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STUDY ACOUSTIC PARAMETER OF AQUEOUS SOLUTION OF HYDROXYCHLOROQUINE AT DIFFERENT CONCENTRATIONS AND TEMPERATURES

S. H. Shrirame Nilkanthrao Shinde Science & Arts college, Bhadrawati dist-Chandrapur Email: Shrirame827528@gmail.com
A. B. Dhote Nilkanthrao Shinde Science & Arts college, Bhadrawati dist-Chandrapur Email: dhoteaparna71@gmail.com

Abstract:
Current scenario ultrasonic study plays major role in determination of reactivity and molecular interaction in liquid solution. other parameter like adiabatic compressibility, intermolecular free length, acoustic impedance are calculated from observed values of ultrasonic velocity, density and viscosity. We understand the hydrogen bonding in solution. Hydroxychloroquine is antimalarial drugs used to treat malaria.

Key Words:
Antimalarial, Hydroxychloroquine, Ultrasonic, Molecular Interaction.

Introduction:

Ultrasonic technique is being used for understanding molecular interaction in aqueous solution and it has many benefits for human being. Ultrasound is a sound which is not audible by human it is above the human audible range. Ultrasonic waves are high frequency with frequencies above 20 kHz. It is non-destructive technique that is why it is used in industrial work. From values of ultrasonic velocity, density and viscosity other thermodynamic parameter calculated on the basis of this data molecular interaction can be predicted. Present work on hydroxychloroquine it is an antimalarial drug used to treat malaria. Ultrasound technique has many applications in medical field such as sonography, cardiology, obstetrics and other internal medicines[1-3].

Now days Ultrasonic technique employ major role in electronics, agriculture, chemical and pharmaceuticals, oceanography, food processing, testing of material and mechanical machinery of materials. There is some interest in realizing intermolecular interactions in liquid mixtures. Thermoacoustic properties of pure and liquid mixtures of organic compound are having great importance in the field of science and industrial engineering. The thermodynamic parameter like intermolecular free length, acoustic impedance, adiabatic compressibility is being used to study various intermolecular interactions between solute and solvent in solution.[4-6].

A drug is a natural or synthetic substance when taken into a living body affect its functioning and is used to diagnosed mitigate, treat or prevent of disease the substance that Couse change in a change in an organism's psychology or physiology when consumed. drugs can be Consumed via inhalation, injection, and smoking, and ingestion, absorption via a patch on the skin, suppository, or dissolution under the tongue. Antimalarial drugs are being used for the prevention and treatment of malaria infection. Many antimalarial drugs that target the erythrocyte stage of malaria infection. Hydroxychloroquine is an antibiotic that also can be used to prevent malaria. Hydroxychloroquine is a partially efficacious causal prophylactic (liver stage of Plasmodium) drug and a slow acting blood schizontocidal agent highly effective for the prevention of malaria[7-10].

In the present work ultrasonic velocity, density and viscosities of aqueous solution of Hydroxychloroquine at different concentration's (0.001M, 0.01M and 0.1M) and at different temperature (298.15K, 303.15K and 308.15K) was measured. This data is useful to calculate thermodynamic parameters such as adiabatic compressibility, Intermolecular free length, Specific impedance. From these reactivity and molecular interaction of the drug is predicted.

The structure of Hydroxychloroquine is

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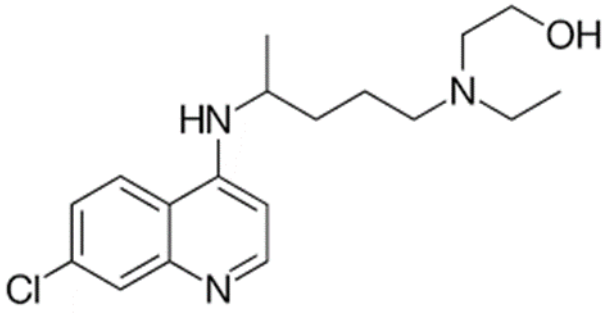

Experimental:

Ultrasonic velocities (U) in solution of Hydroxychloroquine (0.001, 0.01 and 0.1M) were measured by using an ultrasonic interferometer (Mittal type, model F-81) operating at 2MHz frequency and temperature 298K, 303K and 308K. The accuracy of the speed of sound was ±0.1 ms-1. The temperature maintain by digitally controlled constant temperature water bath is used to circulate water through a steel double-walled measurement chamber containing the experimental solution at the desired temperature.

