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Research Article

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Acoustic study of atropine sulphate in water of various concentrations at 35^{O}C using ultrasonic interferometer

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ABSTRACT

Acoustic study of Atropine sulphate water binary mixture is carried out at 35^{o}Cand the data's are correlated using Concentration, Density, Ultrasonic velocity, Acoustic Impedance, Free length, Adiabatic compressibility and Relaxation time. The data reveal the molecular interaction of atropine-water molecule system.

INTRODUCTION

Ultrasonic studies provide wealth information about the state of the liquid. Ultrasonic velocity measurement has been adequately employed to understand the nature of the molecular interaction in binary mixture [1- 6] and ionic interaction in electrolytic solution [7]. Measurement of ultrasonic velocity and other acoustical properties can be related to physico- chemical behaviour and molecular interaction [8-15] in a number of binary systems. The investigations were carried out on the Atropine sulphate-water system by ultrasonic method [16-18]. The investigation and ultrasonic studies on Atropine sulphate-water system at 35 ^{o}C was carried out by J.Balakrishnan and Co-workers. The acoustic parameters have been calculated for these two binary mixtures at different concentration of Atropine sulphate-water system.

EXPERIMENTAL SECTION

Atropine sulphate (AR grade) and water (Double Distilled) are used. Atropine was dissolved in water of various ratio's to prepare different concentration 1.0%,0.8%,0.6%,0.4% and 0.2%.The binary mixture are prepared by using volume percentage(%) by using jobs variation method [19-21]. The ultrasonic velocity (U) have been measured using ultrasonic interferometer (Model F81) supplied by Mittal Enterprises, New Delhi operating frequency of 2 MHz with accuracy of $\pm$ 0.1%. The viscosities (ή) of pure compounds and their binary mixture were determined using Oswald viscometer by calibrating with double distilled water. The densities (ρ) of atropine and water were measure accurately using 10ml specific gravity bottle in an electronic balance precisely and the accuracy in weighing is $\pm$ 0.1 mg. The temperature of the pure solution and the binary mixture were maintained at 35 ^{o}C with $\pm$ 0.1^{o}C accuracy using a thermostat. The acoustical parameters are calculated from U, ρ, and ή [22- 26] using following relation.

1. Adiabatic Compressibility (β)

The structural changes of the molecule in the mixture take place due to existence of electrostatic field between interacting molecules. The structural arrangement of molecules results in a considerable change in a adiabatic compressibility, which can be express as

$$\beta = 1/ U^2\rho \ Kg^{-1}ms^2$$

Where U is ultrasonic velocities and ρ is density of liquid mixtures.

2. Free Length (L_f)
The free length is the distance covered by sound wave between the surfaces of the neighbouring molecules and is related to ultrasonic velocity and density as

$$Lf = K / (\rho U)^{1/2} m$$

$$K = (93.875 + 0.345T) \times 10^{-8}$$

3. Acoustic Impedance (Z).
The specific acoustic impedance is related to density and ultrasonic velocity by the relation.

$$Z = U\rho \quad Kgm^{-2}S^{-1}$$

4.Relaxation Time.(τ).
Relaxation time and adsorption coefficient are directly correlated. The adsorption of sound wave is the result of time lag between the passing of ultrasonic wave and return of molecular to their equilibrium position. It is computed using the relation

$$\tau = 4\eta / 3\ \rho U^2 \text{ sec}$$

5. Absorption coefficient (α/f^2)
Absorption coefficient is also called attenuation coefficient is a characteristic parameter of medium and it depends on external condition like temperature, pressure and frequency of measurement is given

$$(\alpha/f^2) = 8\Pi^2\eta/[3\rho U^3].Npm^{-1}s^2$$

RESULTS AND DISCUSSION

Concentration and Density
The measured Ultrasonic Velocity (U), Density (ρ) and Viscosity (η) with increase in concentration of atropine sulphate with water 35^{O}C temperatures is given in table-1to 3.The Density of Atropine-water system increases with increases in concentration. It is clearly shows the straight line which is proportional to density and given table-1 and shown in fig:-.1 Ultrasonic velocity decreases with increases in concentration, Viscosity increases with increase in concentration.

