EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 3
Issue: 11
254-257
Year: 2016

ULTRASONIC VELOCITY, DENSITY MEASUREMENT OF SYNTHESIZED SCHIFF BASES IN ETHANOL AT 303K

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Article Received on 26/08/2016 **Article Revised on 16/09/2016** **Article Accepted on 06/10/2016**

ABSTRACT
In the present investigation, some important acoustical parameters such as ultrasonic velocity, intermolecular free length, specific acoustic impedance, relative association, adiabatic compressibility, apparent molal compressibility, apparent molal volume, of synthesized Schiff bases in 70% ethanol-water mixture at 303 K have been studied. With help of experimental data, the effect of concentration of solute on different acoustical parameters in ethanol-water mixture has been studied and interprets solute-solvent, solute-solute interaction in the system.

KEYWORD: Ultrasonic velocity, intermolecular free length, relative association.

INTRODUCTION
The molecular interactions in the liquid mixtures is very important to study the structural properties of molecules and great deals of interest in investigating the solute-solute, solute-solvent and solvent-solvent molecules. The measurements of ultrasonic velocity are helpful to interpret solute-solvent, ion-solvent and solvent-solvent interaction in aqueous and non-aqueous medium. The ultrasonic studies are useful in extensive research in different field of science.[1-4] This is because of its ability of characterizing physicochemical behavior of liquid medium.[5-6] The ultrasonic velocity measurement is highly sensitive to molecular interaction and can be used to provide qualitative information about the physical nature and strength of molecular interaction in the liquid mixture.[7-9] The measurements of ultrasonic velocity are helpful to interpreted solute- solvent, ion-solvent interaction in aqueous and non-aqueous medium.[10-11] Numerous workers have done the acoustical study by the measurement of density and ultrasonic velocity of different aqueous and non-aqueous system at different temperature, different concentration of solute and in different percentage of organic solvent[12-14] Tayade et al[15] have been studied the investigations of acoustic parameters of (4S,6S,12aS)-4-(dimethylamino)-1,4,4a,5,5a,6,11,12 a-octahydro-3,6,10,12,12a-pentahydroxy- 6-methyl-1,11-dioxonaphthacene-2-carboxamide at different concentrations at 296° K in 60% ethanol-water mixture by using single crystal interferometer with frequency 1 MHz. Mirikar et al[16] have been studied the ultrasonic velocity, density and viscosity measurement of amino acid in aqueous electrolytic solutions at 308.15° K by using an ultrasonic interferometer working at 2 MHz frequency. It is observed that there is existence of solute-solvent and solute-solute interactions in the system. Godvani et al[17] have been investigated the studies of molecular interactions in solutions of phenylephrine drug at 308.15° K by using single crystal variable path ultrasonic interferometer operating at 2 MHz. The authors reported that the density, ultrasonic velocity and viscosity increases with concentration. Aswale et al[18] have been studied the ultrasonic investigation of molecular interaction in paracetamol solution at different concentrations and at 303° K. The present paper deals with the effect of concentration on acoustical parameters of synthesized Schiff bases at 303 K.

Experimental
The schiff base ligand N'-(7-hydroxy-4methyl-2-oxo-2H-chromen-8-yl) methylene) isonicotinohydrazide (HMCMIH) were synthesized in the laboratory by literature method.[19] The characterization of ligand was carried out by FTIR and NMR spectroscopy. All the chemicals used are of good analytical grade (AR). The ethanol was purified by the method described by Vogel.[20] The solution of different concentration of ligand was prepared by dissolving required amount of ligand in purified ethanol solvent. The density of solvent and solutions were measured by specific gravity bottle

having 10 ml capacity. The ultrasonic velocities were measured by using ultrasonic interferometer having frequency 2 MHz (Mittal Enterprises Model No. F-81). The constant temperature was maintained by circulating water through the double wall measuring cell, made up of glass.

Theory and Calculation

The sound velocity of ligand was measured in the concentration range of 1 $x10^{-3}$ to 9 $x10^{-3}$ M in 70% ethanol-water mixture.