1. Ultrasonic velocity:

Ultrasonic velocity in solutions are directly measured by ultrasonic interferometer.

$$V = \lambda . f \qquad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

λ is the wave length of ultrasonic wave to excite the crystal.

f is the frequency of generator.

2. Density

Density of solutions were determined using specific gravity density bottle by relative measurement method with an accuracy of ±0.1Kgm-3.

$$d = M/V \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where,

d is density of solution

M is mass of solution

V is volume of solution

3. Viscosity

Viscosity of solutions were determined by using Ostwald viscometer.

The viscosity of solution is calculated by using

$$\eta_L = \eta_W \times \rho_L t_L / \rho_W \times t_W \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where,

η_W = Absolute viscosity of water

t_W = Time of flow of water

ρ_W = Density of water

η_L = Absolute viscosity of liquid

t_L = Time of flow of liquid

ρ_L = Density of liquid

4. Adiabatic compressibility

The relation of adiabatic compressibility with ultrasonic velocity is reverse i.e. it is inversely proportional to ultrasonic velocity it is calculated by following formula.

$$\beta = 1 / v2.d \qquad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where, v is the velocity of ultrasonic waves.

d is density.

5. Intermolecular Free Length

The intermolecular free length depends on the adiabatic compressibility and exhibits similar behaviour as the inverse of the adiabatic compressibility and ultrasonic velocity.it is calculated by following formula.

$Lf = K\sqrt{\beta}\, s$ …….. (5)

Where, Lf is Intermolucular free length, β is adiabatic compressibility and K is temperature dependence constant known as Jacobson's constant and is independent of the nature of liquid.

6. Specific acoustic impedance

Specific acoustic impedance makes the contribution in explaining molecular interactions. Specific acoustic impedance is the complex ratio of the effective sound pressure at a point to the effective particle velocity at that point to effective particle at that point. Specific acoustic impedance is determined from ultrasonic velocity and density by formula,

$Z = vs\ .ds$ …….. (6)

Where,
Z is Specific acoustic impedance
vs is ultrasonic velocity and
ds is density of solution

Result & Discussion:

Table 1: Ultrasonic velocity, densities, viscosities adiabatic compressibility's, intermolecular free length acoustic impedance of aqueous solution of Hydroxychloroquine at different concentrations and at 298K

Sr. No	Concentration (M)	Ultrasonic Velocity (m/s^{-1})	Density ($Kg.m^{-3}$)	Viscosity ($N.s.m^{-2}$)	Adiabatic Compressibility*10^{-10}	Intermolecular Free length (A^0)	Specific impedance *10^4
1	0.001	1375.2	1049.2	0.94	5.039	0.0140	144.2
2	0.01	1402.5	1050.8	0.97	4.837	0.0137	147.3
3	0.1	1433.3	1061.2	1.21	4.586	0.0134	152.1

Table 2: Ultrasonic velocity, densities, viscosities adiabatic compressibility's, intermolecular free length acoustic impedance of aqueous solution of Hydroxychloroquine at different concentrations and at 303K

Sr. No	Concentration (M)	Ultrasonic Velocity (m/s^{-1})	Density ($Kg.m^{-3}$)	Viscosity ($N.s.m^{-2}$)	Adiabatic Compressibility*10^{-10}	Intermolecular Free length (A^0)	Specific impedance *10^4
1	0.001	1391.9	1047.2	0.80	4.928	0.0139	145.7
2	0.01	1445.7	1050.1	0.83	4.556	0.0133	151.8
3	0.1	1458.4	1060.8	0.97	4.432	0.0132	154.7

Table 3: Ultrasonic velocity, densities, viscosities adiabatic compressibility's, intermolecular free length acoustic impedance of aqueous solution of Hydroxychloroquine at different concentrations and at 308K

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Sr. No	Concentration (M)	Ultrasonic Velocity (m/s^{-1})	Density ($Kg.m^{-3}$)	Viscosity ($N.s.m^{-2}$)	Adiabatic Compressibility*10^{-10}	Intermolecular Free length (A^0)	Specific impedance *10^4
1	0.001	1395.5	1045.2	0.70	4.912	0.0138	145.8
2	0.01	1480.8	1049.2	0.72	4.346	0.0130	155.3
3	0.1	1499.2	1058.4	0.86	4.203	0.0128	158.6