Fig -1

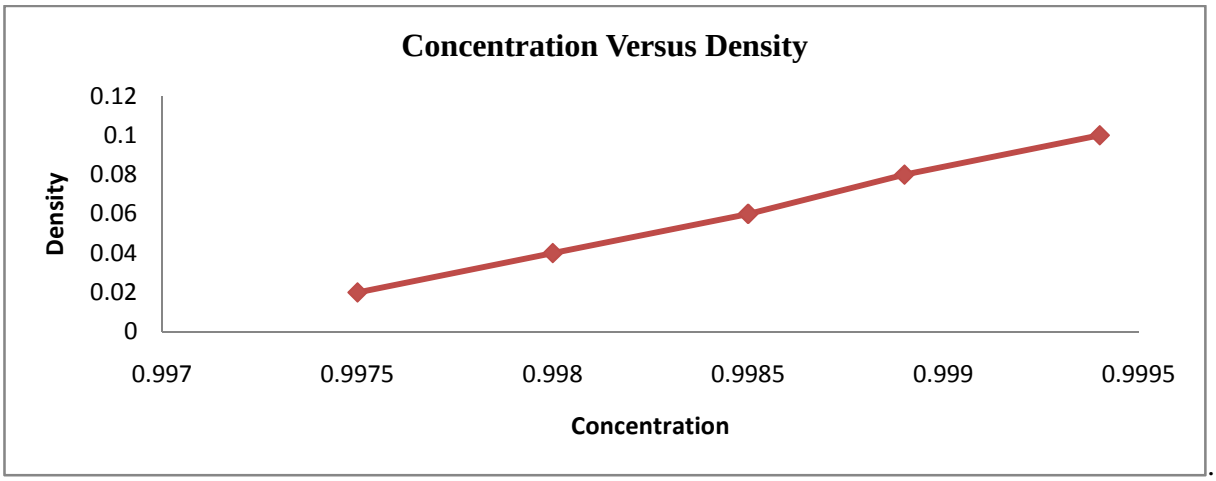


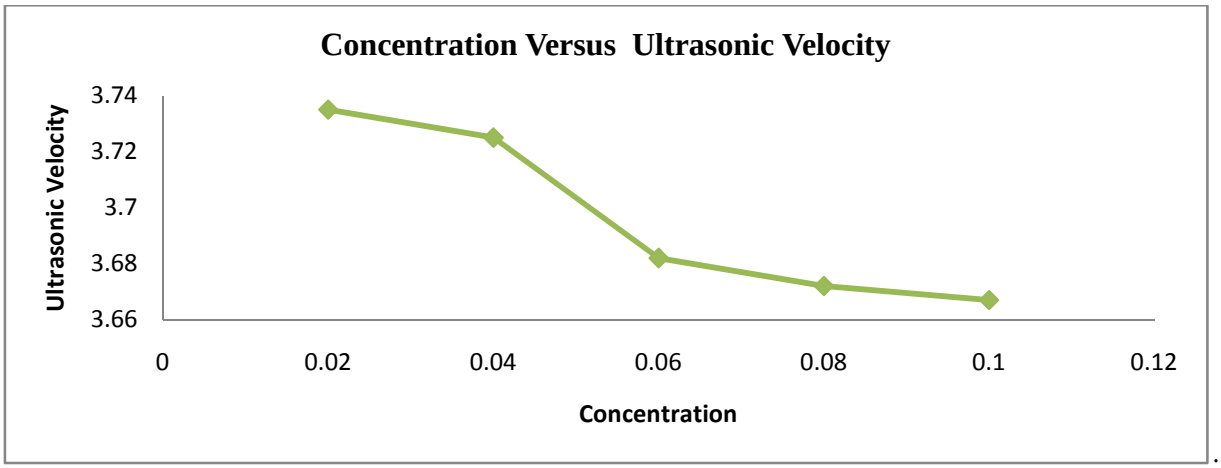
Table -1 Concentration, Density and Ultrasonic Velocity

Concentration %	Density g/mol@ 35°C	Ultrasonic Velocity ms^{-1}
0.1	0.9994	3.667
0.08	0.9989	3.672
0.06	0.9985	3.682
0.04	0.9980	3.725
0.02	0.9975	3.735

Ultrasonic velocity

The ultrasonic velocity decreases with increases in the concentration of atropine sulphate-water system at 35 ^{o}C. This trend suggests that the dipole-dipole interaction is less at higher concentration of atropine sulphate - water binary mixture. When the concentration is increased in atropine sulphate water system, the ultrasonic velocity between 0.4 and 0.6 steep decreases observed due vibration caused by the sound plays vital result, which has the maximum deformation to the concentration and is given in the table-1 and shown in fig:-2. This trend reveals that at higher concentration the molecular interaction between the components is low. The ultrasonic velocity of atropine sulphate water system decreases with increase in concentration shows a difference, this is because of steric effect.

