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Ultrasonic velocity, density of piperacillin and tazobactam solution at 298.15k.

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ABSTRACT

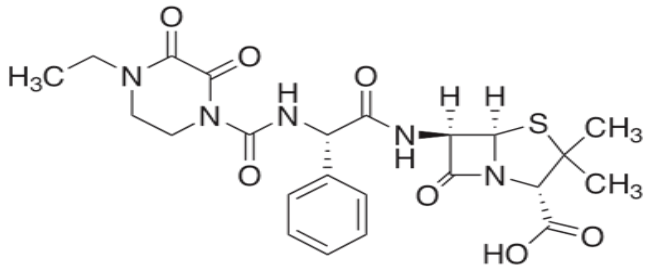
The Intermolecular interaction plays an important role in the development of molecular science Experimental measurements of ultrasonic velocity, density and viscosity have been carried out on aqueous solution of Piperacillin and tazobactamat different concentrations at 298.15K temperature and 2 MHz frequency. Ultrasonic studies may throw more light on the molecular interaction to know the behavior of solute and solvent molecules in liquid mixtures and solutions. Acoustical parameters as Adiabatic compressibility (β_a), Intermolecular free length (L_f) and Relaxation time (τ) for aqueous solution of Piperacillin and tazobactam solution were calculated. These properties are attributed to solute-solvent interactions through hydrogen bonding.

Keywords: Concentration, Impedance Molecular, Ultrasonic, Piperacillin.

INTRODUCTION

The sound velocity is one of the physical properties that help in understanding the nature of liquid state. The ultrasonic velocity measurement provides useful information about the internal structure, complex formation and molecular interaction in liquids because of their accuracy [1-3]. The ultrasonic technique is a powerful and effective tool for investigation of different types of molecular interaction present in the solution [4-7]. The measurement of ultrasonic velocity has been adequately employed in understanding the molecular interactions in liquid mixtures.

Ultrasonic velocity measurement has been successfully employed to detect and assess weak and strong molecule interactions, present in binary and ternary liquid mixtures. The structural arrangements are influenced not only by the shape of themolecules but also by their mutual interactions. The biological activity of drug molecules and the activation energy of the metabolic process basically depend on the type and strength of the inter-molecular interactions [8-9] Piperacillin and tazobactam combination is an antibiotic that belongs to the group of medicines known as penicillins and beta-lactamase inhibitors [10].It works by killing the bacteria and preventing their growth. However, this medicine will not work for colds, flu, or other virus infections. 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 Piperacillin tazobactam is as follows-



METHODOLOGY

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 sound density, velocity and viscosity, various acoustical parameters such as adiabatic compressibility (β_a), Intermolecular free length (L_f)and relaxation time (τ) have been calculated from the measured data using the following standard expressions:

$$\beta_a = (U^2\rho)^{-1} \quad \ldots (1)$$

$$L_f = K_T\beta a^{1/2} \quad \ldots (2)$$

$$\tau = 4/3\eta\beta_a \quad \ldots. (3)$$

Where, K_T is the temperature dependent constant, K is constant equal to $4.28*10^9$ in MKS system; T is the experimental temperature,

RESULTS AND DISCUSSION

The experimentally measured values of Density (ρ), Ultrasonic velocity (U) and Viscosity (η) and calculated thermodynamic parameters Adiabatic compressibility (βa), Intermolecular free length (L_f) and relaxation time (τ) of aqueous solution of Piperacillin and tazobactam at different concentrations at temperatures 303 K at frequency 2 MHz are presented in Table-1.

Table-1 and fig.1 clearly shows that, ultrasonic velocity decreases with increasing concentration of aqueous solution of Piperacillin and Tazobactam at temperatures 298.15K, it shows that less cohesion exist in solution of Piperacillin and Tazobactam indicating weak solute–solvent interaction. The linear decrease of density and ultrasonic velocity with increase inconcentration of solute confirmed the decrease of cohesive forces because of weak molecular interactions. Velocity decreases in this system, suggesting thereby more dissociation between solute and solvent molecules. This indicates that, strong interaction observed at lower concentration of solute [11].

Table 1: Measured values of Ultrasonic velocity (U), density (ρ), viscosity (η) and Adiabatic compressibility (βa) free length (Lf), Acoustic Impedance(Z) and Relaxation Time (τ) of Piperacillin and Tazobactamat 298.15 K and 2MHz Frequency.

