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Molecular Interaction In Aqueous Solution of Ceftriaxone Sodium and Cefotaxime Sodium : An Ultrasonic Study

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ABSTRACT

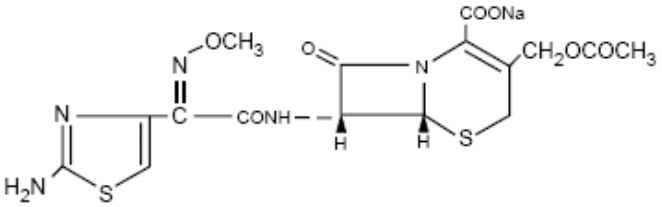
Ultrasonic velocity, viscosity and density have been measured for antibiotic Cefotaxime sodium and Ceftriaxone sodium in water at different concentrations, temperatures and frequency at 2MHz. As the acoustical parameters like relative association, specific acoustic relaxation time and free volume would be more useful to predict the molecular interaction. By using ultrasonic velocity, viscosity and density of the prepared solution of Cefotaxime sodium and Ceftriaxone sodium in water these acoustical parameter have been determined. It has been identified that the molecular interactions in aqueous solution of Cefotaxime sodium were stronger than that of in aqueous solution of Ceftriaxone sodium. And also there is a strong solute - solvent interaction occurring in aqueous solution of Cefotaxime sodium than that of aqueous solution of Ceftriaxone sodium.

Keywords : Viscosity, density, Ultrasonic velocity, Cefotaxime sodium, Ceftriaxone sodium

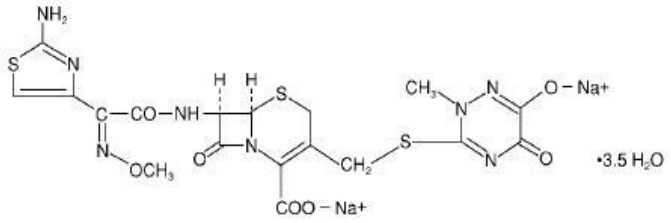
I. INTRODUCTION

Ultrasound creates number of applications in medicine and research. After first antibiotic penicillin invention number of natural, semi synthetic and synthetic antimicrobials were discovered and applied in clinics, achieving great progress in bacterial infection therapy[1]. However, many decades later, Due to lack of new drug development and rapid emergence of resistant bacteria, bacterial infections have again become a serious threat [2]. To understand the physical and chemical properties of drug action, it is necessary to consider the bonds formed by drug molecules which are influenced by thermal agitation and chemical invironment[3]. A number of researchers[4-15]have investigated molecular interaction in aqueous solution of different antibiotics. In pharmaceuticals Cefotaxime sodium and Ceftriaxone sodium is used as an antibiotic.

Cefotaxime sodium -



Ceftriaxone sodium –



Comparative study of Cefotaxime sodium and Ceftriaxone sodium was studied at different temperature, concentration and at 2MHz frequency in the investigation. Intermolecular interactions in aqueous solution of Cefotaxime sodium and Ceftriaxone sodium have been investigated on the basis of acoustical and thermodynamic parameters like relative association, specific acoustic relaxation time and free volume.

II. EXPERIMENTAL

From Alkem laboratories Limited cefotaxime sodium obtained and ceftriaxone sodium obtained from Prosperity 6 pharmaceutics Limited was used as a antibiotic. All the chemicals used were of analytical grade. For preparation of solutions double distilled water was used. Using specific gravity bottle densities of various solutions were measured. These values were accurate up to ± 0.1 kg/m^3. For measurement of Viscosities of the various solutions Oswald's viscometer was used. A special thermostatic water bath was used for measurement of density and ultrasonic velocity during which temperature variation was maintained within ±0.01^{0}C. For measurement of ultrasonic velocity of various solutions Multi frequency interferometer (Mittal Enterprises, Model F-83) with accuracy of ±0.03% was used. CA-124 (CB/CA/CT series, Contech) digital electronic balance having an accuracy of ± 0.0001g was used for weighing.

III. RESULT AND DISCUSSION

Measurements of densities, viscosities and ultrasonic velocities of water and aqueous solution of cefotaxime sodium and ceftriaxone sodium have been made in the present investigation.

Specific acoustic relaxation time is calculated by equation as

$$\tau = 4/3\beta.\eta \qquad \ldots\ldots (1)$$

Relative association is calculated by the equation as

$$R_A = \frac{d_s}{d_0}\left(\frac{v_0}{v_s}\right)^{1/3}$$

Where, v_0 and v_s are ultrasonic velocities in solvent and solution respectively.

Free volume is calculated by following equation as

$$V_f = [M_{eff}v/K\,\eta]^{3/2} \qquad \ldots\ldots.(3)$$

Where, M_{eff} is effective molecular weight, K is a temperature independent constant which is equal to 4.28×10^9 for all liquids.

Viscosity of Solution is calculated by equation as

$$\eta_2 = \eta_1.t_2.d_s/t_1.d_0 \qquad \ldots\ldots (4)$$

Where, η_1=viscosity of water, η_2= viscosity of experimental liquid, t_1=time flow of water, t_2=time flow of experimental liquid, d_0=density of water and d_s=density of experimental liquid.

For aqueous solution of cefotaxime sodium and ceftriaxone sodium the values of ultrasonic velocities, densities, viscosities, specific acoustic relaxation time, relative association and free volume at different concentrations, temperatures and frequency at 2MHz are tabulated in table 1 and 2 respectivel

Table 1 : Acoustic parameters of aqueous solution of Cefotaxime sodium at 2MHz.

