Vol 4 | Issue 1 | 2014 | 51-54.

e-ISSN 2248 - 9169
Print ISSN 2248 - 9150

International Journal of
Experimental Pharmacology

www.ijepjournal.com

STUDIES OF ACOUSTIC, THERMODYNAMIC AND ADDITIVE PROPERTIES OF SUBSTITUTED HETEROCYCLIC DRUGS IN ETHYL ALCOHOL

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ABSTRACT

Acoustical and additive properties have been measured for substituted heterocyclic drug (Ramipril) in ethyl alcohol at different temperature. The measurement have been perform to evaluate acoustical parameter such as adiabatic compressibility (βs), Partial molal volume, intermolecular free length (L_f), apparent molal compressibility, specific acoustic impedance (Z), relative association (R_A), salvation number (Sn) and also studied the molar polarization, polarisability constant and thermodynamic properties like free energy change, enthalpy change, entropy change of system.

Keywords: Molar polarization, Polarisability constant, Ultrasonic velocity, Intermolecular free length, Relative association.

INTRODUCTION

The substituted heterocyclic drug (2S, 3aS, 6aS)-1-[(2S)-2-{[(2S)-1-ethoxy-1-oxo-4-Phenylbutan -2-yl] amino} propanoyl]-octa hydrocyclopenta[b] pyrrole-2-carboxylic acid (Ramipril). Ramipril is beneficial for cardiovascular events and overt nephropathy in people with diabetes [1**]**. Ramipril used in kidney diseases [2].

The thermodynamic properties of solution are important in chemistry and biology. A study of the viscosities of such solutions was among the earliest in the field of solution chemistry. Agrawal have been studied the activation Gibb's free energy, entropy and enthalpy change by measuring the viscosity of aqueous solution of tetramethyl, tetraethyl, tetra n-propyl, tetran-butyl and tetran-pentyl ammonium cyclohexa sulfamate in the temperature range 293.15 to 323.15 K [3].

In the recent years, measurements of the Ultrasonic velocity are helpful to interpreted solute-solvent, ion-solvent interaction in aqueous and non aqueous medium [4-5]. Fumio

Kawaizumi [5] have been studied the acoustical properties of complex in water. Jahagirdar et. al. has studied the acoustical properties of four different drugs in methanol and he drawn conclusion from adiabatic compressibility . The four different drugs compress the solvent methanol to the same extent but it shows different solute-solvent interaction due to their different size, shape and structure [6]. Meshram et al studies the different acoustical properties of some substituted Pyrazolines in binary mixture acetone-water and observed variation of ultrasonic velocity with concentration [7]. Palani have investigated the measurement of ultrasonic velocity and density of amino acid in aqueous magnesium acetate at constant temperature [8]. The ion-dipole interaction mainly depends on ion size and polarity of solvent. The strength of ion-dipole attraction is directly proportional to the size of the ions, magnitude of dipole. But inversely proportional to the distance between ion and molecules. Voleisines has been studied the structural properties of solution of lanthanide salt by measuring ultrasonic velocity [9]. Syal *et. al*. has been studied the ultrasonic velocity of PEG-8000, PEG- study of acoustical properties of substituted

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heterocyclic compounds under suitable condition [10]. Tadkalkar et al have studied the acoustical and thermodynamic properties of citric acid in water at different temperature [11]. Mishra et al have investigated ultrasonic velocity and density in non aqueous solution of metal complex and evaluate acoustic properties of metal complex [12]. M. Arvinthraj et al have determined the acoustic properties for the mixture of amines with amide in benzene at 303K-313K .They also determined thermodynamic parameters [13]. SK Thakur et al have studied the different acoustical parameters of binary mixture of 1-propanol and water [14].

The refractive index is an important additive property of molecular structure of liquid. The extent of refraction depends on –i) the relative concentration of atom or molecule ii) The structure of atom or molecule. So refractive index gives idea about geometry and structure of molecule. Refraction of light is additive property, but also depends on the structural arrangement of atom in molecule. This can some time be used to determine the structure of an unknown compound whose molecular formula is known.

Sangita Sharma et. al.[15] has been studied density and refractive index of binary liquid mixture Eucalyptol with Hydrocarbon at different temperature. Oswal et al [16] have been studied refractivity properties of some homologous series such as n-ethanoate, methyl alkanoates, ethyl alkanoates etc. were measured in the temperature range from 298.15 to 333.15 ^{0}K

After review of literature survey the detail study of substituted heterocyclic drugs under identical set of experimental condition is still lacking. It was thought of interest to study the acoustical and thermodynamic properties of substituted heterocyclic drug under suitable condition.

MATERIALS AND METHODS

The viscometer put in double wall glass cell. For viscosity measurement Ostwald viscometer (10 ml) was used. The constant temperature was maintained by circulating water through the double wall measuring cell, made up of glass. The flow time was also measured by using digital clock (0.01 Sec).The substituted heterocyclic drugs (Amodiaquine, Carvedilol, Lisinopril, Cloxacillin and Ceftazidime are used in the present study. The density was determined by using specific gravity bottle by relative measurement method with accuracy $1x10^{-5}$ gm/cm^3. The ultrasonic velocity was measure by using ultrasonic interferometer having frequency 3MHz (Mittal Enterprises, Model No F-82) .The constant temperature is mentioned by circulating water through the double wall measuring cell made up of steel.

