ACOUSTIC PARAMETERS OF CHOLESTERYL OLEYL CARBONATE AT VARIOUS TEMPERATURE

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ABSTRACT

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.For this certain important physical parameters such as adiabatic compressibility, specific acoustic impedance, relative association, intermolecular free length, relaxation time, free volume, Rao's constant, Wada's constant etc. are evaluated using ultrasonic velocity, density and viscosity of Cholesteryl oleyl carbonate at different temperatures..

Key Words: Cholesteryl oleyl carbonate , Raos constant, acoustic parameters, ultrasonic velocity.

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INTRODUCTION

As gas is characterized by three variables such as temperature, pressure and volume liquid is characterized by parameters free volume, internal pressure and temperature. The associate nature of water with solute is learnt by its hydration Number [1]. While its structure making or breaking property is got from its free volume and internal pressure. To determine these parameters the ultrasonic velocity is a simple probe used by physicist along with basic quantities like density and viscosity [2]. The physico-chemical behavior and molecular interaction in pure liquid components and their mixtures is studied on the basis of acoustic and thermodynamic properties[3].The ultrasonic study is also useful to understand behavior of biomolecules [4]. Literature survey shows that ultrasonic study of liquid mixture is highly useful in understanding the nature of molecular interaction [5-7] and physicochemical behavior of liquid mixture[8-10]. In continuation of our work [11-12] in the present investigation the ultrasonic velocity, density and viscosity of 0.01M Cholesteryl oleyl carbonate at different temperature is measured and acoustic and thermodynamic parameters have been calculated. From these parameters the effect of temperature on molecular interaction is interpreted.

EXPERIMENTAL SECTION

We have used the ultrasonic Interferometer (Mittal Enterprises Make) for the observation of ultrasonic velocity (C) and knowing the frequency we can find out various parameters such as adiabatic compressibility, Rao No. and temperature variation using temperature bath. An ultrasonic interferometer is a widely used device to determine the ultrasonic velocity in liquids with high precision. The principle applied in the measurement of ultrasonic velocity (C) is based on the accurate determination of the wavelength (λ) in the medium. Ultrasonic wave of known frequency (ν) are generated by a quartz crystal fixed at the bottom of the measuring cell. These waves are reflected by movable metallic plate kept parallel to the quartz crystal. If the separation between these two (i.e. quartz crystal and metallic plate) is exactly a whole multiple of sound wavelength, the standing waves are formed in the medium. This acoustic resonance gives a reactionary electrical response in the form of an anode current on the frequency generator deriving the crystal. If the distance between the plate and crystal is now increased and decreased and the variation is exactly one half wavelength ($\lambda/2$)

or a multiple of it, the anode current of the frequency generator becomes maximum. By knowing the wavelength (λ), the ultrasonic velocity can be calculated by the relation

C(velocity) = λ (wavelength) × ν (frequency)

Some Formulae of the parameters to be calculated

The adiabatic compressibility (β_a) of the system is

(1) $$\beta_a = \frac{1}{\rho C^2}$$

The specific acoustic impedance (Z) is expressed as

(2) $$Z = \rho . C$$

The molar sound velocity or Rao's number (R_n) is

(3) $$R_n = \left(\frac{M}{\rho}\right) . C^{1/3}$$

And molar compressibility or Wada constant (B_w)

$$B_w = \left(\frac{M}{\rho}\right) \beta_a^{-1/7}$$

where, C is the ultrasonic velocity, ρ is the density and M is the molecular weight of the compound taken.The experimentally determine values are listed in table -1.

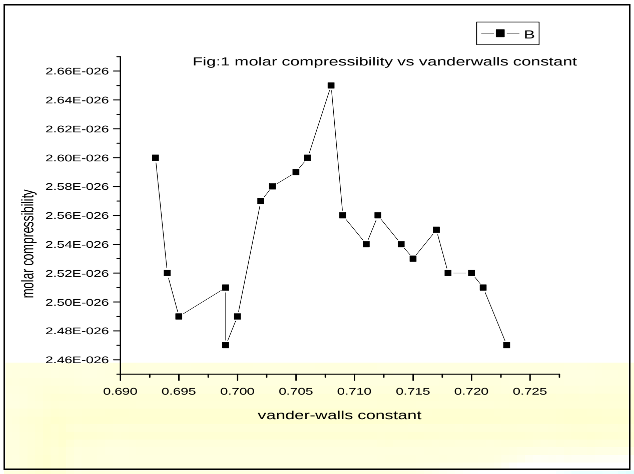
Table 1 : Thermodynamic parameters of Cholesteryl oleyl carbonate