Temperature (K)	Concentration (M)	Ultrasonic Velocity (m/s)	Density (Kg/m^3)	Viscosity $\eta x10^3$ (NSm^{-2})	Specific relaxation time $\tau x10^{-10}$ (sec)	Relative association (R_A)	Free Volume $V_f x10^{-8}$ (m3/mole)
303.15	0.001	1489.33	1016.16	0.8699	5.13	1.0225	1.27
	0.01	1491.21	1025.55	0.9301	4.19	1.0315	1.41
	0.1	1524.10	1043.55	1.1765	6.46	1.0420	2.20
308.15	0.001	1526.54	1006.14	0.9168	4.32	1.0143	1.43
	0.01	1527.13	1016.52	0.9262	5.50	1.0246	1.46
	0.1	1564.90	1039.00	0.9467	5.26	1.0388	1.66
313.15	0.001	1563.38	999.53	0.7559	3.85	1.0004	1.11
	0.01	1528.29	1010.52	0.7642	4.12	1.0191	1.10
	0.1	1637.99	1038.66	0.7855	4.05	1.0235	1.34

Table 2 : Acoustic parameters of aqueous solution of Ceftriaxone sodium at 2MHz.

Temperature (K)	Concentration (M)	Ultrasonic Velocity (m/s)	Density (Kg/m^3)	Viscosity $\eta x10^3$ (NSm^{-2})	Specific relaxation time $\tau x10^{-10}$ (sec)	Relative association (R_A)	Free Volume $V_f x10^{-8}$ (m3/mole)
303.15	0.001	1488.09	1025.40	0.8431	4.9508	1.0321	1.2128
	0.01	1488.34	1030.70	0.8736	5.1022	1.0374	1.2873
	0.1	1489.44	1054.37	1.1529	6.5722	1.0609	2.0700
308.15	0.001	1524.32	1020.93	0.7507	4.2197	1.0297	1.0600
	0.01	1525.20	1026.42	0.7794	4.3523	1.0350	1.1300
	0.1	1525.49	1044.61	1.0019	5.4956	1.0533	1.7400
313.15	0.001	1554.55	1015.52	0.6720	3.6511	1.0183	0.9220
	0.01	1563.54	1016.94	0.7208	3.8670	1.0178	1.0400
	0.1	1598.64	1038.52	0.8508	4.2745	1.0317	1.4600

From Table1 it is observed that for aqueous solution of cefotaxime sodium at 2MHz frequency, values of ultrasonic velocity increases with increases in concentration and temperature. Increase in ultrasonic velocity is due to addition of solute is indicative of greater association of molecules which in turn due to effective solute-solvent interaction. Molecular forces weaken due to increase in concentration and hence change in velocity is observed. On increasing the concentration, ultrasonic velocity increases indicate

greater solute -solvent interaction due to formation of hydrogen bond between molecule of cefotaxime sodium and water. The value of density and viscosity deceases with increase of temperature and same increases with increase in concentration. Increase in temperature, values of density and viscosity decrease shows decrease in intermolecular forces due to increasing the thermal energy of the system. Moderate attraction between solute and solvent molecules reflect due to increasing values of density, viscosity and ultrasonic velocity. Relaxation time and relative association decreases with rise in temperature and same increases with increase in concentration. This suggests between molecules of solute cefotaxime sodium and solvent water strong intermolecular interaction. Free volume increase with increasing concentration and temperature suggests molecular packing in medium increase this supports strong of molecular interaction in aqueous solution of cefotaxime sodium.

Table 2 suggests at 2MHZ frequency, with increases in concentration and temperature values of ultrasonic velocity of aqueous solution of ceftriaxone sodium increases. The increased values of ultrasonic velocity indicate of greater molecular association due to cohesion brought by the ionic hydration and also due to effective solute-solvent interaction. With increase in concentration relaxation time, relative association and free volume increases and same decreases with increase in temperature. This confirms in aqueous solution cefriaxone sodium presence of specific molecular interaction.

Aqueous solution of cefotaxime sodium has high value of ultrasonic velocity than aqueous solution of ceftriaxone sodium. It reflects that in aqueous solution of cefotaxime sodium strong solute-solvent interaction exists than ceftriaxone sodium. Cefotaxime sodium has low relaxation time, relative association and free volume than ceftriaxone sodium which shows that cefotaxime sodium forms the closely pack structure, high breaking of solvent structure and higher close packing of molecules in aqueous solution of cefotaxime sodium than ceftriaxone sodium. Thus on comparing acoustic and thermodynamic parameters, in aqueous solution of cefotaxime sodium strong intermolecular interaction exists than ceftriaxone sodium.

IV. CONCLUSION

On the basis of acoustic and thermodynamic parameters, it is confirm that in aqueous solution of cefotaxime sodium strong intermolecular interaction exist than ceftriaxone sodium solution. Thus cefotaxime sodium may be thought as potent and more powerful antibiotic than ceftriaxone sodium.

PTh-PEO polymer composites were prepared successfully by in situ chemical oxidative polymerization of thiophene doped with Li2SO4. FTIR study confirms the successful polymerization of polymer composite. The value of transference number of all polymer composite samples was investigated by dc polarization techniques and found to be in the range of 0.80 to 0.89. This suggests that the charge transport in the PTh-PEO composite doped is predominantly due to ions only.

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