The wavelength of ultrasonic wave is calculated using relation,

$2D = \lambda$ ---------- (1)

Where, λ is wave length and D is distance in mm.

The ultrasonic velocity is calculated by using relation,

Ultrasonic velocity (U) = λ x Frequency x 10^3 ---------- (2)

Some acoustical parameters have been calculated using the standard relations.

The adiabatic compressibility (βs) of solvent and solution are calculated by using equations,

Adiabatic compressibility solution (βs) = $1/ U_s^2 \times d_s$ ---------- (3)

Adiabatic compressibility solvent ($\beta 0$) = $1/ U_0^2 \times d_0$ ---------- (4)

Acoustic impedance (Z) = $U_s \times d_s$ ---------- (5)

Where, U_0, d_0, β_0 and U_s, d_s, βs are ultrasonic velocity, density and adiabatic compressibility of solvent and solution respectively.

Intermolecular free length (L_f) = $K\sqrt{\beta s}$ ---------- (6)

Relative association (R_A) = $(ds /d0) \times (U0 /Us)^{1/3}$ ---------- (7)

Where, K is Jacobson's constant[21] is calculated by using relation,

$K= (93.875+0.375xT) \times 10^{-8}$ ---------- (8)

Where, T is temperature at which experiment is carried out.

Apparent molal compressibility (ϕ_k) has been calculated by using the relation,

$$(\phi_k) = 1000 X \frac{\beta s\, d_0 - \beta_0\, ds}{m \times ds \times d_0} + \frac{\beta s \times M}{ds} \quad \text{---------- (9)}$$

Apparent molal Volume (ϕ_v) has been calculated by using the relation,

$$(\phi_v) = \frac{M}{ds} X \frac{(d_0 - ds) \times 1000}{m \times ds \times d_0} \quad \text{---------- (10)}$$

$\phi_k = \phi_k^0 + S_k C$ ---------- (11)

$\phi_v = \phi_v^0 + S_v C$ ---------- (12)

RESULT AND DISCUSSION

In the present investigation, different acoustical properties such as ultrasonic velocity (Us), adiabatic compressibility (βs), intermolecular free length (L_f), specific acoustic impedance (Z), are listed in table-1. Partial molal volume (ϕ_v), apparent molal compressibility (ϕ_k), relative association (R_A), solvation number (Sn) are listed in table-2. Limiting apparent molal compressibility (ϕ_k^0), limiting apparent molal volume (ϕ_v^0) and their constant (S_k, S_v) are listed in table-3.

It is found that ultrasonic velocity increases with increase in concentration. The variation of ultrasonic velocity in solution depends upon the increase or decrease of intermolecular free length after mixing the solute. The intermolecular free length (Lf) decreases on increasing the concentration of solute hence increase in ultrasonic velocity with the concentration. This indicates that there is a strong interaction between ion and solvent molecules which suggesting a structure promoting behavior of the added solute. The value of specific impedance increases with increase in concentration of solute in ethanol solvent. The specific acoustic impedance is directly proportional to ultrasonic velocity and inversely proportional to adiabatic compressibility and shows similar behaviour to that of ultrasonic velocity and opposite to that of adiabatic compressibility. It was found that the value of adiabatic compressibility decreases with increase in concentration of solution indicates that there is strong solute-solvent interaction and the solution is becoming more and more compressible. The decrease in adiabatic compressibility with increase in concentration of solution may be due to aggregation of solvent molecule around solute molecules indicate the presence of solute-solvent interaction.

The relative association is measure of extent of association of the component in the mixture. The value of relative association decreases with increase in concentration indicates strong interionic interaction between solute and solvent. There were regular increases in solvation number with the increase in concentration; it indicates the solvent molecule forms strong coordination bond in primary layer. It indicates the increase in size of secondary layer of solvation.

It was observed that apparent molal volume increased with concentration in system. It indicates the existence of strong ion-solvent interaction. It was found that the value of apparent adiabatic compressibility decreases with increase in concentration indicates that there is strong solute solvent interaction. It shows weak electrostatic attractive force in the vicinity of ions causing electrostatic salvation of ions. It can be concluded that weak molecular association is found in all substituted heterocyclic drugs and synthesized schiff bases in ethanol.

