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# Variation of Wada Constant, Raos Constant and Acoustic Impedance of Aqueous Cholesteryl Oleyl Carbonate with Temperature

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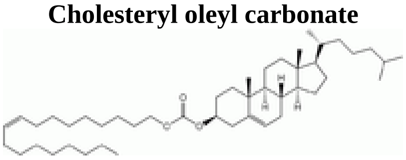
**Abstract:-** The behaviour of ultrasonic wave propagation through liquid solution has become an important tool for studying physical and chemical properties of liquid solutions. The density, viscosity and ultrasonic velocity of of cholesteryl oleyl carbonate have been studied. From the experimental data various thermo acoustical parameters such as free volume, internal pressure and Rao's constant and Wada's constant have been evaluated. Molecular interactions in aqueous cholesteryl oleyl carbonate in terms of these thermo-acoustical parameters have been discussed.

**Keywords:-** Rao's constant, Wada's constant, refractive index,density, acoustic impedance

## I. INTRODUCTION

**Cholesteryl oleyl carbonate** (COC) is an organic chemical, an carbonate ester of cholesterol and oleyl alcohol with carbonic acid. It is a liquid crystal material forming cholesteric liquid crystals with helical structure. It is a transparent liquid,or a soft crystalline material with melting point around 20 °C. It can be used with cholesteryl nonanoate and cholesteryl benzoate in some thermochromic liquid crystals. It is used in some hair colors, make-ups, and some other cosmetic preparations. It can be also used as a component of the liquid crystals used for liquid crystal displays.

**Cholesteryl oleyl carbonate**



| | |
|---|---|
| Molecular formula | $C_{46}H_{80}O_3$ |
| Molar mass | 681.13 g/mol |

## II. EXPERIMENTAL

Stock solution of a aqueous cholesteryl oleyl carbonate was prepared in doubled distilled water. The densities of pure solvent and their solutions were measured with accuracy 0.0001 g/cm3.The ultrasonic velocity of Pure solvent and their solutions were measured by using digital ultrasonic interferometer operating at 2 MHz. All the measurements were carried out at 302.15 K. The uncertainty of temperature is 0.1 K and that of concentration is 0.0001 mol/dm3. Viscosity was measured with Ostwald viscometer. Uncertainties in the measured viscosities were within ±0.03%. The thermodynamic parameters such as Rao's constant (R) and Wada's constant(W) using ultrasonic velocity, density and viscosity data have been evaluated. The experimental data of ultrasonic velocity (U),viscosity and Rao's constant(R) ,Wada's constant(W) are given in Table 1 & 2

## III. THEORY

The velocity of ultrasonic waves in the liquid mixture have been measured using an ultrasonic interferometer (Mittal Enterprises, New Delhi) working at a fixed frequency of 2MHZ with a tolerance of ± 0.005%. The measuring cell is a specially designed doublewalled vessel with provision for temperature constancy. The high frequency generator excites a quartz crystal fixed at the bottom of the measuring cell, at its resonant frequency. The capacity of the measuring cell is 12cc. A fine micrometer screw, with a least count of 0.01mmm at the top of the cell, can be raised (or) lowered the reflector plate in the liquid through a known distance. The measuring cell is connected to the output terminals of the high frequency generator through a shielded cable. Ultrasonic waves, normal to quartz crystal, are reflected from the reflector plate. Stationary waves are formed in the region between reflector plate and the quartz crystal. The micrometer is slowly moved till a number of maximum readings (n) of the anode current is passed. The total distance moved by the micrometer is noted (d). From the experimental data of density and ultrasonic velocity and viscosity of pure solvent and solutions, various acoustical parameters were calculated using following standard equations.

Viscosity ($\eta s$)
$\eta s = (\rho s ts/\rho w tw)\ \eta w$
Where
$\eta s$ and $\eta w$ are the viscosities of liquid solution and water respectively
$\rho s$, $\rho w$ are densities of solution and water respectively
& ts, tw are flow rate of solution and water respectively
Rao's constant (R)
R = [Mw/ $\rho s$ ] x U1/3
Wada constant (W)
W=[ Mw/ $\rho s$ ] x $\beta$-1/7
Where $\beta$ is an adiabatic compressibility
**Acoustic Impedance (Z)**
The Specific acoustic impedance is given by
Z = U$\rho$
Where U and $\rho$ are velocity and density of liquid respectively