Fig - 2



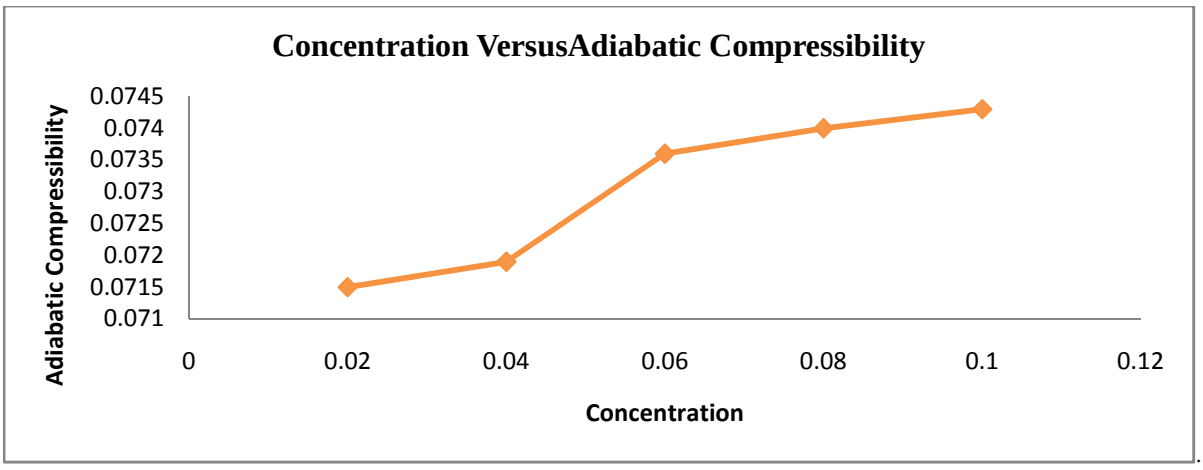
Adiabatic Compressibility

As the concentration increases from 0.02% to 0.1%, the adiabatic compressibility increases since the molecules are closer so the arrangements are compact is given in the table-2 and shown in fig:-3.

Table -2 Concentration Vs Adiabatic Compressibility

Concentration of Substance %	Adiabatic Compressibility $Kg^{-1}ms^{2}$
0.1	0.0743
0.08	0.0740
0.06	0.0736
0.04	0.0719
0.02	0.0715