The values of ϕ_k^0 and S_k are presented in table- 3. The value of limiting molal compressibility gives information about solute-solvent interaction. The positive values of ϕ_k^0 indicate weak solute-solvent interaction is present in solution. The values of S_k are negative for all the ligands which indicate there is weak solute-solute interaction. The values of ϕ_v^0 and S_v are positive for all the ligands which are presented in table- 3. The positive values of ϕ_v^0 indicate that solute-solute interactions predominate. The positive values of S_v indicate the presence of solute-solvent interaction over solute-solute interaction.

Table-1 Ultrasonic velocity, density, adiabatic compressibility (β_S), Specific acoustic impedance (Z) Intermolecular free length (L_f).

Conc. Moles/ lit (m)	Density (ds) Kg m-^{3}	Ultrasonic velocity (Us) m s^{-1}	Adiabatic compressibiliy (β_S) x10^{-10} m^{2}N^{-1}	Inter molecular free length (L_f) x10^{-11}m	Specific acoustic impedance (Zx10^6) kg m^{-2} s^{-1}
HMCMIH + Ethanol					
1x10^{-3}	794.24	1158.16	9.3867	6.1619	9.1985
2x10^{-3}	794.33	1160.58	9.3465	6.1487	9.2188
3x10^{-3}	794.37	1163.88	9.3238	6.1412	9.2455
4x10^{-3}	794.39	1166.52	9.2929	6.1310	9.2667
5x10^{-3}	794.43	1170.48	9.2771	6.1258	9.2986
6x10^{-3}	794.46	1172.64	9.25	6.1169	9.3161
7x10^{-3}	794.49	1175.96	9.1872	6.0961	9.3428
8x10^{-3}	794.51	1179.84	9.1804	6.0938	9.3739
9x10^{-3}	794.54	1187.90	9.1528	6.0846	9.4383

Table-2 Concentration (m), relative association (R_A), apparent molal compressibility (ϕ_k), apparent molal volume (ϕ_v), solvation number (S_n)

Conc (m) Moles/lit	Apparent molal volume (ϕ_v) m^{3}mole^{-1}	Apparent molal compressibility (ϕk) x 10^{-10} m^2 N^{-1}	Relative association (R_A)	Solvation number (S_n)
HMCMIH + Ethanol				
1x10^{-3}	0.2482	3.8174	0.9935	0.9733
2x10^{-3}	0.2561	3.8005	0.9926	0.9690
3x10^{-3}	0.2851	3.7784	0.9912	0.9633
4x10^{-3}	0.3076	3.7609	0.9901	0.9589
5x10^{-3}	0.3147	3.7349	0.9885	0.9522
6x10^{-3}	0.3221	3.7207	0.9876	0.9486
7x10^{-3}	0.3274	3.6992	0.9863	0.9432
8x10^{-3}	0.3333	3.6745	0.9847	0.9369
9x10^{-3}	0.3362	3.6240	0.9814	0.9240

Table-3 Limiting apparent molal compressibility (ϕ^0_k), limiting apparent molal volume (ϕ^0_v), S_v and S_k

Ligand	Limiting Apparent molal volume (ϕ^0_v) m^{3}mole^{-1}	Limiting Apparent molal compressibility (ϕ^0_k)x 10^{-10} m^2 N^{-1}	S_v M^{3}kg$^{1/2}$ Mole-$^{3/2}$	S_k M^{3}mole^{-2} kg.Pa^{-1}
HMCMIH	0.200	3.927	2.322	-2.842

CONCLUSION

The present study shows the experimental data for ultrasonic velocity, density at 303K for synthesized schiff base (HMCMIH) in 70% ethanol. From experimental data, the acoustical properties were calculated. The solute-solvent interaction and ion-ion / solute-solute interaction existing between schiff base and ethanol were also studied with the help of experimental data. Lastly it has been concluded from the experimental data, that the solute-solvent interaction in schiff base and ethanol systems are strong.

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