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Determination of Adiabatic Compressibility, Intermolecular Free Length and Specific Acoustic Impedance of Substituted 2-oxo-2H-Chromene-3-Carbohydrazide Derivatives in 60% (DMF+Water) Solvent at 305K

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ABSTRACT

Investigation of adiabatic compressibility (βS), intermolecular free length (Lf) and specific acoustic impedance (Z) of substituted 2-oxo-2H-chromene-3-carbohydrazide derivatives in 60% (DMF+water) Solvent at 305K. The solute solvent interaction is understood from the magnitude of partial molar volume and partial molar compressibility at various concentration.

Keywords: - Substituted 2-oxo-2H-chromene-3-carbohydrazide derivatives, Apparent molal compressibility, Solvation number, Apparent molal volume and Adiabatic compressibility.

I. INTRODUCTION

In the recent years, an ultrasonic study has acquired the status of an important tool to know the structure and properties of matter. Ultrasonic investigations find extensive applications in characterizing and physico-chemical study of binary and ternary liquid mixtures. The ultrasonic velocity measurements are highly sensitive to molecular interaction. Ultrasonic investigation has wide range of application in material science, agriculture, medicine, biology, industry, oceanography and sonochemistry research due to its non-destructive nature . Ultrasonic velocity, density, adiabatic compressibility (βs), intermolecular free length (Lf) and specific acoustic impedance (Z) in binary mixture of substituted azomethine drugs are studied . Ultrasonic velocities have applications in several industrial and technological processes . Ultrasonic studies of substituted imidazolinones in DMF-solvent at constant temperature and different concentrations have done . Acoustic study of 2-hydroxi diethylammonium lactatein in different media at 288-323.15K is done . Acoustical properties of four different drugs have investigated in methanol and water . Specific acoustic impedance (Z), intermolecular free length (Lf) and adiabatic compressibility (βS) are studied for substituted -2, 3- dihydroquinazolin-4(1H)-ones in DMF-water as solvent . Molecular interaction of amide with aliphatic amine in benzene at different temperatures is reported . Ultrasonic velocity is done for levofloxacin, hemihydrate, tacrolimus, monohydrate and lisinoprildihydrate at two different temperatures .

Literature survey indicates that no acoustical data on substituted 2-oxo-2H-chromene-3-carbohydrazide derivatives has produced. In the present work,

different properties such as adiabatic compressibility (βs), intermolecular free length (Lf), specific acoustic impedance (Z) have evaluated for following substituted 2-oxo-2H-chromene-3-carbohydrazide derivatives in 60% of (DMF+water) mixture at different concentrations of ligands. In the present work, following substituted coumarines have synthesized by standard method .

Ligand (LA) =N-[(E)-1-(5-bromo-2-hydroxy-phenyl) ethylideneamino]-2-oxo-chromene-3-carboxamide

Ligand (LB) =N-[(E)-1-(5-chloro-2-hydroxy-phenyl) ethylideneamino]-2-oxo-chromene-3-carboxamide

Ligand (LC) =N-[(E)-1-(3,5-dichloro-2-hydroxy-phenyl) ethylideneamino]-2-oxo-chromene-3-carboxamide

Ligand (LD) = N-[(E)-1-(2-hydroxy-5-methyl-phenyl) ethylideneamino]-2-oxo-chromene-3-carboxamide

II. METHODS AND MATERIAL

THEORY AND FORMULAE

Sound speeds can be measured using a single frequency ultrasonic interferometer. The ultrasonic waves of known frequency produced by a quartz crystal are reflected by a movable metallic plate kept parallel to the quartz plate. When the state of acoustic resonance is reached due to the formation of standing waves, an electrical reaction occurs on the generator driving the quartz plate and its anode current becomes maximum. The micrometer is slowly moved until the anode current meter on a high frequency generator shows a maximum. The distance thus moved by the micrometer gives the values of wavelength .

The distance traveled by micrometer screw to get one maximum in ammeter (D) is used to calculate wavelength of ultrasonic wave using following relation:

$$2D = \lambda \quad (1)$$

Where, λ is wavelength and D is distance in mm.

From the knowledge of the wavelength, the ultrasonic velocity can be obtained by the relation:

$$\text{Ultrasonic velocity } (U) = \lambda \times \text{Frequency} \times 103 \quad (2)$$

Using the measured data some acoustical parameters can be calculated using the standard relations.