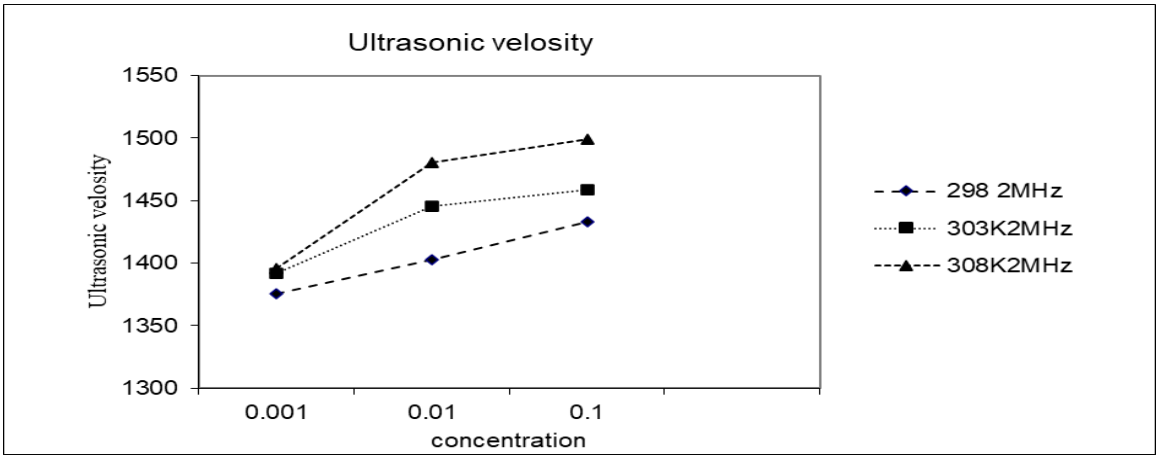

Fig.1: Variation of ultrasonic velocity with concentration and temperatures

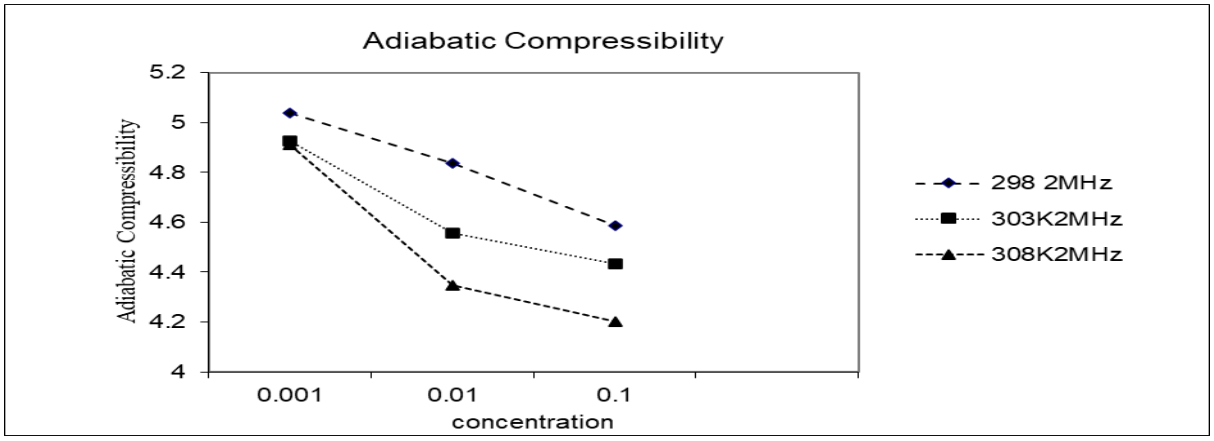

Fig.2: Variation of adiabatic compressibility with concentration and temperatures