**Table 1.** Variation of density, ultrasonic velocity and raos constant,wada constant of aqueous cholesteryl oleyl carbonate

| Abs. Temp | c | $n_D$ | □ x $10^{-3}$ | □a x $10^{10}$ | Z x $10^{-6}$ | $R_n$ x $10^{26}$ | $B_w$ x $10^{26}$ |
|---|---|---|---|---|---|---|---|
| | m/s | | Kg $m^{-3}$ | $m^2 N^{-1}$ | Kg $m^{-2}$ | $m^{10/3} s^{-1/3}$ | $m^{20/7} kg^{1/7} s^{-2/7}$ |
| 303 | 1748 | 1.504 | 0.9829 | 3.33 | 1.72 | 1.39 | 2.60 |
| 304 | 1568 | 1.503 | 0.9807 | 4.15 | 1.54 | 1.34 | 2.52 |
| 305 | 1492 | 1.502 | 0.9786 | 4.59 | 1.46 | 1.32 | 2.49 |
| 306 | 1504 | 1.501 | 0.9740 | 4.54 | 1.46 | 1.33 | 2.51 |
| 307 | 1420 | 1.497 | 0.9731 | 5.10 | 1.38 | 1.31 | 2.47 |
| 308 | 1456 | 1.497 | 0.9720 | 4.85 | 1.42 | 1.32 | 2.49 |
| 309 | 1616 | 1.496 | 0.9701 | 3.95 | 1.57 | 1.37 | 2.57 |
| 310 | 1624 | 1.495 | 0.9680 | 3.92 | 1.57 | 1.37 | 2.58 |

**Table 2.** Variation of Raos constant, adiabatic compressibility with temperature

| Abs. Temp | n□/2 | □ | c | $n_D$ |
|---|---|---|---|---|
| | mm | mm | m/s | |
| 303 | 4.37 | 0.874 | 1748 | 1.504 |
| 304 | 3.92 | 0.784 | 1568 | 1.503 |
| 305 | 3.73 | 0.746 | 1492 | 1.502 |
| 306 | 3.76 | 0.752 | 1504 | 1.501 |
| 307 | 3.55 | 0.71 | 1420 | 1.497 |
| 308 | 3.64 | 0.728 | 1456 | 1.497 |
| 309 | 4.04 | 0.808 | 1616 | 1.496 |

**Table 3.** Variation of acoustic impedance, vanderwalls constant

| □ | □ | Z(=□c) |
|---|---|---|
| g/cc | kg/$m^3$ | Sp. Acoustic impedance |
| 0.9829 | 982.90 | 1.72E+06 |
| 0.9807 | 980.70 | 1.54E+06 |
| 0.9786 | 978.60 | 1.46E+06 |
| 0.9740 | 974.00 | 1.46E+06 |
| 0.9731 | 973.10 | 1.38E+06 |
| 0.9720 | 972.00 | 1.42E+06 |

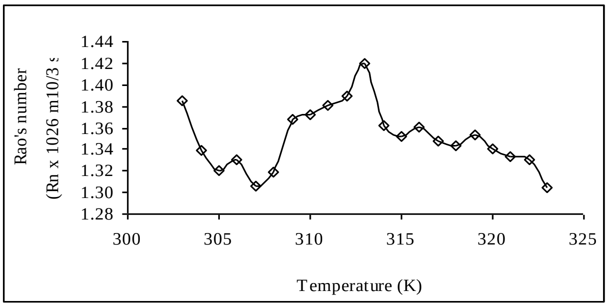
## IV. RESULT AND DESCUSSION

It is observed that viscosity increases with rise in concentration. This indicates that there exists a strong interaction between solute and solvent which is also supported by ultrasonic velocity. The variation of raos constant with temperature is as shown in Fig. 1 The molecules of liquid are not closely packed and as such there is always some free space between them. The wada constant changes with temperature as shown in Fig. 2 which shows that solute solvent molecules are coming close to each other and the space between them is decreasing with rise in temperature. This supports to the strong solute – solvent interaction in liquid solution.Internal pressure is the fundamental property of liquid which provides an excellent basis for examining the solution phenomena and studying the various properties of the liquid state. It is a measure of change in internal energy of liquid solution as it undergoes a very small isothermal change. It is a measure of cohesiveor binding forces between the solute and solvent interaction. It is found that vanderwalls constant is increasing with increasing temperature as shown in Fig. 3. This shows that binding forces between the solute and solvent in liquid solution are becoming stronger which shows that there exists a strong molecular interaction or binding forces between the solute and solvent interaction. It is found that vanderwalls constant is increasing with increasing temperature as shown in Fig. 3. This shows that binding forces between the solute and solvent in liquid solution are becoming stronger which shows that there exists a strong molecular interaction.