The adiabatic compressibility of solvent and solution can be calculated by using equations:

$$\text{Adiabatic compressibility of solution } (\beta s) = 1/ Us2 \times ds \quad (3)$$

$$\text{Adiabatic compressibility of solvent } (\beta 0) = 1/ U02 \times d0 \quad (4)$$

The acoustic impedance (Z) is calculated using equation:

$$\text{Acoustic impedance } (Z) = Us \times ds \quad (5)$$

Where, Uo and Us are ultrasonic velocity in solvent and solution respectively.

Do and ds are density of solvent and solution respectively.

Where, do and ds are the densities of the pure solvent and solution, respectively.

m is the molality and M is the molecular weight of solute.

□o and □s are the adiabatic compressibility of pure solvent and solution respectively.

According to the studies intermolecular free length (Lf) is given by:

$$\text{Intermolecular free length } (Lf) = K\sqrt{\beta s} \quad (6)$$

The constant K is called the Jacobson's constant.

The value of Jacobson's constant can be calculated by using relation

$$K = (93.875 + 0.375 \times T) \times 10\text{-}8 \quad (7)$$

Where, T is the temperature at which experiment is carried out.

EXPERIMENTAL

All the chemicals used are of analytical grade. The density measurements are made with the specific gravity bottle. All the weighings are made on one pan digital balance (petit balance AD-50B) with an accuracy of + 0.001 gm. The speed of sound is obtained by using variable path crystal interferrometer (Mittal

Enterprises, Model MX-3) with accuracy of + 0.03% and frequency 1MHz. In the present work, a steel cell fitted with a quartz crystal of variable frequency is employed. The instrument is calibrated by measuring ultrasonic velocity of water at 32o C.

III. RESULTS AND DISCUSSION

In present work the measurement of ultrasonic velocity and density at a different concentration of substituted 2-oxo-2H-chromene-3-carbohydrazide derivatives in 60% of DMF+water solvent is carried out at 305K temperature. From the table no 1 it is observed that as the concentration decreases ultrasonic velocity decreases for all the system. This is only happen due to the strong dipole-induce dipole interaction between the components. Adiabatic compressibility increases with decrease in the concentration it is observed in fig. no. 2. The decrease in adiabatic compressibility due to the more cohesion is expected in more concentration solution. The dispersion of solvent molecules around ion supporting weak ion solvent interaction due to this adiabatic compressibility increases with decreasing the concentration of solvent. Table no. 1 shows that intermolecular free length (Lf) is more in more dilute solution. The positive deviation in sound velocity and negative deviation in compressibility is only happen because of decrease in intermolecular free length. Table no. 1 shows that the specific acoustic impedance decreases as the concentrate decreases. Fig no. 4 shows that the variation of specific acoustic impedance.

IV.CONCLUSION

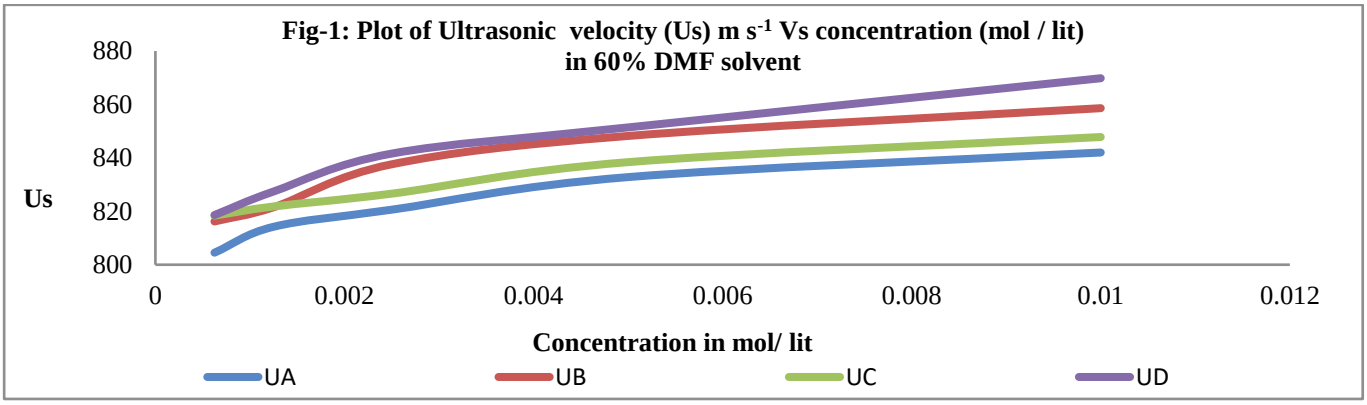
The ultrasonic velocity increases in more concentrated solution due to the possibility of making hydrogen bond increase which gives the packed structure. In this system it shows ion solvent interaction it is only because of decreases in adiabatic compressibility with increase in concentration. Specific acoustic impedance increases with increases in concentration indicate that there is associative molecular interaction. Decreases in intermolecular free length (Lf) leads to positive deviation in sound velocity and negative deviation in compressibility. From this it is concluded that in this system there is significant interaction between solute and solvent molecules.