In the present investigation different parameters such as adiabatic compressibility, apparent molal volume, intermolecular free length (L_f), apparent molal compressibility, specific acoustic impedance (Z), relative association (R_A), Solvation number (S_n) were studied.

$$Adiabetic\ comprressibility(\beta o) = \frac{1}{Uo^2 dc}$$

$$Adiabetic\ comprressibility(\beta s) = \frac{1}{Us^2 ds}$$

$$\text{Apparent molal volume}(\phi_v) = \left(\frac{M}{ds}\right) x \frac{(d_o - d_s)x10^3}{m\ x\ d_s\ x\ d_o}$$

$$\text{Apparent molal compressibility}(\phi_k) = 1000x\ \frac{(\beta_s d_o - \beta_o d_s)x10^3}{m\ x\ d_s\ x\ d_o} + \frac{\beta_s M}{d_o}$$

$$\text{Specific acoustic impedance } (Z) = U_s d_s$$

$$\text{Intermolecular free length } (L_f) = K\sqrt{\square} ds$$

$$\text{Relative association } (R_A) = x\ 1\left(\frac{d_s}{d_o}\right)^{1/3}$$

$$\log\left[\frac{\eta r_2}{\eta r_1}\right] = \frac{\Delta H}{2.303R}[T_2 - T_1]/[T_1 T_2]$$

$$(\Delta G - \Delta H)/T = \Delta S$$

$$\text{Molar polarisation}(Rm) = \frac{(n^2-1)}{(n^2+2)} x \frac{M}{d} = \frac{4\pi N\alpha}{3}$$

Results and discussion:-

In the present investigation, different thermodynamic parameters, such as adiabatic compressibility, Partial molal volume, intermolecular free length (L_f), apparent molal compressibility, specific acoustic impedance (Z), relative association (R_A), salvation number (Sn).

From table-1, these found that ultrasonic velocity increases with increase in temperature. Such an increase in ultrasonic velocity clearly shows that molecular association is being takes place in these mixtures. Variation of ultrasonic velocity in solution depends upon the increase or decrease of molecular free length after mixing the component, based on a model for sound propagation proposed by Eyring and Kincaid [17]. It was found that, intermolecular free length decreases linearly on increasing the temperature of solution. The intermolecular free length decrease due to less force of interaction between solute and solvent by forming hydrogen bonding. This was happened because there is less significant interaction between ions and solvent molecules suggesting a structure promoting behavior of the added electrolyte .This may also indicates that increase in number of free ions showing the occurrence of ionic association due to stronger ion-ion interaction. The value of specific acoustic impedance (Z) increases with increase in temperature. The increase of adiabatic compressibility is decrease with increase in temperature may be due to loss of solvent molecule around ions, this supporting stronger ion-solvent interaction. This indicates that there is not significant solute-solvent interaction. The decrease in adiabatic compressibility following a increase in ultrasonic velocity showing there by stronger intermolecular interaction.

From table-2, it is observed that apparent molal volume increases with decrease in temperature indicates the existence of strong ion-solvent interaction. The values of apparent molal volume are all negative values indicate the presence of solute solvent interaction [18] .The value of apparent molal compressibility is decrease with increase in temperature. It shows weak electrostatic attractive force in the vicinity of ions. It can be concluded that weak molecular association is found in solution. The value of relative association increases with increase in temperature of system. It is found that there is strong interaction between solute and solvent.

The Solvation number decrease with increase in temperature due to strong solute-solvent interaction. There is regular decrease in solvation number with increase temperature indicates the decrease in size of secondary layer of Solvation. The Solvation number in all system decreases with increase in temperature indicates the solvent molecule forms weak coordination bond in primary layer.

The rise of the temperature is accompanied by a decrease of the viscosity of the solution. The rise of the temperature is accompanied by a decrease of the density of the solution. The table 1 shows values of viscosity and density at different temperature. The thermodynamic functions of viscous flow were estimated from the dynamic Viscosity values. Flow process is governed by the ability of molecule to move into the prepared hole and the readiness with which the holes are prepared in the liquid.

The values of Gibb's free energy were calculated. The values of Gibb's free energy were determine and are given in table 2. The values of Gibb's free energy are negative. The values of enthalpy change in reaction were determined and are also negative in all systems. From the values of □G and □H, the reaction is spontaneous and exothermic in nature. The values of entropy change were determined from equation. The positive value of entropy change indicates the reaction must be spontaneous process of flipping of molecule over each other. Entropy change was positive due the destruction of hydrogen bond in compounds.