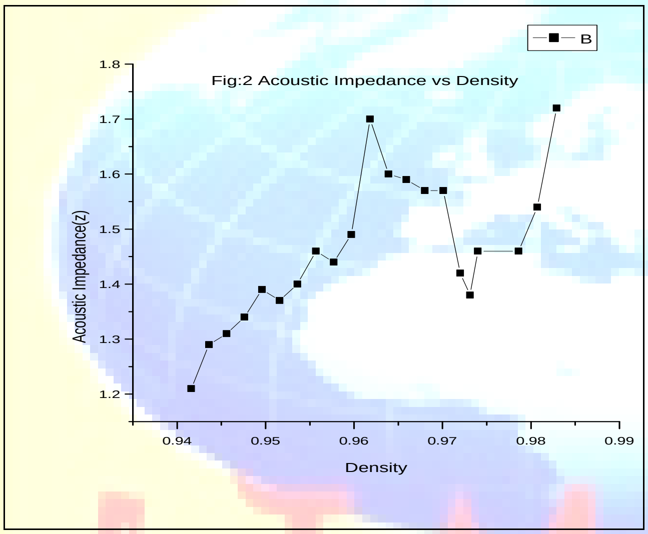
Abs. Temp	Va(=(M/ρ){1-c_{exp}/c_α})	R_n x 10^{26} $m^{10/3}$ $s^{-1/3}$	B_w x 10^{26} $m^{20/7}$ $kg^{1/7}$ $s^{-2/7}$	γ(=1-c_{exp}^2/c_α^2) relaxation strength
303	-0.064	1.39	2.60	-0.194
304	0.014	1.34	2.52	0.040
305	0.047	1.32	2.49	0.130
306	0.042	1.33	2.51	0.116
307	0.079	1.31	2.47	0.212
308	0.063	1.32	2.49	0.172
309	-0.007	1.37	2.57	-0.020
310	-0.011	1.37	2.58	-0.030
311	-0.019	1.38	2.59	-0.056
312	-0.026	1.39	2.60	-0.076
313	-0.073	1.42	2.65	-0.216
314	0.023	1.36	2.56	0.064
315	0.044	1.35	2.54	0.121
316	0.034	1.36	2.56	0.093
317	0.059	1.35	2.54	0.158

318	0.070	1.34	2.53	0.185
319	0.059	1.35	2.55	0.158
320	0.083	1.34	2.52	0.217
321	0.095	1.33	2.52	0.247
322	0.105	1.33	2.51	0.269
323	0.143	1.31	2.47	0.356

Table 2:

Abs. Temp	Z x 10^{-6} Kg m^{-2}	M_r(=(M/ρ) {n^2-1/n^2+2}) Molar refraction	n_D	ρ g/cc
303	1.718109	0.205188	1.504	0.9829
304	1.537738	0.205303	1.503	0.9807
305	1.460071	0.205397	1.502	0.9786
306	1.464896	0.206019	1.501	0.9765
307	1.381802	0.204814	1.497	0.9743
308	1.415232	0.205046	1.497	0.9722
309	1.567682	0.205096	1.496	0.9701
310	1.572032	0.20519	1.495	0.968
311	1.58794	0.205636	1.495	0.9659
312	1.600074	0.206062	1.495	0.9639
313	1.696615	0.206158	1.494	0.9618
314	1.485616	0.206609	1.494	0.9597
315	1.43655	0.207041	1.494	0.9577
316	1.456487	0.207117	1.493	0.9557
317	1.399885	0.207573	1.493	0.9536
318	1.37411	0.207651	1.492	0.9516
319	1.394013	0.208088	1.492	0.9496
320	1.341802	0.208527	1.492	0.9476
321	1.312493	0.208607	1.491	0.9456
322	1.290845	0.209049	1.491	0.9436
323	1.209014	0.20913	1.49	0.9416





