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ULTRASONIC STUDIES ON MOLECULAR INTERACTIONS IN BINARY MIXTURES OF DRUG SULPHAGUANIDINE WITH CARBONTETRACHLORIDE AT 303 K

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Densities, viscosities and ultrasonic velocities of binary mixtures of drug sulphaguanidine with carbontetrachloride over entire composition range have been measured at 303 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, sulphaguanidine, isentropic compressibility, carbontetrachloride (CTC).

INTRODUCTION

Ultrasound studies are extensively used in probing the physico-chemical behaviour of binary liquid mixtures.[1-2] Ultrasonic velocity is one of the most important physical property that helps in understanding the nature of liquid state. 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.[3-5]These parameters provide information about solute- solute and solute-solvent interactions. Such information can be helpful in predicting the absorption of drugs and drug transport across biological membranes.[6-7]Sulpha drugs are the subject of interest due to its pharmacological and medicinal use as antimicrobial agent. Several researchers[8-11] have studied the molecular interaction of various drugs with organic solvents. However there is no data available on the interaction of drug sulphaguanidine with organic solvents. This prompted us to undertake the present study. This study will help to improve the thermodynamic interpretation of molecular interaction of sulpha drugs with organic solvents.

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 +0.05%, temperature of 30^{o}C was maintained through thermostat. The density was measured using double walled

bicapillarypyknometer. The viscosity was measured using Ostwald's viscometer which was previously calibrated.

RESULT AND DISCUSSION

The calculated 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 $\beta_s = \frac{1}{V^2\rho}$ ….. (1)

where, V = Ultrasound velocity

ρ = Density

Lowering isentropic compressibility = $\beta_s - \beta_{so}$ …. (2)

where, β_s = isentropic compressibility of drug solution

β_{so} = isentropic compressibility of solvent

Intermolecular free length, $L_f = K\sqrt{\beta_s}$ …. (3)

where, K = constant depending on temperature

Shear's relaxation time, $\tau_s = \frac{4}{3}\eta\beta_s$ …. (4)

where, η = viscosity

Specific acoustic impedance, $Z = V\rho$ …. (5)

Solvation number, $S_n = \frac{n_1}{n_2}\left[1 - \frac{\beta_s}{\beta_{s0}}\right]$ …. (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 drug sulphaguanidine with carbontetrachloride 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.

In the present system, sulphaguanidine drug is polar and carbontetra- chloride molecules are non polar. The nature and strength of heteromolecularsulphaguanidine-CTC interaction is determined by interacting molecules.

Table 1. Values of density (ρ), viscosity (η) and velocity (V) for Sulphaguanidine + CCl_4 system at 30°C

Molar conc. of Sulphaguanidine	Ultrasound velocity (V) m/S	Density (ρ) g/mL	Viscosity (η) Nm^{-2}
0.0021	920	1.5639	0.9968
0.0043	922	1.5782	1.0111
0.0064	924	1.5924	1.0253

0.0086	926	1.6066	1.0395
0.0107	927	1.6209	1.0538
0.0129	930	1.6351	1.0680
0.0150	932	1.6493	1.0822
0.0171	934	1.6635	1.0964
0.0193	935	1.6778	1.1107
0.0214	937	1.6920	1.1249

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 Sulphaguanidine + CCl_4 system at 30°C

Molar conc. of Sulphaguanidine (mol L^{-1})	$\beta_s \times 10^{-14}$ (dynes/cm^2)	Lowering isentropic compressibility	$L_f \times 10^{-10}$ (m)	τ_s	$Z \times 10^{-15}$	S_n
0.0021	75.55	1.83	0.5484	100.4077	1.4388	0.1595
0.0043	74.54	2.84	0.5448	100.4854	1.4551	0.2470
0.0064	73.55	3.83	0.5412	100.5523	1.4714	0.3327
0.0086	72.59	4.79	0.5376	100.6089	1.4877	0.4167
0.0107	71.64	5.74	0.5341	100.6555	1.5041	0.4990
0.0129	70.71	6.67	0.5306	100.6925	1.5206	0.5797
0.0150	69.80	7.58	0.5272	100.7201	1.5372	0.6589
0.0171	68.91	8.47	0.5238	100.7388	1.5537	0.7366
0.0193	68.03	9.35	0.5205	100.7487	1.5704	0.8127
0.0214	67.17	10.21	0.5172	100.7504	1.5071	0.8875

From Table 1 & 2 it is observed that ultrasonic velocity increases while intermolecular free length decreases with increase in concentrations. This decrease in free length (L_f) with molar concentration may be due to dipolar association between the molecules. It is also supported by decrease in isentropic compressibility (Table 2) in the binary mixture.

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.[12-13]

Conclusion

The reason behind the association in the present polar-non polar system may be weak dipole-induced dipole type of interaction. London dispersion forces may also lead to association in the sulphaguanidine-CTC system.

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