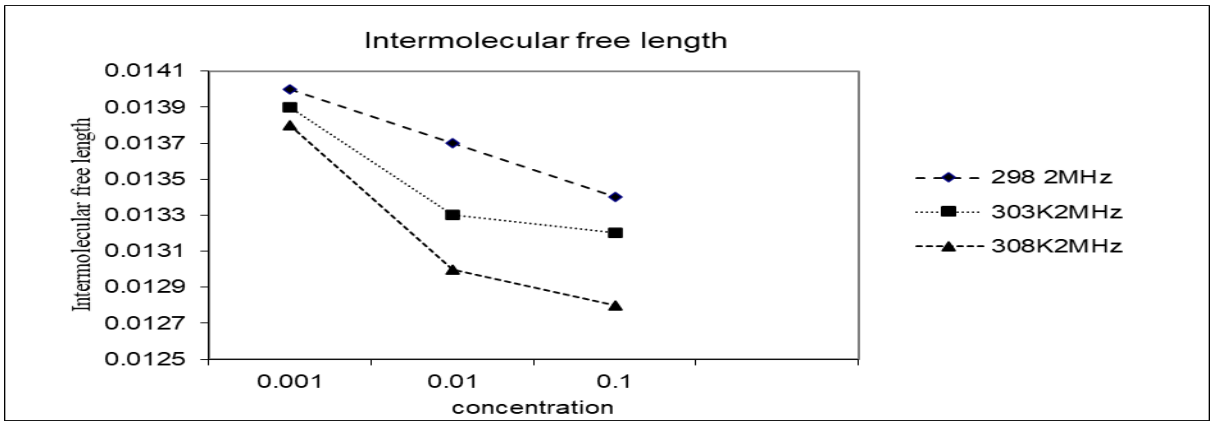

Fig.3: Variation of Intermolecular Free Length with concentration and temperatures

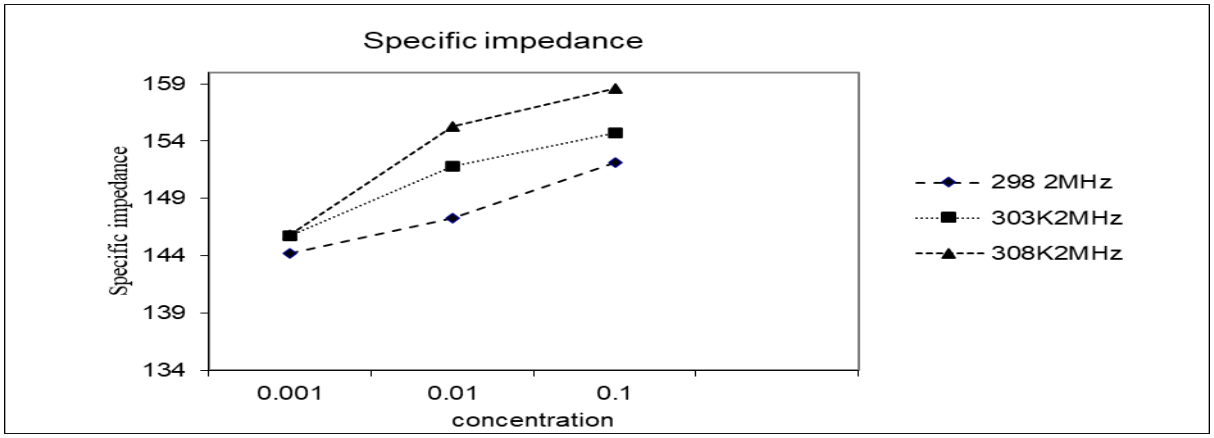

Fig.4 variation of Specific impedance with concentration and temperatures.

From above tables shows acoustic parameters which were determined form the measured values of ultrasonic velocity, viscosity and density.

From the above table 1, 2, 3 and fig. 1, 2, 3 and 4 we concluded that the ultrasonic velocity of the Hydroxychloroquine solution increases with temperature and concentrations. Density and viscosity increase with concentration but decrease with temperature This linear increase in velocity, with concentration it cleared that an increase cohesive forces because of strong molecular interactions[10].

From table values of 1, 2, 3 and fig. 2, 3 decrease of adiabatic compressibility and intermolecular free length with concentration and temperature it is clear that solute solvent interactions. This indicates a strong intermolecular interaction between solute and solvent molecules due to formation of hydrogen bonding between hydroxychloroquine and water molecule. From fig.4 Acoustic impedance increases with increase in concentration and temperatures suggest strong molecular interaction between Hydroxychloroquine and water molecules[11-12].

Conclusion

From the above values of ultrasonic velocity, density, viscosity, adiabatic compressibility, Intermolecular free length free length and acoustic impedance it concluded that strong solute solvent interaction presents in 0.1M solution of Hydroxychloroquine at 308 K.

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