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Acoustic Study in Aqueous Solution of Pantoprazole at Different Concentration

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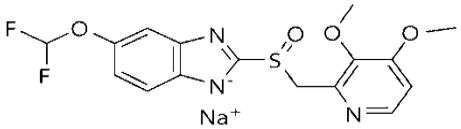
Abstract: *Ultrasonic velocity measurement have been successfully employed to detect and assess weak and strong molecule interactions present in solution When ultrasonic waves are present in the solution, the molecules get perturbed. Due to some elasticity of the medium, perturbed molecules regain their equilibrium positions. When a solute is added to a solvent, its molecules attract certain solvent molecules towards them. Experimental measurements of ultrasonic velocity, density and viscosity have been carried out on aqueous solution of Pantoprazole at different concentrations at 303.18 K temperature and 2 MHz frequency. Acoustical parameters such as free volume (Vf), Cohesive energy and Specific acoustical impedance (Z) for aqueous solution of Pantoprazole solution were calculated from ultrasonic velocity and effect of concentration on molecular interaction was predicted.*
Keywords: *Cohesive, energy, Molecular, Pantoprazole, acoustic*

I. Introduction:

The propagation of ultrasonic waves can determinenature of molecular interaction present in the system.Ultrasonic wave propagation in a medium affects its physical properties.The ultrasonic studies are extensively used to estimate the thermodynamic properties and predict the intermolecular interactions in pure liquid [1], liquid mixtures [2] and ionic interactions in electrolytic solutions[3].The Physico-chemical behavior of liquids mixtures and measurements can used to study molecular interactions in the liquids by ultrasonic study [4,5].The free volume is broadly defined as the averages volume in which the center of the molecule can move inside the hypothetical cell due to the repulsion on the surrounding molecules[6] . Cohesive energy is the energy gained by arranging the atoms in a crystalline state, as compared with the gas state· Pantoprazole sodium is used to treat certain stomach and esophagus problems (such as acid reflux). It works by decreasing the amount of acid that stomach makes. This medication relieves symptoms such as heartburn, difficulty swallowing, and persistent cough. It helps heal acid damage to the stomach and esophagus; helps prevent ulcers, and may help prevent cancer of the esophagus. Pantoprazole belongs to a class of drugs known as proton pump inhibitors (PPIs).Pantoprazole can also be used to treat or reduce the risk of stomach ulcers due to medications known as nonsteroidal anti-inflammatory drugs (NSAIDs), which irritate the stomach. In the present investigation ultrasonic velocity, densities and viscosities were measured at different concentrations. The effect of concentration on molecular interaction was predicted from acoustical parameters.
The structure of pantoprazole is as below



II. Materials And Methods

The ultrasonic velocity (U) in liquid mixtures which prepared by taking purified AR grade samples, have been measured using an ultrasonic interferometer (Mittal type, Model F-81) working at 2MHz frequency and at temperature 303K. The accuracy of sound velocity was ±0.1 ms^{-1}. An electronically digital operated constant temperature water bath has been used to circulate water through the double walled measuring cell made up of steel containing the experimental solution at the desire temperature. The density of pure liquids and liquid mixtures was determined using pycknometer by relative measurement method with an accuracy of ±0.1Kgm^{-3}. An Ostwald's viscometer was used for the viscosity measurement of pure liquids and liquid mixtures with an

accuracy of ±0.0001NSm^{-2}. The temperature around the viscometer and pycknometer was maintained within ±0.1K in an electronically operated constant temperature water bath. All the precautions were taken to minimize the possible experimental error.

