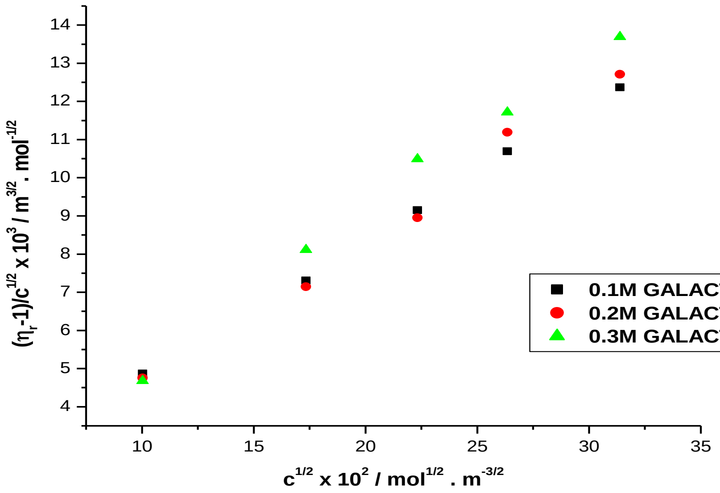

FIG.1. PLOT OF (η_r – 1)/√c vs √c FOR THIAMINE HYDROCHLORIDE IN VARIOUS COMPOSITIONS OF GALACTOSE + H_2O AT 303.15K

Jones –Dole equation parameters (A & B) have been calculated by using the least squares method to the linear plot of (η_r – 1)/√c vs √c and are given in Table-2. Values of the coefficient A were found positive but very small in magnitude for thiamine hydrochloride in whole concentration range of galactose + water at 303.15K resulting into weak solute-solute interactions .

TABLE 2

JONES – DOLE EQUATION PARAMETERS FOR THIAMINE HYDROCHLORIDE (DIFFERENT COMPOSITIONS) IN BINARY AQUEOUS SOLUTIONS OF GALACTOSE AT 303.15K.

Composition of Galactose in Water	**A x 10^3 ($m^{3/2}mol^{-1/2}$)**	**B x 10^3 (m^3 mol^{-1})**
0.1	1.254 (±0.117)	0.354 (±0.005)
0.2	0.726 (±0.457)	0.382 (±0.020)
0.3	0.679 (±0.421)	0.419 (±0.018)

Values of B-coefficient for thiamine hydrochloride in binary aqueous solution of galactose are positive in the entire composition range of binary aqueous mixtures of galactose at 303.15K, thereby showing the presence of well-built solute–solvent interactions and these are further strengthened with the increase of galactose content in water at 303.15K.

EFFECT OF TEMPERATURE

Because of the identical behavior of galactose in different composition of binary aqueous mixtures of galactose at 303.15K, the impact of temperature has been studied only in 0.1m of galactose in water at 298.15K, 303.15K, 308.15K, 313.15K and 318.15K temperatures.

TABLE 3

DENSITIES, VISCOSITIES AND RELATIVE VISCOSITIES FOR THIAMINE HYDROCHLORIDE IN 0.1m GALACTOSE+WATER AT DIFFERENT TEMPERATURES

Molality m (mol Kg^{-1})	**Density ρ x 10^{-3} (kgm^{-3})**	**Viscosity η (cP)**	**Relative Viscosity η/η_0**
TEMPERATURE= 298.15 K			η_0= 0.9142**cP**
0.01	1.01106	0.91860	1.00482

0.03	1.01297	0.92563	1.01250
0.05	1.01484	0.93263	1.02017
0.07	1.01667	0.97378	1.02588
0.10	1.01939	0.94746	1.03638
TEMPERATURE= 303.15 K			**η_0=** 0.8193**cP**
0.01	1.00982	0.82330	1.00488
0.03	1.01172	0.82967	1.01266
0.05	1.01359	0.83603	1.02042
0.07	1.01542	0.84238	1.02818
0.10	1.01811	0.85109	1.03880
TEMPERATURE= 308.15 K			**η_0=** 0.7394**cP**
0.01	1.00821	0.74303	1.00491
0.03	1.01011	0.74881	1.01273
0.05	1.01197	0.75605	1.02252
0.07	1.01379	0.76035	1.02834
0.10	1.01646	0.76971	1.04099
TEMPERATURE= 313.15 K			**η_0=** 0.6687**cP**
0.01	1.00628	0.67202	1.00497
0.03	1.00818	0.67732	1.01289
0.05	1.01004	0.68395	1.02281
0.07	1.01187	0.68924	1.03072
0.10	1.01454	0.69647	1.04153

