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Investigation of Acoustical Behavior of Dichlofenac sodium drug in Ethanol at Different Temperature

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Abstract: ***The approach of this work to evaluate the various physic-chemical behaviors of liquid system with respect to temperature and the outcome indicates the structural sense and interactions in the liquid mixture. Physic-chemical investigations play a vital role to understand the nature and strength of molecular aggregation that exist in binary liquid system and their sensitivities to variations in composition and the molecular structure of pure components. The drug-solvent molecular interactions play an important role in the understanding of drug action. In the present investigation we tried to study of various molecular interactions in alcohol solution of dichlofenac sodium by measuring ultrasonic velocity, density, viscosity and thermodynamic parameters at 2 MHz at different temperature with different concentrations. The variation of acoustic and thermodynamic parameters are indicates different kind of molecular interactions, physic-chemical behavior and their strength.***

Keywords Ultrasonic velocity, density and Acoustical parameters, Dichlofenac sodium, Ethanol.

1. Introduction

The mechanism of pharmacokinetics and pharmacodynamics of any drug, in medicinal and drug chemistry, the viscometric, refractometric and interferometric measurements play an important role [1-3].Viscometric, refractometric and interferometric measurement methods are very useful to sort out suitable interactions in the drug solution. Drug activity and drug effect can be explained by knowing suitable types of interactions. Drug action, although complex result from various kinds of physico-chemical interactions, eg. Ion-dipole, ionic or covalent, hydrogen bonding, charge transfer interactions, hydrophilic interactions etc.[4,5]. formokinetic processes involve transport of drug across biological membranes, which can be understood by transport property measurements such as ultrasonic velocity, viscosity, thermal conductivity and diffusion. Diclofenac sodium is a nonsteroidal anti-inflammatory drug (NSAID) with analgesic and antipyretic properties. It has been found to relieve pain, reduce fever, swelling and tenderness, and increase mobility in patients with rheumatic disorders. Diclofenac sodium is rapidly and almost completely absorbed and distributed to blood, liver, and kidney. When drug is absorbed and transmitted in blood; the drug metabolism starts and at last there occurs excretion of bye-product, if formed. All systems in the body directly or indirectly take part in this process. Each step in the pharmacokinetics and pharmacodynamics depends on solute-solvent, solute-solute-solvent and solute-solvent-solvent interactions.[6-8]. The vital role of acoustic methods to identify the physiochemical interactions of the solution and method related to ultrasonic velocity measurements in minimum volumes of liquids [9-11]. Most of the information procured from ultrasonic study of fluids is confined to the determination of hydration number and compressibility [12-14]. The dependence of acoustical parameters on composition and temperature resulting from molecular interaction between components of liquid mixture [15-17].

The present paper deals with the measurement of density, viscosity, speed of sound, internal pressure, surface tension etc.in the liquid mixture of diclofenac sodium and ethanol at different temperatures i.e. 10ºC,15ºC,20ºC. Ultrasonic technique investigation is to study molecular interaction, drug absorption, transmission activity of alcoholic drug solution.

2. Materials and Methods

The solvent ethanol and analgesic drug tramadol were used AR grade (E-Merck chemicals, Germany) without further purification. The purity of chemicals has been checked out by comparing the ultrasonic velocity, densities data with standard literature value [18-19]. All the measurement of ultrasonic velocity of the solution by using ultrasonic interferometer supplied by Vi-Micro system, Chennai (Model VCT: 71) having frequency 2 MHz with on overall accuracy of 0.0001 m/s. The densities of solution are measured using 10 ml specific gravity bottle. Specific gravity bottle having accuracy of $\pm$ 2 X10^{-2} kg/m^3.Automatic temperature controller water bath supplied by Lab-Hosp Company Mumbai having accuracy ±1K temperature. Viscosities were measured at desired temperature using Oswald's viscometer; the viscometer has been calibrated using doubled distilled water with literature value. The time flow of doubled distilled water and experimental solution are measured with digital stop clock having accuracy of 0.01 sec (Model: RACER- 10W).Weights were measured with an electronic digital balance (Contech CA-34) having accuracy 0.0001gm. By the above experimental set up utilized to determine the ultrasonic and thermo-acoustic parameters in mixtures of ethanol and diclofenac at T= (283.15K-293.15K) at various molar concentrations.

