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Ultrasonic Velocity and Related Acoustical Parameters at Different Concentrations of 2-Hydroxy-5-Chloro Substituted Chalconedibromides in Ethanol at 303K

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Abstract

Ultrasonic velocity and density measurements of 2-hydroxy-5-chloro substituted chalconedibromides in ethanol have been carried out at 303K in the concentration range 0.05 to 0.005 mol dm^{-3} in 100% ethanol. Different acoustic properties like apparent molal volume, apparent molal compressibility, intermolecular free length, specific acoustic impedance and relative association have been determined. The results of the present study suggest the presence of molecular interactions in ethanol. These parameters have been interpreted in terms of solute-solvent and solute-solute interactions, which provide important and valuable information regarding internal structure, molecular association, complex formation and stability of complexes.The effect of different substituents in this solvent i.e. ethanol and effect of dilution on 2-hydroxy-5-chloro substituted chalconedibromides were investigated

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Keywords: Ultrasonic velocity, acoustic parameters, interferometric measurements, 2-hydroxy-5-chloro substituted chalconedibromides, solute-solvent interaction.

Introduction

Ultrasonic is the branch of acoustic, which consists of waves of high frequencies. It is the technique used for the study of molecular interaction in liquids. Ultrasonic technique is used to study the nature of molecular interaction in liquids[1,2], liquid mixture[3,4], stability of complexes[5], and electrolyte solution[6,7,8]. In this present investigation, an attempt have been made to determine the densities and ultrasonic velocities at different concentrations of 2-hydroxy-5-chloro substituted chalconedibromide viz. L_2, L_3 and L_4 in ethanol at 303 K. The data obtained during the study is used for determining the most significant acoustic parameters like adiabatic compressibility, apparent molar volume, acoustic impedance, intermolecular free length, relative association.

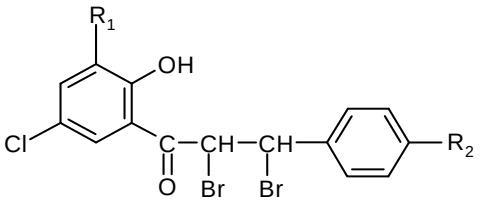
These parameters explore solute-solute and solute-solvent interactions in different concentrations of ligand solution. Ultrasonic velocity and density of 1-(2-hydroxy-3-substituted-5-chlorophenyl) ethenyldiphenylenamines in dioxane medium at different concentration has been measured by Raghuwanshi et.al[9]. Raghuwanshi[10] studied various acoustic parameters of benzopyrazoline and its complexes with Cu(II), Ni(II), Cr(II) and Fe(II) in 70% Dioxane-water mixture. Deshmukh[11] studied ultrasonic behaviour of acrylophenone and its complexes with Fe(II), Cu(II), Ni(II), Cr(II) and Co(II) in

acetone as a solvent. Ultrasonic studies on 1,4-dioxane and methanol binary liquid mixtures at different temperatures by Peshwe et.al[12]. Burghate[13] have made ultrasonic study of some substituted chalcone in different percentage and in different concentration of acetone-water mixture.

Experimental

The chemicals and solvent used of A.R. grade to synthesized substituted chalconedibromide as a ligand.

1. 2'-hydroxy-5'-chloro chalcone (L_1)
2. 2'-hydroxy-5'-chloro chalconedibromide (L_2)
3. 2'-hydroxy-5'-chloro-4-methoxy chalconedibromide (L_3)
4. 2'-hydroxy-3'-bromo-5'-chloro chalconedibromide (L_4)



R_1 = -Br, -H

R_2 = -H, $-OCH_3$

These chalconedibromides are synthesized by known method[14]. The solvent ethanol was purified by standard procedure[15]. Densities were measured with the help of bicapillarypyknometer (10.1 % kg m^{-3}) Pyknometer used of Borosil, 0.01M solution of ligand in ethanol solvent. Weighing were made on Citizen CY 104 one pan digital balance (± 0.0001 gm). A special thermostatic arrangement was done for density and ultrasonic velocity measurements. Elite thermostatic bath was used, in which continuous stirring of water was carried out with the help of electric stirrer and temperature variation was maintained within ± 0.1 ^{0}C.