The values of densities, viscosities and relative viscosities for the various concentration of the solutions of thiamine hydrochloride in 0.1m galactose+ water mixture at varied temperatures have been determined and are given in Table -3 .The plots of $(\eta_r - 1)/\sqrt{c}$ vs $\sqrt{c}$ for the solutions of thiamine in 0.1m galactose+ water mixture at different temperatures have been found to be linear in accordance with Jones –Dole equation. A sample plot for the same is shown in Fig.2

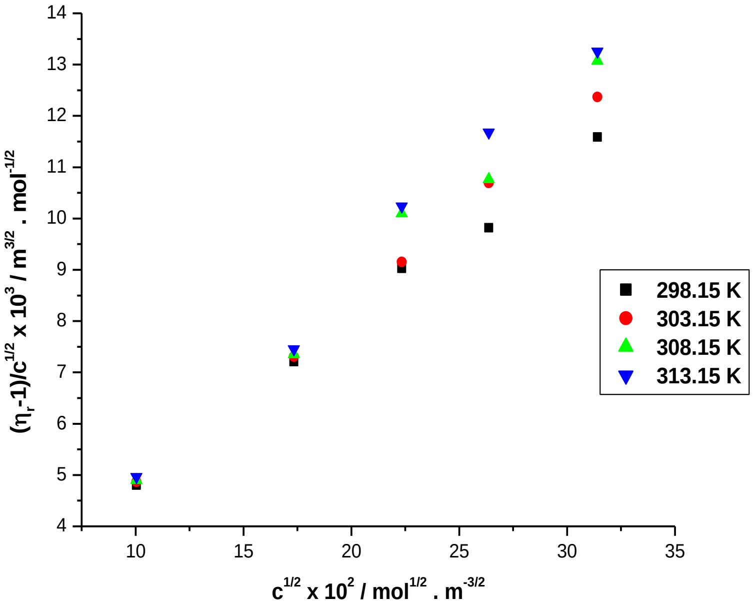

FIG.2 PLOT OF $(\eta_r-1)/\sqrt{c}$ VS $\sqrt{c}$ FOR THIAMINE HYDROCHLORIDE IN 0.1m GALACTOSE+ H_2O AT EQUIDISTANT TEMPERATURES.

TABLE 3

JONES – DOLE PARAMETERS OF THIAMINE HYDROCHLORIDE IN 0.1m GALACTOSE+WATER AT DIFFERENT TEMPERATURES

Temperatures (K)	**A x 10^3 ($m^{3/2}mol^{-1/2}$)**	**B x 10^3 (m^3 mol^{-1})**
298.15	1.733(±0.281)	0.314 (±0.123)
303.15	1.254 (±0.117)	0.354 (±0.005)
308.15	1.014 (±0.561)	0.383 (±0.024)
313.15	0.881 (±0.506)	0.402 (±0.223)

Jones–Dole equation parameters have been calculated by applying least squares method to the linear plots of $(\eta_r - 1)/\sqrt{c}$ vs $\sqrt{c}$ and these values, for the solutions of thiamine hydrochloride in 0.1m galactose+ water at different temperatures were recorded in Table -4. By observing values of A coefficient it is clear that solute-solute interactions are reduced with the increase in temperature leading to more ion solvation. On the other hand values of B – coefficients are positive and increases with rise in temperature indicating the strengthening of solute–solvent interactions with the rise in temperature.

Also values of dB/dT is positive for the solution of thiamine hydrochloride in 0.1m galactose+ water mixture thereby suggesting that thiamine hydrochloride act as structure breaker in galactose+ water mixture.

CONCLUSION: In the present studty thiamine hydrochloride has been found structure breaker in 0.1m galactose+ water mixture and ion – solvent interactions are also found strengthened with the increase in temperature.

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