The formulation of ultrasonic and thermo-acoustic parameters as follows

Adiabatic Compressibility **(β) =1 / U^2ρ** …… (1)

Specific Acoustic Impedance **(Z) = U ρ**…….. (2)

Intermolecular Free Length **(L_f) = K_T $\beta^{1/2}$** ……(3)

Relaxation Time **(τ) = (4/3)*β*η**…… (4)

Relative association **(Ra) = (ρ/ ρ_0) (U_0 / U)$^{1/3}$** …….(5)

Internal Pressure **(P) = bRT (K η / U)$^{1/2}$x (ρ$^{2/3}$/ M$^{7/6}$eff)** ……..(6)

Free Volume **(V_f) = (M_{eff} U / η K)$^{3/2}$** ……(7)

Molar volume **(Vm) = Meff /ρ**……. (8)

Surface Tension **(σ) = (6.3 x10^{-4}) ρU$^{3/2}$** ……..(9)

3. Data interpretation by graphical tactic as follows

Following figures are various ultrasonic and thermo-acoustic parameters V/S molarity

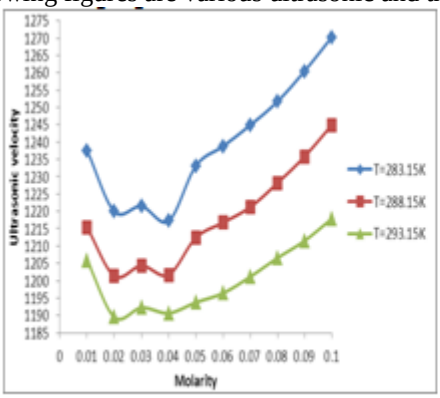

Figure 1: Ultra.Velocity

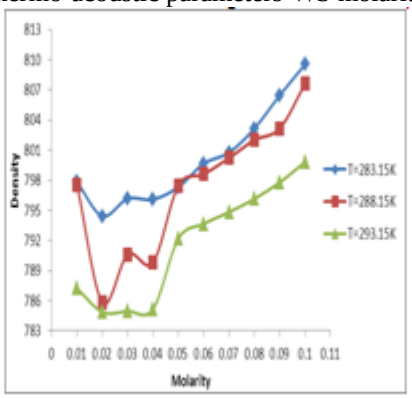

Figure 2: Density

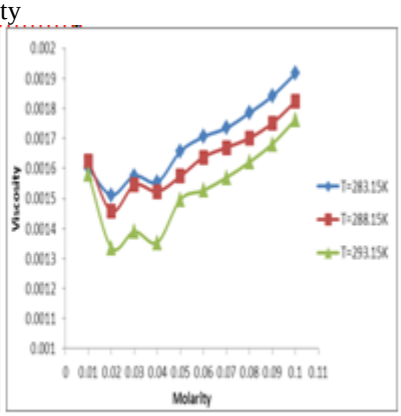

Figure 3: Viscosity

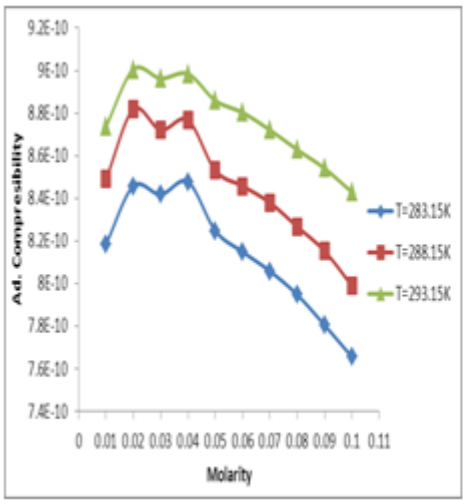

Figure 4: Ad. Compressibility

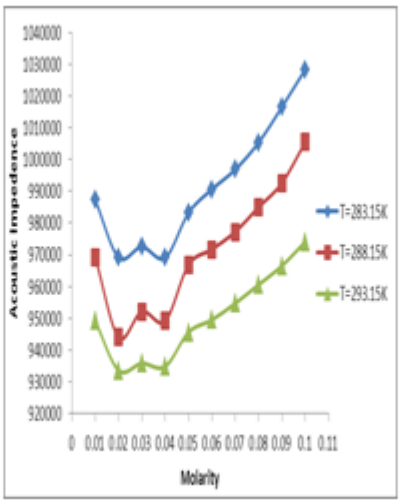

Figure 5: Aco.Impedance

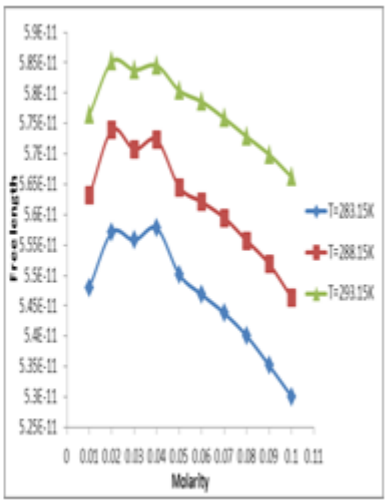

Figure 6: Free length

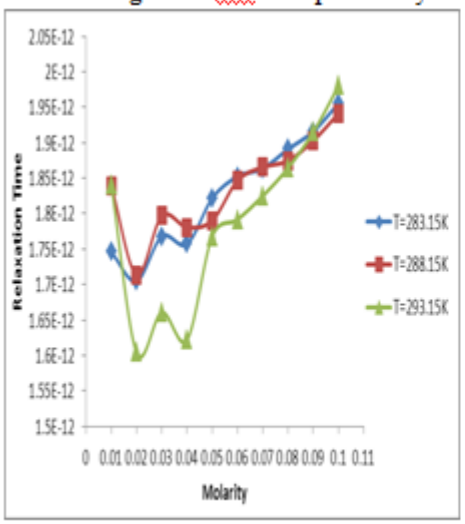

Figure 7: Relaxation time

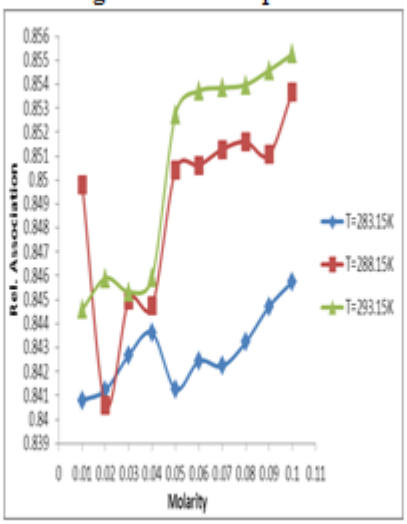

Figure 8: Rel.Association

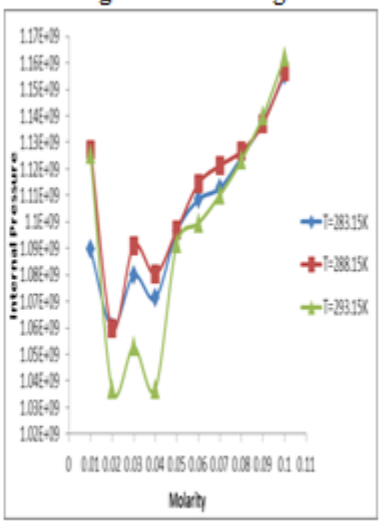

Figure 9: Internal Pressure

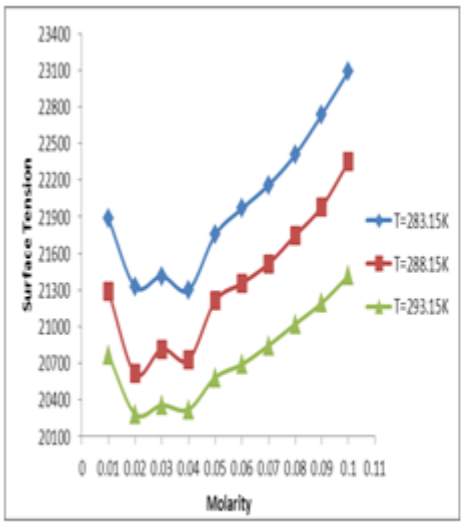

Figure 10: Surface tension

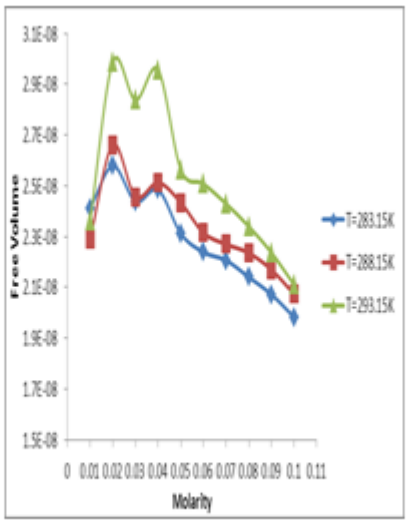

Figure 11: Free Volume

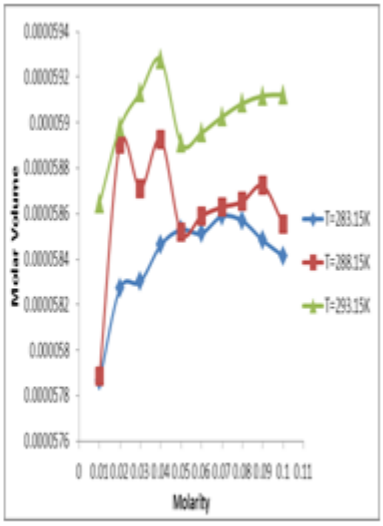

Figure 12: Molar Volume

4. Results and Discussion