| **$\square_a(=1/\square c^2)$ adiabatic compressibility** | | **$R_n(=Mc^{1/3}/\square)$ Rao's no.** |
|---|---|---|
| 3.33E-10 | 3.33 | 1.3857E-26 |
| 4.15E-10 | 4.15 | 1.3394E-26 |
| 4.59E-10 | 4.59 | 1.3202E-26 |
| 4.54E-10 | 4.54 | 1.3300E-26 |
| 5.10E-10 | 5.10 | 1.3059E-26 |
| 4.85E-10 | 4.85 | 1.3184E-26 |
| 3.95E-10 | 3.95 | 1.3677E-26 |

| **b van der wall's constant** | **$r(=[3b/16\square N]^{1/3})$ effective molecular redius** |
|---|---|
| 0.693 | 4.095E-09 |
| 0.694 | 4.098E-09 |
| 0.695 | 4.101E-09 |
| 0.699 | 4.107E-09 |
| 0.699 | 4.108E-09 |
| 0.700 | 4.110E-09 |
| 0.702 | 4.113E-09 |

**Fig.1** variation of raos constant with temperature




## V. CONCLUSIONS

Ultrasonic velocity and density have been measured for aqueous solution of cholesteryl oleyl carbonate of at 2 MHz. Viscosity and internal pressure increases with concentration shows solute Solvent interaction present in the solution and are stronger. The Wada's constant and Rao's constant decreases with rise in concentration. This shows that solute solvent interaction in the system takes place and supports the facts.

## REFERENCES

[1]. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, 8th edition,

edited byRobert.
[2]. P. K. Mishra, A. Dash, B. Behra, B. B. Swain and V. Chakravortty, Acoustics lett., 19 (1995) 99.
[3]. S. Baluja and S. Oza, Fluid Phase Equilibria, 2005, 200 (1), 49-54
[4]. M. K. Ravat and Sangeeta, Indian Journal of Pure and Applied Physics, 2008, 46, 187-192
[5]. A. Ali and A. K. Nain, Acoustic lett. , 1996, 19-53.
[6]. H. Ogawa and S. J. Murakami, J. Solution Chem., 1987, 16, 315,
[7]. S. D. Deoskarkar, M, M. L. Narwade, Rasayan J. Chem., 2010, 3(1), 55-59
[8]. C.V. Suryanarayana, J. Acoust. Soc. Ind., 4, 111, 197.
[9]. K. Sreekanth, D.Sravana, M. Kondaiah, and D. KrishnaRao, J., Chem.Pharm. Res. 2011, 3(4), 29.
[10]. V. D. Bhandakkar, O.P. Chimankar, N.R. Pawar. J. Chem. Pharm. Res., 2010, 2(4), 873.
[11]. L.R.Lagemann and Dunbar W.S.N., J Phys. Chem., 1995, 49.
[12]. A. Wissler., J. Amer Chem. Soc., 1949, 71, 1272.
[13]. S.S.Aswale, P.B. Raghuwanshi, D.T.Tayde. and S. R. Aswale, J. Indian Chem. Soc., 2007, 84, 159.
[14]. S.J. Bhatti, J. S. Vivk and Sing D. P., Acoustica (Germany), 1982, 50, 291.
[15]. A.Nithya, S. Nithyanandhan, S. Mullainthan and M. Rajasekaran, E-Journal of Chemistry, 2009, 6(1), 138.
[16]. K.Patil, V.Umare, International journal of research in pure and applied Physics, 2012, 2(4), 25-27.

**Fig. 2** Variation of Wada's constant with temoerature

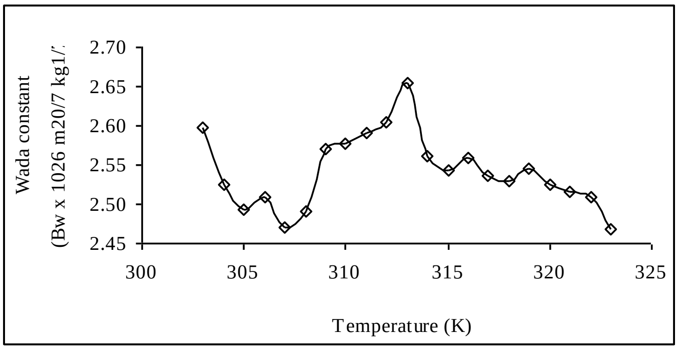



**Fig 3.** Variation of vanderwalls constant with temperature