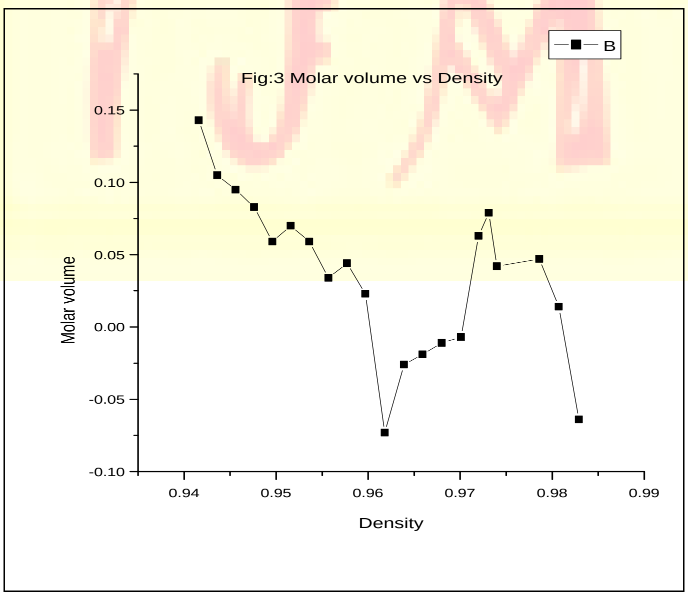
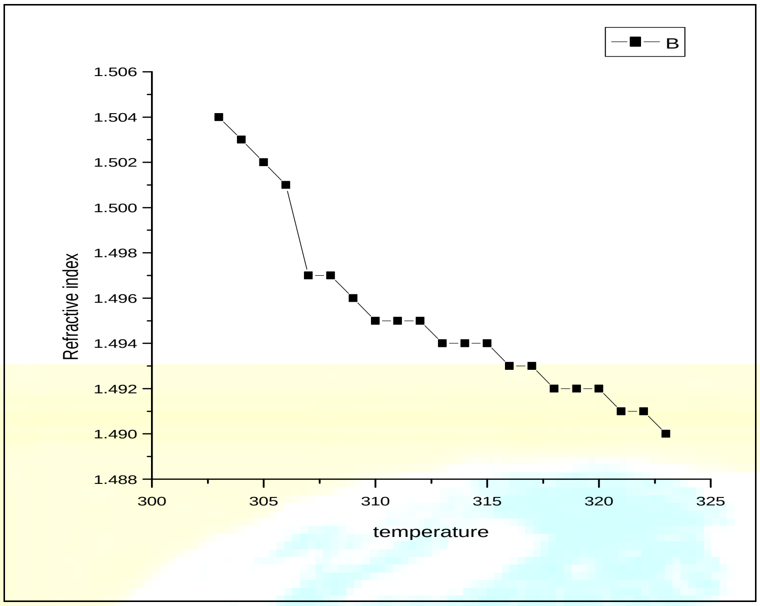
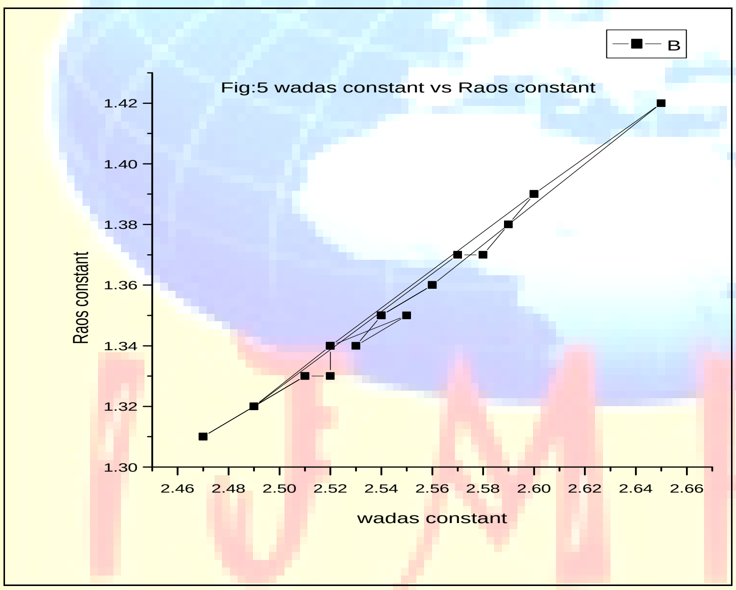


Fig:4 Refractive index vs Temperature


B
1.506
1.504
1.502
1.500
1.498
1.496
1.494
1.492
1.490
1.488
Refractive index
300
305
310
315
320
325
temperature


B
Fig:5 wadas constant vs Raos constant
1.42
1.40
1.38
1.36
1.34
1.32
1.30
Raos constant
2.46
2.48
2.50
2.52
2.54
2.56
2.58
2.60
2.62
2.64
2.66
wadas constant

RESULTS AND DISCUSSION

From the observed values the adiabatic compressibility, specific acoustic impedance, relative association, Rao's constant, Wada's constant were calculated. Rao's constant, also known as molar sound velocity, increases with increasing concentration shows that there is strong interaction between solute and solvent molecules. Wada's constant also known as molar adiabatic compressibility may be considered for existing interaction. Various acoustic parameters were measured and their variations are plotted in the graphs shown. The Wada constant and Rao's constant varies almost linearly in general. Note that these relationships between acoustics parameters were established not for any solute solvent but in general for various types of solvents and shows general interdependence and hence are very important.

CONCLUSION

The acoustical and thermodynamic parameters calculated from measured properties suggest the strong molecular interaction in the solution. Ultrasonic investigations in aqueous solution of Cholesteryl oleyl carbonate give useful information in understanding interaction of solute with solvent.

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