Fig – 3



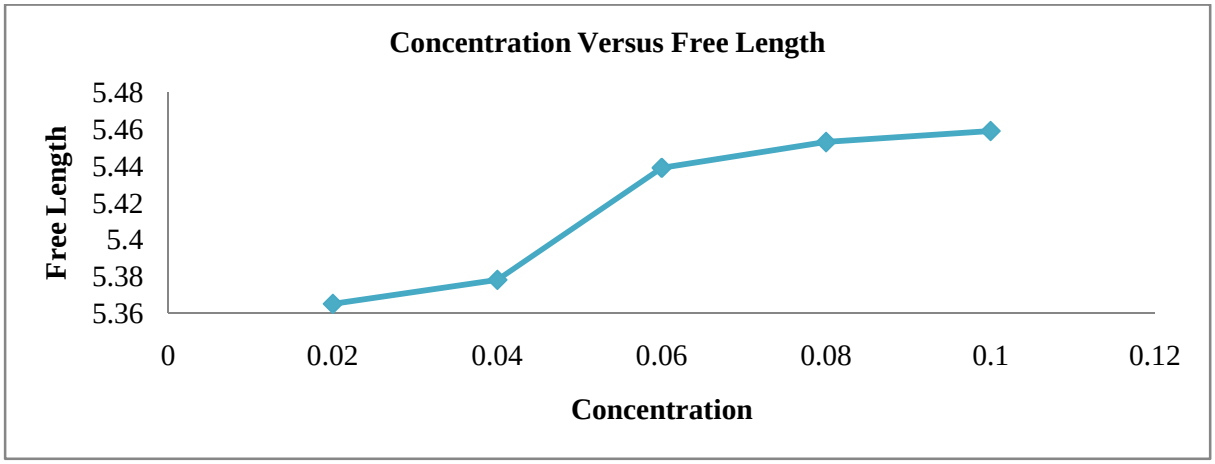
Free length

The Free length of a system is a measure of interaction attraction between the components in a binary mixture. This increase in free length indicates the weakening of the intermolecular attraction. The concentration increases from 0.02% to 0.1%, the free length of molecule also increases which shows dipole-dipole interaction is less at higher concentration, is given in the table-3 and shown in fig:-4.

Table -3 Concentration Vs Free Length

Concentration of Substance %	Free Length ($m \times 10^{-7}$)
0.1	5.459
0.08	5.453
0.06	5.439
0.04	5.378
0.02	5.365

Fig – 4



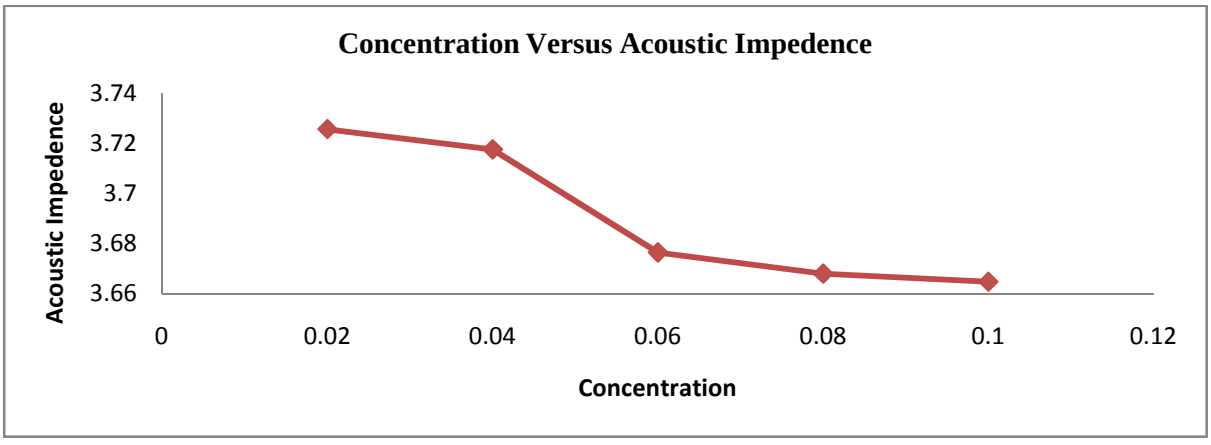
Acoustic Impedance

The increase in acoustic impedance with can be explained on the basis of lyophobic interaction between solute and solvent molecule. The plot of acoustic impedance verses concentration is given in the table:-4 and figure: - 5.As the concentration increases from 0.02% to 0.1%, the Specific Acoustic Impedence decreases

Table -4 Concentration Vs Specific Acoustic Impedence

Concentration of Substance %	Specific Acoustic Impedence $Kgm^{-2}\ s^{-1}$
0.1	3.6647
0.08	3.6679
0.06	3.6764
0.04	3.7175
0.02	3.7256