In the present study evaluation of ultrasonic and thermo-acoustic parameters of diclofenac sodium in ethanol at different temperature (T = 283.15k – 293.15K) and it has been exposed by graphical (fig.1-12). Ultrasonic velocity decreases with increase in temperature. Which is clearly shows that molecular dissociation is being takes place in the solution. Variation of ultrasonic velocity in solution depends upon the increase or decrease of molecular free length after mixing the solute (fig.1). Ultrasonic velocity increases nonlinearly with increase in mole fraction of solute. Dipole-dipole interaction or hydrogen bonded complex formation between unlike molecules which leads to increase in sound velocity and decreases compressibility. Density is a measure of solvent-solvent and ion solvent interactions. Decrease in density with concentration indicates the decrease of solvent-solvent and solute- solvent interactions and shrinkage in the volume, which in turn is due to the presence of solute molecules. In other words, decrease in density is due to structure maker property of the solvent due to added solute. Increase of specific acoustic impedance with concentration at a given temperature, this is due to increase in the strength of intermolecular attraction. Free length is the distance between the surfaces of the neighboring molecules and variation in free length with concentration and temperature is similar to that of adiabatic compressibility. The relative association depends on either the breaking up of solvent molecules or solvation of ions that are present. In the present case relative association indicates prominent solute-solvent interaction. Acoustic relaxation time is found to decrease with increase in temperature and varies with changes in concentration. A comparative study of adiabatic compressibility and acoustical relaxation time indicates that the variations in acoustical relaxation time are mainly due to the changes in the viscosity of the solutions due to both concentration and temperature. Free volume is the effective volume in which the center of a molecule can move when all other molecules are held fixed at their mean positions. Free volume increases with decrease in concentration of solute. The increase in free volume indicates the increase in entropy of the system. Internal pressure is a measure of cohesive energy of the system hence these variations may be due to the structure making nature of the solute in the solvent. It implies that there is a solute- solvent interaction taking place in the solution. The increase variation of surface tension with temperature and concentration of solute also supports the significant associative interaction in the solution

5. Conclusion

Thus, the inference drawn from the studies is that there is structure making and structure breaking property in the solution. Systems are characterized by hydrogen bond; the solute-solvent can be interpreted in terms of structural changes due to hydrogen bond interactions between various components of the solvent and solution systems. Various acoustical parameters also support the existence of drug – solvent interactions. The results obtained from these studies can thus be helpful for pharmacological application of drugs.

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