Table-1 Ultrasonic velocity, Density, Adiabatic compressibility (β_s), Intermolecular free length (L_f) and Specific acoustic impedance (Z) in 60% (DMF+Water) solvent at 305K

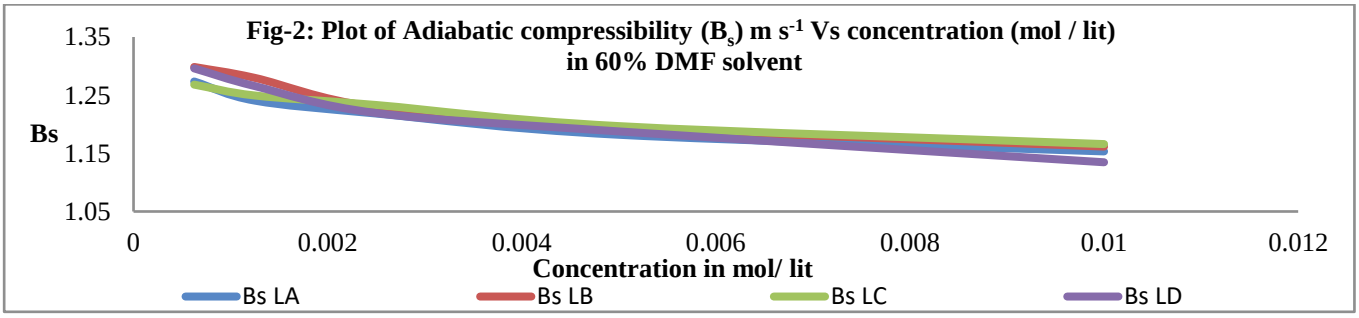
Conc. (m) (mol lit^{-1})	Density (d_s) (kg m^{-3})	Ultrasonic Velocity (U_s) (m s^{-1})	Adiabatic compressibility (β_s) x 10^{-9} (m^{2}N^{-1})	Intermolecular free length (L_f) x 10^{-11} (m)	Specific acoustic impedance (Z) x 10^5 (kg m^{-2}s^{-1})
Ligand L_A					
0.01	1230.1	842.1	1.1533	6.9886	10.3566
0.005	1221.2	832.8	1.1819	7.0918	10.1684
0.0025	1218.8	820.6	1.2184	7.2038	10.0014
0.00125	1215.9	814.2	1.2406	7.2690	9.8998
0.000625	1213.2	804.5	1.2735	7.3649	9.7601
Ligand L_B					
0.01	1167.8	858.6	1.1616	7.0337	10.0267

0.005	1163.3	848.2	1.1948	7.1337	9.8671
0.0025	1159.7	837.6	1.2291	7.2352	9.7136
0.00125	1157.9	821.5	1.2797	7.3827	9.5121
0.000625	1156.1	816.2	1.2985	7.4367	9.4352
Ligand L_C					
0.01	1193.3	847.8	1.1659	7.0467	10.1168
0.005	1188.7	838.4	1.1968	7.1395	9.9660
0.0025	1186.9	826.6	1.2331	7.2469	9.8109
0.00125	1185.1	821.8	1.2494	7.2948	9.7391
0.000625	1183.3	818.4	1.2681	7.3307	9.6841
Ligand L_D					
0.01	1165.1	869.8	1.1346	6.9511	10.1340
0.005	1161.5	851.4	1.1877	7.1124	9.8890
0.0025	1157.9	841.6	1.2193	7.2064	9.7448
0.00125	1154.2	827.4	1.2656	7.3418	9.5498
0.000625	1151.5	818.6	1.2960	7.4294	9.4261

