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Ultrasonic Behavior and Study of Molecular Interaction Synthesized Schiff Base Ligand in Different Percentage of Ethanol – Water Mixture.

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ABSTRACT

Ultrasonic velocity and density measurement of synthesized Schiff base ligand were carried out in different percentage of ethanol-water mixture at 303 K. The obtained experimental data have been used to evaluate acoustical parameters such as intermolecular free length, specific acoustic impedance, relative association, adiabatic compressibility, apparent molal compressibility, and apparent molal volume. These parameters are used tointerpret solute-solvent, solute-solute interaction in the system.

Keyword-Ultrasonic velocity, intermolecular free length, relative association.

I. INTRODUCTION

The ultrasonic velocity technique is one of the most powerful techniques for studying the nature of intermolecular interaction in liquid. The ultrasonic velocity and other acoustic parameters can be measured with great accuracy and provides a powerful way to determine intermolecular interactions. 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 measurements of ultrasonic velocity are helpful to interpreted solute- solvent, ion-solvent interaction in aqueous and non-aqueous medium[**7-8]**.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[**9-11]**.The ultrasonic and viscometric studies of α amino acids in different percentage of aqueous dioxane systems have been carried out by Raut et al**[12]**. The ultrasonic interferometric investigations of 3-(chloroaryl)-5-aryl-1-substituted pyrazolines in different percentage of dioxane medium at different temperature have studied by Deshmukh and Raghuwanshi**[13]**. They are reported that the ultrasonic velocity decreases with increase in percentage of organic solvent.Thorat S. A. and Thakur S. D.have studied theultrasonic behaviour and molecular interaction of substituted 3,5-diaryl isoxazoline in different percentage DMF-water mixture at 305 K. They reported that there is weak solute-solvent interaction in all systems**[14]**. Deosarkar et al investigated the acoustical studies of some pyrazoles in different percentage of dioxane-water mixture at 303.15 k at 2 MHz frequency. They observed that the interactions areexist between pyrazoles and dioxane water mixture and solute-solvent interactions are more favorable than other interactions**[15]**. The

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ultrasonic behviour and study of molecular interactions of chalcone in dioxane at different concentrations and in different percentages of dioxane- water mixture at 305 K at 1 MHz frequency have been investigated by Pathare**[16]**. The present paper deals with the effect of different percentage of ethanol solvent on acoustical parameters of synthesized Schiff base ligand at 303 K.

II. EXPERIMENTAL

The schiff base ligand 8-((6-methoxybenzo[d]thiazol-2-ylimino) methyl)-7-hydroxy-4-methyl-2H-chromen-2-one (MBMHMC) were synthesized in the laboratory by literature method[**17**]. 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**[18]**. The solution of solute was prepared by dissolving required amount of ligand in different percentage of purified ethanol solvent. The acoustical parameters are determined at fixed concentration of solute 1 x 10^{-2} M. 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 3MHz (Mittal Enterprises Model No. F-81).The constant temperature was maintained by circulating water through the double wall measuring cell, made up of glass.

III. THEORY AND CALCULATION

The sound velocity of ligand was measured in different percentage of ethanol-water mixture.

The wavelength of ultrasonic wave is calculated using relation,

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

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

The ultrasonic velocity is calculated by using relation,

Ultrasonic velocity (U) = $\lambda \times$ Frequency $\times 10^3$ ---------------------------------- (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 (β0) = $1/ U_0^2 \times d_0$ -------------------------- (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) = $(ds /d_0) \times (U_0 /Us)^{1/3}$ -------------------------------- (7)

Where, K is Jacobson's constant**[19]** 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,

$\beta s\ d_0 - \beta_0\ ds$ $\beta s \times M$

(ϕ_k) = 1000 X -------------------- + ----------- --------------------------------- (9)

m x ds x d_0 ds

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

M $(d_0 - ds)$ x 1000

(ϕ_v) = ------ X ---------------------- ---------------------------------- (10)

ds m x ds x d_0

$\phi_k = \phi_k^0 + S_kC$ --- (11)

$\phi_v = \phi_v^0 + S_vC$ -- (12)

IV. 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. It is found that ultrasonic velocity decreases with increase in percentage of ethanol. The ultrasonic velocity is related to intermolecular free length. The variation of ultrasonic velocity in solution depends upon the increase or decrease of intermolecular free length after mixing the solute is based on a model for sound propagation proposed by Eyring and Kincaid**[20]**. The intermolecular free length (Lf) increases with increasing the percentage of ethanol hence decrease in ultrasonic velocity with increasing the percentage of ethanol. This indicates that there is a weak interaction between ion and solvent molecules which suggesting a structure non-promoting behavior of the added solute. This also implies increase in number of free ions showing the occurrence of ionic dissociation due to weak ion-ion interactions. The value of specific acoustic impedance decreases with increase in the percentage of ethanol for given system. This is due to decrease in the strength of intermolecular attraction. 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 increases with increase in percentage of ethanol indicates that there is weak solute-solvent interaction may be due to departure of solvent molecules around ions. The relative association is the property used to understand the interaction in solution. The relative association is measure of extent of association of the component in the mixture. The value of relative association decreases with increase in percentage of ethanol. This is due to the breaking up of the associated solvent molecules on addition of ethanol in it.The solvation number decreases with the increase in percentage of ethanol solvent for synthesized schiff base ligand. It indicates weak solute-solvent interaction and decrease in size of secondary layer of solvation and also indicates the solvent molecules form weak coordination bond in primary layer.

It was observed that apparent molal volume increased with increase in percentage of ethanol solvent the system. It indicates the existence of strong ion-solvent interaction.The apparent molal volume increases due to decreasing dielectric constant of medium with increase in percentage of ethanol solvent. The value of apparent molal compressibility increases with increase in percentage of ethanol for the system. The positive value of apparent molal compressibility shows the strong electrostatic attractive force in the vicinity of ions causing electrostatic solvation of ions.

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

% Ethanol	Density (ds)Kg m^{-3}	Ultrasonic velocity (Us) m s^{-1}	Adiabatic compressibiliy (β_S) x$10^{-10}m^2N^{-1}$	Intermolecular free length (L_f) x10^{-11}m	Specific acoustic impedance (Zx10^6)kg m^{-2} s^{-1}
MBMHMC + Ethanol					
10	795.7	1624.36	4.7631	4.3894	1.2925
20	795.55	1615.78	4.8147	4.4131	1.2854
30	795.32	1598.72	4.9194	4.4608	1.2714
40	795.15	1577.28	5.0551	4.5219	1.2541
50	795.02	1553.02	5.2152	4.5929	1.2346

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

% Ethanol	Apparent molal volume (ϕ_v)m^3mole^{-1}	Apparent molal compressibility (ϕk) x $10^{-10}m^2 N^{-1}$	Relative association(R_A)	Solvation number (S_n)
MBMHMC + Ethanol				
10	0.0187	2.1959	0.9954	0.9795
20	0.0344	2.2201	0.9953	0.9790
30	0.0660	2.2690	0.9944	0.9758
40	0.0975	2.3319	0.9907	0.9615
50	0.1292	2.4060	0.9891	0.9554

V. CONCLUSION

The present study shows the experimental data for ultrasonic velocity, density at 303K for synthesized schiff base (MBMHMC) in 70% ethanol. From experimental data, the acoustical properties werecalculated. The solute-solvent interaction and ion-ion / solute-solute interaction existing between schiff base ligand and different percentage of 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 weak.

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