Table 1. Ultrasonic velocity, density, adiabatic compressibility, Specific acoustic impedance (Z) Intermolecular free length (L_f) at different temperature

Temperature(K)	Density (ds) Kg m-^{3}	Ultrasonic velocity (Us) m s^{-1}	Adiabatic compressibiliy x10^{-10}m^{2}N^{-1}	Intermolecular free length (L_f) x10^{-11}m	Specific acoustic impedance (Zx10^6)kg m^{-2} s^{-1}
Ramipril + Ethyl alcohol					
298	993.95	1040.20	9.2983	6.13279	1.03391
303	993.59	1046.64	9.1875	6.09616	1.03993
308	992.72	1050.13	9.1346	6.07856	1.04249
313	992.32	1055.68	9.0424	6.04782	1.04757
318	991.54	1059.34	8.9871	6.0293	1.05038

Table 2. Relative association (R_A), apparent molal compressibility, apparent molal volume, Solvation number (S_n) -

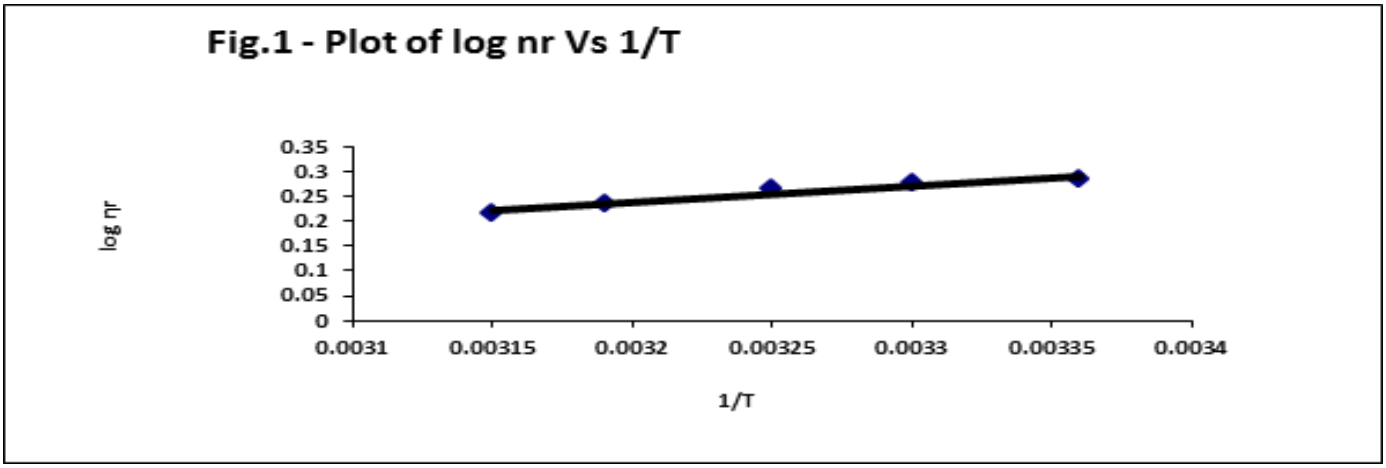
Temperature(K)	Apparent molal volume m^{3}mole^{-1}	Apparent molal compressibility m^2 N^{-1}	Relative association (R_A)	Solvation number (S_n)
Ramipril + Ethyl alcohol				
298	26.3251	3.78592	1.20703	0.34581
303	26.9816	3.74176	1.21691	0.34013
308	27.5953	3.72323	1.22261	0.33259
313	28.2662	3.68681	1.22853	0.32524
318	28.7860	3.66689	1.23258	0.31850

Table 3. Viscosity measurement and thermodynamic parameters at different temperature

Temp.(K)	1/T	Density (Kg/M^3)	Time (Sec)	η_r	log η_r	ΔG (JM^{-1}K^{-1})	-ΔH (JM^{-1}K^{-1})	ΔS (JK^{-1})
Ramipril + Ethyl alcohol								
298	0.00336	993.95	148	1.9244	0.2843	-6423.87	--	--
303	0.00330	993.59	129	1.8838	0.2750		1678.72	15.661
308	0.00325	992.72	117	1.8352	0.2637		3739.17	-12.140
313	0.00319	992.32	108	1.7129	0.2337		9177.60	-29.321
318	0.00315	991.54	98	1.6449	0.2161		12370.0	-38.899

Table 4. The values of molar refraction and polarizability constant at different temperature

Temp.(K)	Density (Kg/M^3)	R.I. (η)	Rmx10^5	α□x 10^{-29}
298	993.95	1.3384	8.7565	3.47
303	993.59	1.3363	8.7104	3.45
308	992.72	1.3351	8.6898	3.44
313	992.32	1.3230	8.6439	3.42
318	991.54	1.3290	8.5562	3.39



CONCLUSION

In the present study mentions the experimental data for ultrasonic velocity, density at different temperature for substituted heterocyclic drug in ethyl alcohol. From experimental data calculated acoustical parameters and studied to explanation solute-solvent interaction and ion-ion / solute-solute interaction are existing between drugs and organic solvent mixture. From experimental data it can be conclude that weak solute-solvent interaction in all systems. The viscous flow of this substituted heterocyclic drug in ethyl alcohol is thermodynamically spontaneous and exothermic process. Because gibbs free energy change and enthalpy change are negative and entropy change is positive which is indicate the spontaneity of reaction according to thermodynamics.

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