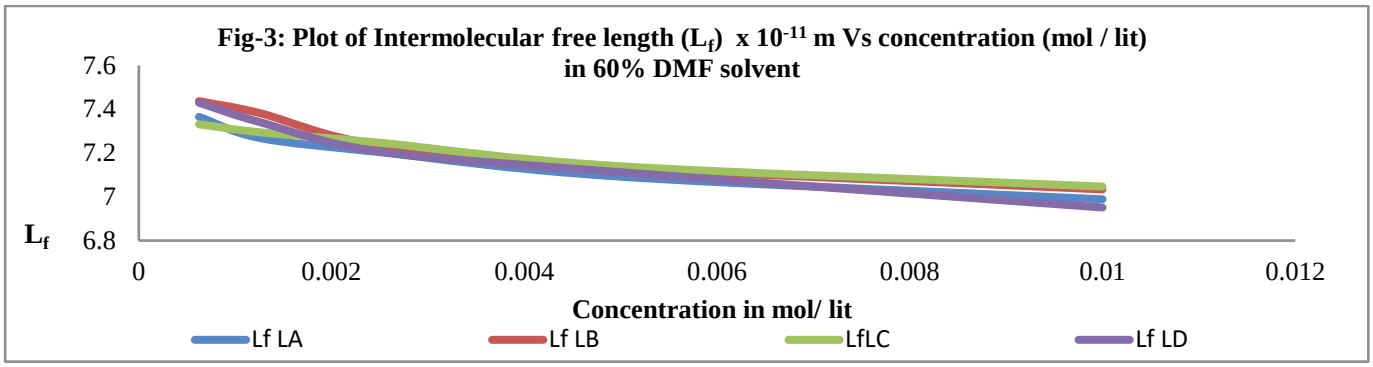
Plots of Ultrasonic velocity (Us) of different ligands at different concentration in 60%(DMF + water) solvents



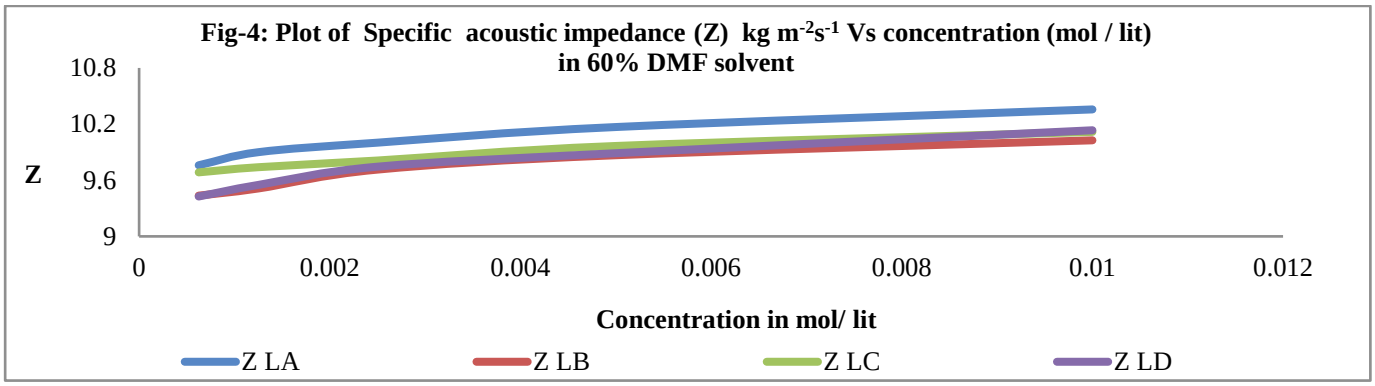
Plots of Adiabatic compressibility (βS) of different ligand at different concentration in 60%(DMF + water) solvents



Plots of Intermolecular free length (Lf) of different ligand at different concentration in 60%(DMF + water) solvents



Plots of Specific acoustic impedance (Z) of different ligand at different concentration in 60% (DMF + water) solvents



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