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Study of Molecular Interaction of Streptomycin Drug at 303 K temperature and 2 MHz

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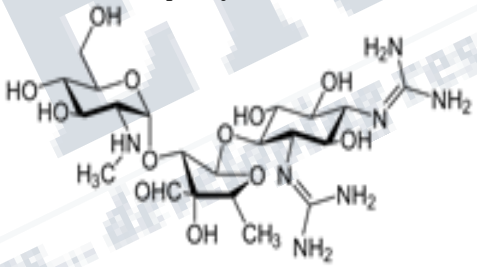
***Abstract*:--Experimental measurement of ultrasonic velocity, density and viscosity have been carried out on aqueous solution of Streptomycin at different concentrations at 303 K temperature and 2 MHz frequency. For velocity measurement, Ultrasonic Interferometer (Model No. F-81, Mittal, New Delhi) working at fixed frequency 2 MHz was used. From the experimental data of density (ρ), ultrasonic velocity (U) and viscosity (η), various acoustical parameters such as adiabatic compressibility (βa), Intermolecular free length (Lf), free volume (Vf) and Relaxation time (τ) were calculated. Ultrasonic studies may throw more light on the molecular interaction to know the behavior of solute and solvent molecules in liquid mixtures and solutions. Changes in concentration and temperature affect compressibility of solution, which in turn affects molecular interactions in liquid mixtures and solutions and structure making and structure breaking properties of solute in aqueous solution of Streptomycin. From this results drug absorption, transmission, activity and drug effects can be directly predicted.**

***Index Terms*— Acoustical parameters, Molecular interactions, Streptomycin and binary liquid mixtures.**

I. INTRODUCTION

Ultrasonic study is very much useful for characterizing the Physico-chemical behavior of liquids mixtures and measurements are used to study molecular interactions in the liquids 1,2. The ultrasonic technique is a powerful and effective tool for investigation of different types of molecular interaction present in the solution. The measurement of ultrasonic velocity has been adequately employed in understanding the molecular interactions in liquid mixtures. Ultrasonic velocity measurement have been successfully employed to detect and assess weak and strong molecule interactions, present in binary and ternary liquidmixtures3 Molecular interaction studies can be carried out by bothspectroscopic4-5 and non–spectroscopic6-7 techniques. However, ultrasonic velocity8 and viscosity9 measurements have been widely used in the field of interactions and structural aspect evaluation studies. The ultrasonic study of liquid mixtures have of greater significance in under-standing intermolecular interactions between the component molecules as they can locate numerous applications in industrial and technological processes10-11 . Antibiotics, also called antibacterial, are a type of antimicrobial12 drug used in the treatment and prevention of bacterial infections 13-14 .They may either kill or inhibit the growth of bacteria. Streptomycin is an antibiotic used to treat a number of bacterial infections. This includes tuberculosis, Mycobacterium avium complex, endocarditis, brucellosis, Burkholderia infection, plague, tularemia, and rat bite fever. 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 streptomycin 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.

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Using the experimental data of ultrasonic sound density, velocity and viscosity, various acoustical parameters such as adiabatic compressibility (βa), Intermolecular free length (L_f), free volume (V_f) and Relaxation time (τ) have been calculated from the measured data using the following standard expressions:

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

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

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

$\tau = 4/3\ \eta\ \beta a$ ..... (4)

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, $M_{eff} = \Sigma\, x_i m_i$, 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 Adiabatic compressibility (βa), Intermolecular free length (L_f), free volume (V_f) and Relaxation time (τ) of aqueous solution of Streptomycin at different concentrations at temperatures 303 K at frequency 2 MHz are presented in Table-1.

Table-1 clearly shows that, density decreases with concentration of aqueous solution of Streptomycin at temperatures 308K. The ultrasonic velocity values also have the opposite trend in the system. Viscosity decreases in this system, suggesting thereby more association between solute and solvent molecules [6-8].

The structural change of the molecules in the mixture takes place due to the existence of electrostatic field between the interacting molecules. The structural arrangement of the molecule affects the adiabatic compressibility. From the Table-1, the adiabatic compressibility and free length decreases with increase of mole fraction of the Streptomycin in the solution. This indicates the presence of specific molecular interaction between the molecules of the liquid mixture. Generally, when the ultrasonic velocity increases; the value of free length decreases [9,10].

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 Streptomycin concentration. It represents that there is molecular interaction between the aqueous solution of Streptomycin molecules. Thus, a progressive increase in free volume in aqueous solution of Streptomycin mixtures clearly indicates the existence of intermolecular interaction, due to which the structural arrangement is considerably affected. But, relaxation time (τ) decreases. This also indicates the significant interactions in the system [11-14].

Table 1: The experimentally measured values of Density (ρ), Ultrasonic velocity (U), Viscosity (η) and the calculated values of Adiabatic compressibility (βa), Intermolecular free length (Lf), free Volume (Vf) and Relaxation time (τ) for aqueous solution of Streptomycin at different concentrations at temperatures 303 K at 2MHz frequency.

Concentration	U (m/s)	ρ (kg/m³)	η*10⁻³ (CP)	βa *10⁻¹⁰ (Pa⁻¹)	Lf *10⁻¹⁰ (m)	Vf*10⁻⁷ (m³mol⁻¹)	τ *10⁻¹³(s)
0.05	1570.36	1242.10	0.9056	3.265	0.3719	0.8061	3.942
0.025	1590.96	1240.00	0.8620	3.186	0.3674	1.009	3.662
0.0125	1602.48	1238.00	0.7872	3.146	0.3651	1.319	3.302
0.00625	1612.8	1235.60	0.7539	3.111	0.3631	1.588	3.128

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, βa, L_f, V_f and τ data. The variation in ultrasonic velocity (U), density (ρ) and viscosity (η) and other related thermodynamic parameters such as βa, L_f, V_f, and τ at various concentrations and at 303K temperature in the aqueous solution of Streptomycin shows the variation to be non-linear. Strong intermolecular interactions are confirmed in the systems investigated. Components maintain their individuality in the system investigated. All the experimental determinations of acoustic parameters are strongly correlated with each other. This provides useful information about inter and intra molecular interactions of the mixture as existing in the liquid system.

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