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Acoustic studies for binary mixtures of sulphadrug sulphadoxine and chloroform at 308 K

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Abstract: Densities, viscosities and ultrasonic velocities of binary mixtures of drug sulphadoxine with chloroform over entire composition range have been measured at 308 K. These data have been utilized to calculate acoustic parameters viz. isentropic compressibility, lowering isentropic compressibility, intermolecular free length, specific acoustic impedance, relative association and solvation number. The results are interpreted in terms of intermolecular interactions between the component of the mixtures.

(**Keywords :** Ultrasonic velocity, sulphadoxine, Chloroform, isentropic compressibility, Specific acoustic impedance, intermolecular free length)

Introduction

Ultrasound studies are extensively used in probing the physico-chemical behaviour of binary liquid mixtures.[1-2] Ultrasonic velocity is gaining importance in understanding the nature of drug-solvent interaction since physico-chemical properties of the drugs are of great interest to understand the drug action at molecular level[3-5]. Using the measured values of ultrasonic velocity, viscosity and density various acoustic and thermodynamic parameters such as isentropic compressibility, lowering isentropic compressibility, Shear's relaxation time, intermolecular free length can be computed.[6-8] These parameters provide information about solute- solute and solute-solvent interactions. Sulphadrugs are the subject of interest due to its pharmacological and medicinal utility as antimicrobial agents. Several researchers[9-12] have studied the molecular interaction of various drugs with organic solvents. However, there is no data available on the interaction of drug sulphadoxine with chloroform. This prompted us to undertake the present study.

Experimental

The ultrasonic velocity was measured using Ultrasonic Interferometer model F-81 containing quartz crystal working at a frequency of 2 MHz by standard procedure. The accuracy of ultrasonic velocity determination in the solution is +0.001%. The constant temperature of 30°C was maintained through thermostat. The density was measured using double walled bicapillarypyknometer. The viscosity was measured using Ostwald's viscometer which was earlier calibrated.Acoustical parameters were calculated from the measured values of density, viscosity and ultrasonic velocity.

Results and Discussion

From the observed calculated values of density, viscosity and ultrasonic velocity acoustic parameters such as isentropic compressibility, lowering isentropic compressibility, intermolecular free length, Shear's relaxation time, specific acoustic impedance and solvation number were calculated using the following relations (1-6).

Isentropic compressibility

$$\beta_s = \frac{1}{V^2 \rho} \quad \ldots..(1)$$

where, V = Ultrasound velocity
ρ = Density

Lowering isentropic compressibility

$$= \beta_s - \beta_{so} \quad \ldots(2)$$

where,
β_s = isentropic compressibility of drug solution
β_{so} = isentropic compressibility of solvent

Intermolecular free length,

$$L_f = K\sqrt{\beta_s} \quad \ldots.(3)$$

Where, K = constant depending on temperature

Shear's relaxation time,

$$\tau_s = \frac{4}{3}\eta\beta_s \quad \ldots.(4)$$

where, η = viscosity

Specific acoustic impedance,

$$Z = V\rho \quad \ldots.(5)$$

Solvation number,

$$S_n = \frac{n_1}{n_2}\left[1 - \frac{\beta_s}{\beta_{s0}}\right] \quad \ldots.(6)$$

Where,

n_1 = number of moles of solvent
n_2 = number of moles of solute

The measured values such as ultrasonic velocity (V), density (ρ) and viscosity (η) of binary system ofdrug sulphadoxine with chloroform are given in Table 1. The calculated values of parameters: isentropic compressibility, lowering isentropic compressibility, intermolecular free length, Shear's relaxation time, specific acoustic impedance and solvation number are listed in Table 2.

Table 1
Values of density (r), viscosity (h) and ultrasonic velocity (V) for Sulphadoxine + chloroform system at 308K

Molar conc. of Sulphadoxine	Ultrasound velocity (V) m/S	Density (ρ) kg/m^3	Viscosity (η) Nm^{-2}
0.0021	931.6	1465.8	0.9694
0.0043	931.8	1466.1	0.9722
0.0064	932.1	1466.3	0.9740
0.0086	932.5	1466.6	0.9762
0.0107	932.8	1466.9	0.9775
0.0129	933.0	1467.2	0.9785
0.0150	933.2	1468.1	0.9800
0.0171	933.5	1468.4	0.9812
0.0193	933.8	1468.7	0.9842
0.0214	934.0	1468.9	0.9866

Table 1 shows that in sulphadoxine -chloroform system, ultrasonic velocity increases with increase in the molar concentration of sulphadoxinebut the increase is not much which indicates the weaker interaction between the two componentswith increase in the concentration of drug. Density and Viscosity also slightly increases with concentration of drug suggesting feeble association between sulphadoxine and chloroform .

From **Table 2**it is observed that isentropic compressibility(βs) decreases with increase in the concentration of sulphadoxine which indicates the ordered arrangement of sulphadoxine with the concentration of the drug. Decrease in the intermolecular free length (L_f) shows that solute-solvent molecules are coming closer in the system which may be due to the involvement of some weak interactions.

Table 2
Values of Isentropic compressibility (β), lowering isentropic compressibility, Intermolecular free length (L_f), Relaxation time (τ_s), specific acoustic impedance(Z) and solvation number(S_n) for Sulphadoxine + chloroform system at 308 K

.002Molar conc. of Sulphadoxine ($molL^{-1}$)	$\beta_s x10^{-14}$ (N/m2)	Lowering isentropic compressibility	$L_f x10^{-10}$ (m)	τ_s	$Zx10^{-15}$	S_n
0.0021	8.533	0.46	0.5220	0.0113	1.2966	2.49
0.0043	8.530	0.87	0.5186	0.0198	1.3129	2.16
0.0064	8.527	1.23	0.5153	0.1063	1.3290	2.14
0.0086	8.523	1.73	0.5121	0.2315	1.3448	1.81
0.0107	8.519	2.16	0.5089	0.4511	1.3583	1.32
0.0129	8.518	2.58	0.5057	0.6213	1.3701	1.40
0.0150	8.511	3.00	0.5026	0.6500	1.3868	0.53
0.0171	8.507	3.42	0.4995	0.8218	1.4010	0.50
0.0193	8.505	3.83	0.4964	0.9833	1.4621	0.65
0.0214	8.501	4.24	0.4934	1.002	1.4629	0.71

Decreasing values of isentropic compressibility, increase in the solvation number (S_n) and specific acoustic impedance (Z), decreases the intermolecular distance which indicates that in this system there is relatively less gap between the molecules and molecular interactions are associative in nature.[13-15]Since both Sulphadoxine and chloroform are polar molecules, the nonlinear variation of ultrasonic velocity with molar concentration of drug reveals the dispersive type of intermolecular interactions

Conclusion :

The concentration dependencies of ultrasonic velocity, density and viscosities have been measured at 313K for Sulphadoxine-chloroform system.The nonlinear variation of the related parameters isentropic compressibility, lowering isentropic compressibility, intermolecular free length, Shear's relaxation time, specific acoustic impedance and solvation number is in good agreement with the dispersive type of interactionbetween Sulphadoxine and chloroform.

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