Fig - 5



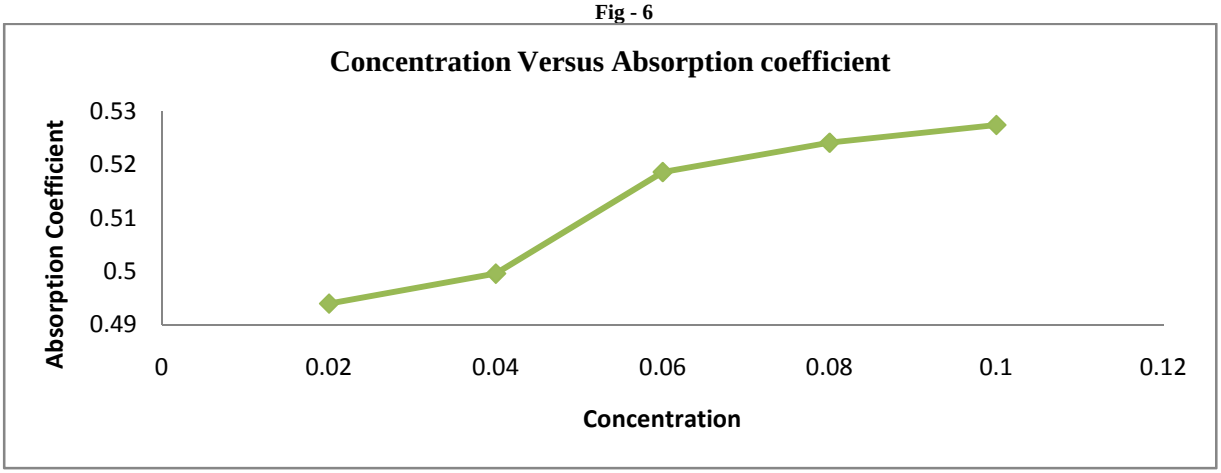
Absorption Coefficient

As the concentration increases from 0.02% to 0.1%, the Absorption coefficient also increases, which indicates the molecular interaction will be more at lower concentration, is given in the table-5 and shown in fig:-6.

Table -5 Concentration Vs Absorption Coefficient

Concentration of Substance %	Absorption coefficient $Npm^{-1} S^2$
0.1	0.5274
0.08	0.5241
0.06	0.5186
0.04	0.4996
0.02	0.4940

Fig - 6



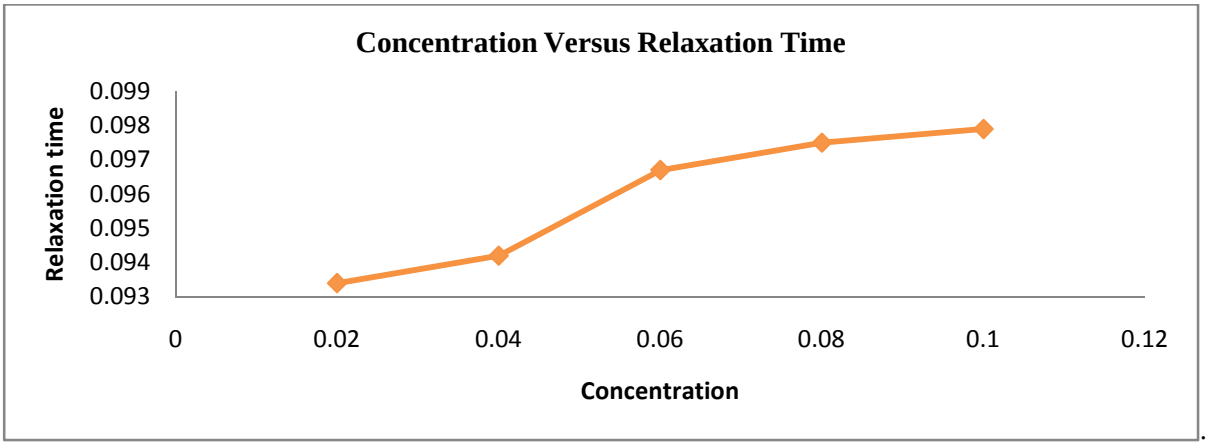
Relaxation time

The relaxation times values for two system increases with concentration uniformly. This chows that the molecular interaction is strong at lower concentration and relatively weak at higher concentration. As the concentration increases from 0.02% to 0.1%, the relaxation time also increases, is given in the table-6 and shown in fig:-7.

Table -6 Concentration Vs Relaxation Time

Concentration of Substance %	Relaxation Time (Sec)
0.1	0.0979
0.08	0.0975
0.06	0.0967
0.04	0.0942
0.02	0.0934

Fig – 7



CONCLUSION

In the present study, it can be inferred that there are interaction among the component of the binary mixture, leading to the possible hydrogen oxygen bond formation, between the two component atropine and water.

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