Concentration (M)	Ultrasonic velocity (U) m/s	Density (ρ) kg/m3	Viscosity (η)	Adiabatic compressibility βa*10^{-10})Pa^{-1}	Intermolecular free length (Lf *10^{-10})m	Acoustic Impedance (Z*10^{6}) kg/m^2s	Relaxation Time (τ*10^{-12}) sec
0.001	1632.33	1512.66	3.46	2.481	0.3242	2.4691	1.145
0.01	1581.66	1508.30	3.89	2.650	0.3351	2.3856	1.375
0.1	1521.30	1505.40	4.09	2.870	0.3487	2.2901	1.565

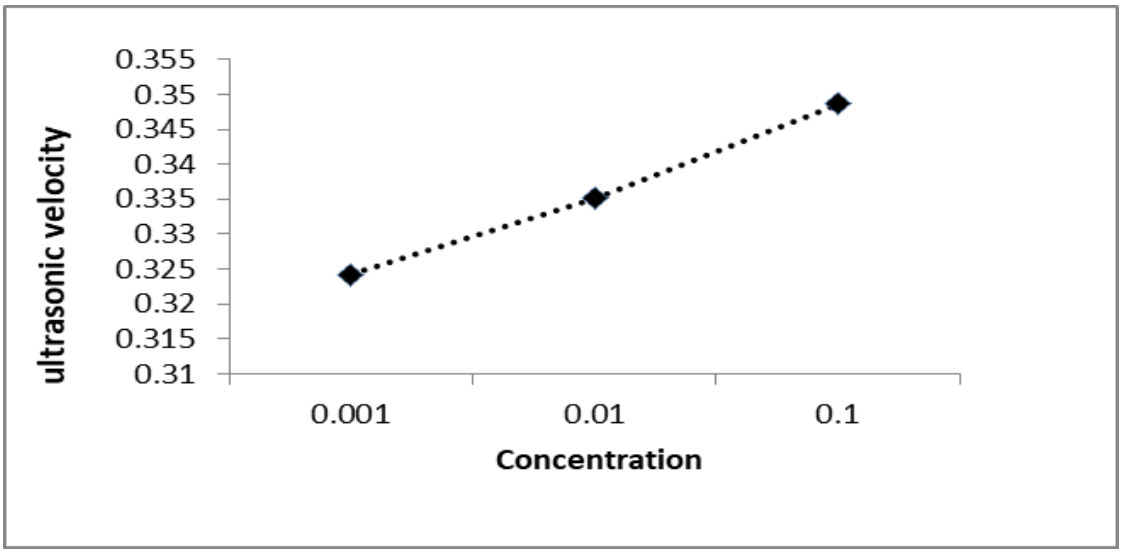


Fig. 1 ultrasonic velocity of Piperacillin and Tazobactam

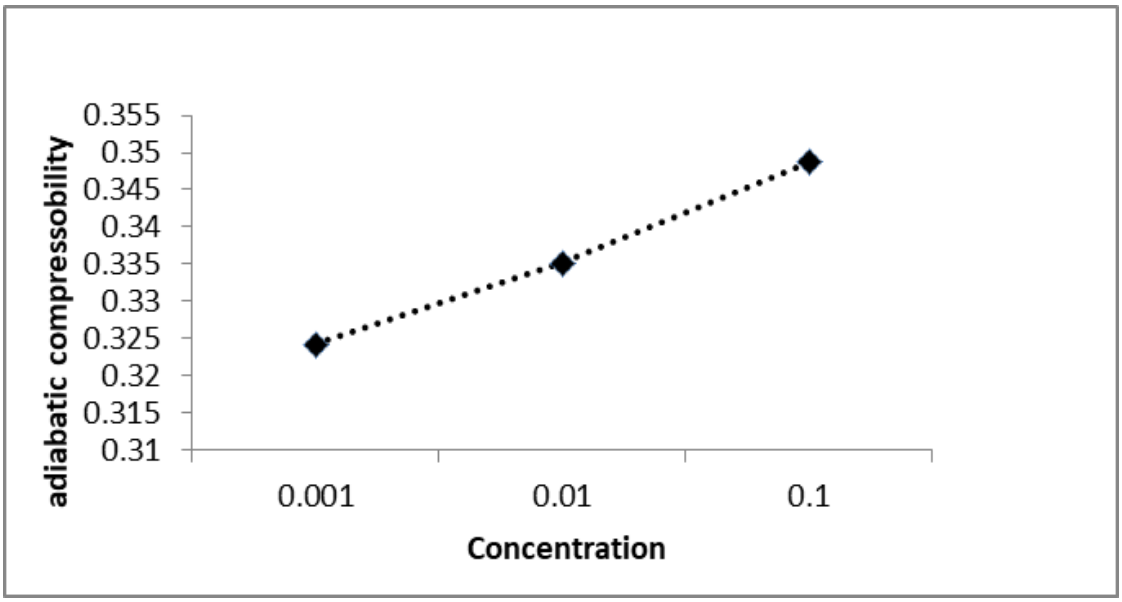


Fig. 2 Adiabatic compressibility of Piperacillin and Tazobactam

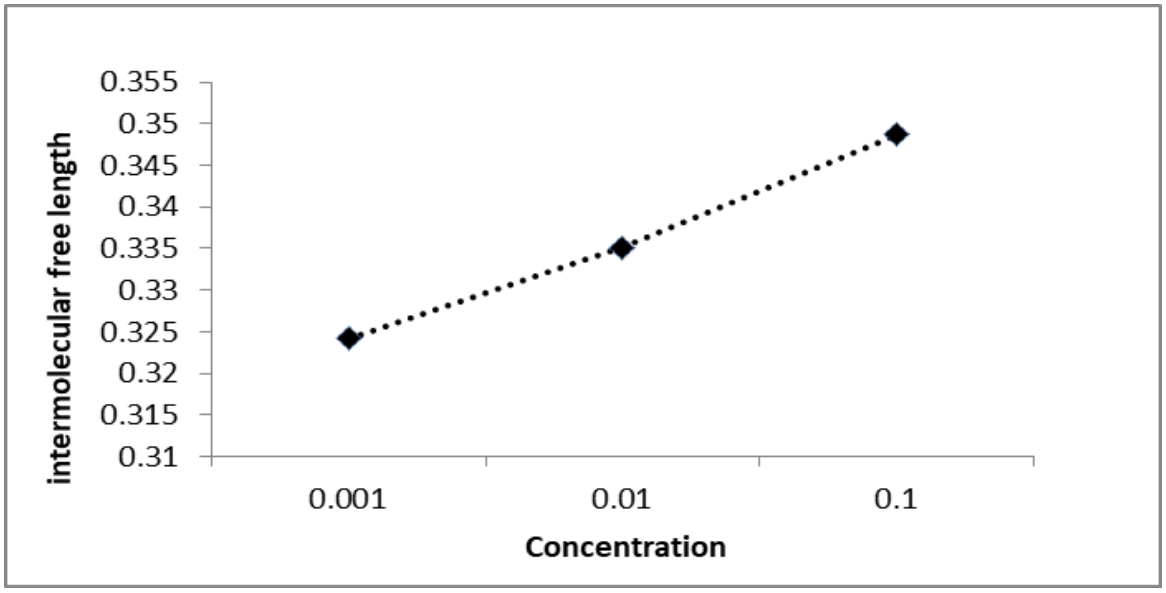


Fig. 3: Intermolecular free length of Piperacillin and Tazobactam

Ultrasonic velocity in the solutions depends on intermolecular free path length. Fig.2 shows that adiabatic compressibility increases with increase in concentration. The increase of adiabatic compressibility in aqueous solution of Piperacillin and Tazobactam shows that there is formation of less hydrogen bonding suggesting weak molecular interaction between solute and solvent.

The free length dependes on the adiabatic compressibility and inverse to that of velocity. The intermolecular free length (L_f) is an important physical property of liquid mixtures which mainly affects the sound velocity.Fig.3 shows thatthe intermolecular free length increases with increases of concentration which decreases the sound velocity. Intermolecular free length is increasing in Piperacillin and Tazobactam shows week molecular interaction in solution.

Literature shows that the impedance approach to explain the molecular interaction in liquid mixtures has been rather less commonly employed [12]. Acoustic impedance is decreasing in Piperacillin and Tazobactam shows week molecular interaction in solvent. The acoustic impedance (Z) (which is the product of ultrasonic velocity and density of the solution) decreases with decrease in concentration, and increase of Z with the concentration of Piperacillin and Tazobactam suggest the presence of intermolecular interactions between solute and solvent. Relaxation time (τ)have completely reverse trend with that of velocity. This also indicates the significant interactions in the system.

CONCLUSION

From the measured data it has been observed that, the measured values of ultrasonic velocity (U), density (ρ), viscosity (η) and other related parameters were calculated for aqueous solution of Piperacillin and Tazobactam. The week molecular interaction in solute-solvent is favored in the Piperacillin and Tazobactamliquid, confirmed from the U, ρ, η, adiabatic compressibility (βa), intermolecular free length (L_f), acoustic impedance (Z) and Relaxation time (τ) at 303K temperatures and 2 MHZ frequency data. From the molecular interactions reactivity of the drug may be predicted.

Conflicts of interest: The authors stated that no conflicts of interest.

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