Using the experimental data of ultrasonic velocity, density and viscosity, various acoustical parameters such as free volume (V_f),Internal Pressure (π_i) and Specific acoustical impedance (Z)Cohesive energy(CE)have been calculated from the measured data using the following standard expressions:

$Z = U \rho$ .... (1)

$V_f = (M_{eff} U/\eta K)^{3/2}$ .... (2)

$\pi_i = bRT(K\eta/U)^{1/2}(\rho^{2/3}/M_{eff}^{7/6})$ …. (3)

$CE = V_f \pi i$…… (4)

Where, Kis the temperature dependent constant having a value $207.7121*10^{-8}$in MKS system at temperature 303K, K is constant equal to $4.28*10^9$ in MKS system, b is a cubical packing fraction taken as 2 for all the liquids, R is the Universal gas constant, T is the experimental temperature, $M_{eff} = \Sigma x_i m_i$, where x_i is the mole fraction and m_i is the molecular weight of the component.

III. Results And Discussion

The experimentally measured values of Density (ρ), Ultrasonic velocity (U) and Viscosity (η) and calculated thermodynamic parameters free volume (V_f),Internal Pressure (π_i) and Specific acoustical impedance (Z)of aqueous solution of Pantoprazole at different concentrations at temperatures 303 K at frequency 2 MHz are presented in Table-1.

Table-1 clearly shows that, density and Viscosity decreases with increasing concentration of aqueous solution of Pantoprazole at temperatures 303K. The ultrasonic velocity values also have the opposite trend in the system. Velocity increases in this system, suggesting thereby more association between solute and solvent molecules [6-8].

The free volume increases with increasing mole fraction of the solute in this system. The increase in free volume show that the strength of interaction increases gradually with the increase in aqueous solution of Pantoprazole concentration. It represents that there is molecular interaction between the aqueous solution of Pantoprazole molecules. Thus, a progressive increase in free volume in aqueous solution of Pantoprazole mixtures clearly indicates the existence of intermolecular interaction, due to which the structural arrangement is considerably affected. As stated above the internal pressure (π_i) decreases with increase in concentration in the systems. Thus, a progressive decrease in internal pressure in mixtures clearly indicates the existence of ion-solvent interaction, due to which the structural arrangement is considerably affected. [9,10].

The acoustic impedance (Z) (which is the product of ultrasonic velocity and density of the solution) increases with increase in concentration, and increase of Z with the concentration of Pantoprazole suggest the presence of intermolecular interactions between solute and solvent. [11-14]..The cohesive energy shows intermolecular hydrogenand the dipole-dipole interaction. In the present study, there is increase in cohesive energy with increasing concentration of pantaprazole indicates that strong interaction exist in the solution..

Table 1: The experimentally measured values of Density (ρ), Ultrasonic velocity (U), Viscosity (η) and the calculated values of free volume (V_f),Internal Pressure (π_i) and Specific acoustical impedance (Z) for aqueous solution of Pantoprazole at different concentrations at temperatures 303 K at 2MHz frequency.

Composition	Velocity U (m/s)	Density ρ(kg/ m^3)	Viscocity $\eta*10^{-3}$ (CP)	Free Volume V_f $*10^{-7}$ (m^3mol^{-1})	Internal Pressure π_i*10^8 (P_a)	Acoustic Impedance $Z*10^6$ (kg/m^2s)	Cohesive
0.00025	1452.66	1530	0.5361	0.3958	28.22	2.2225	11.1694
0.005	1539.42	1520	0.4723	0.5380	25.03	2.3399	13.4661
0.01	1664.66	1506	0.3191	1.1540	18.81	2.5069	21.7067

IV. Conclusion

The ultrasonic velocity, density, viscosity and other related parameters were calculated. The existence of type of molecular interaction in solute-solvent is favored in the system, confirmed from the U, ρ, η, free volume (V_f),Internal Pressure (π_i) and Specific acoustical impedance (Z)data. Thevariation in ultrasonic velocity (U), density (ρ) and viscosity (η) and other related thermodynamic parameters such as free volume (V_f),Internal Pressure (π_i) and Specific acoustical impedance (Z)at various concentrations and at 303K temperature in the aqueous solution of Pantoprazole shows the variation -linear. Strong intermolecular interactions are confirmed in the systems investigated.. This provides useful information about inter and intra molecular interactions of the mixture as existing in the liquid system.

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