The speed of sound waves was obtained by using variable path, single crystal interferometer (Mittal Enterprises, Model M-81S) with accuracy ± 0.03% and frequency 1 MHz was used in the present work. The densities and ultrasonic velocity of liquids in ethanol solvent at 303 K. For the calculation of intermolecular free length the value of Jacobson's constant[16] (K = 631) at temperature 30 ^{0}C is used.

Results and Discussion

In the present investigation measurement of densities and ultrasonic velocities of ligands L_2, L_3, and L_4 at different concentration in ethanol has been carried out and given in Table No.1

Ultrasonic velocity (Us)

It is found from the Table that ultrasonic velocity of ligand L_2, L_3, and L_4 shows irregularity in different concentration of ligand. This indicates that there is a significant interaction between ion and the solvent molecules suggesting the structure promoting behaviour of added solute.

Adiabatic compressibility(βs)

Adiabatic compressibility is one of the important property during the study of solute-solvent interactions and represented by βs. It is also seen from the Table that βs values of ligand L_3 is increases while ligand L_2, and L_4 decreases with decrease in concentration of ligand. This may be due to the change in structure of ligands. The electron withdrawing substituents present on the ligand will directly interfere the interaction between solute and solvent and show change in adiabatic compressibility. At 0.05 M concentration the βs values of ligands is in the order of -

Ligand L_2 > Ligand L_3 > Ligand L_4

Table No. 1: Acoustic parameters for different concentration of ligands in ethanol at 303 K (Frequency: 1 MHz)

Ligands	Conc. M	Us (m. sec^{-1})	ds x 10^3 ($kg.m^{-3}$)	βs x 10^{-10} (pa^{-1})	$ø_v$ (m^3mol^{-1})	$ø_k$x 10^{-10} (m^3 mol^{-1} pa^{-1})	L_f x10^{-2} (m^{-1})	R_A	Z x 10^6 (kg m^{-2} sec^{-1})
L_2	0.050	1198.5	0.8506	8.1846	-0.8029	-18.7222	1.8052	0.9970	1.0194
	0.025	1197.5	0.8695	8.0200	-3.1307	-57.5731	1.7870	0.9981	1.0412
	0.010	1199.4	0.8772	7.9245	-9.5625	-168.794	1.7763	0.9960	1.0521
	0.005	1198.4	0.8805	7.9080	-20.4580	-351.914	1.7744	0.9971	1.0552
L_3	0.050	1198.2	0.8520	8.1752	-0.8060	-18.9719	1.8042	0.9973	1.0209
	0.025	1198.1	0.8609	8.0921	-2.6303	-50.1769	1.7950	0.9974	1.0314
	0.010	1146.9	0.8708	8.7303	-8.6856	-68.8925	1.8644	1.0572	0.9987
	0.005	1147.2	0.8820	8.6149	-20.810	-194.030	1.8521	1.0569	1.0118
L_4	0.050	1197.9	0.8635	8.0704	-1.0700	-23.6192	1.7926	0.9977	1.0344
	0.025	1147.6	0.8718	8.7096	-3.1627	-25.7968	1.8622	1.0564	1.0005
	0.010	1196.9	0.8825	7.9098	-10.1610	-175.201	1.7747	0.9988	1.0563
	0.005	1199.8	0.8892	7.8123	-22.5970	-390.387	1.7637	0.9956	1.0669

Apparent molar compressibility: (φk)

Apparent molar compressibility (φk) is another important acoustic parameter, which explains the solute-solvent and solute-solute interactions in solutions. The structure of solute and the number of atoms present in it will have direct effect on φk values. It is observed that the φk values are negative for all ligands in ethanol. This interprets in terms of loss of compressibility of solute due to strong electrostatic solvation of ions in ethanol at 303 K in different concentrations.

The negative values of φk are indicative of ionic and hydro-phillic interactions in these systems. φk provides information regarding solute-solvent interactions. The appreciable negative values of φk for all of the system reinforce our earlier view about the existence of ion-solvent interactions. Negative value of

φk shows that interaction are insensitive to solvent. It could be also explained by postulating the polar ~OH group interact with the surrounding organic solvent through dipole-dipole interaction in such a way that the surrounding solvent molecule looses its own compressibility to a certain extent.

Apparent molar volume: (φv)

Apparent molar volume is the thermodynamic property of solutions, which express the solute-solvent interactions, and it is obtained from the density and molarity of solution and the molecular mass of the solute.

It is observed that φv values are negative for all ligands in ethanol. Negative value obtained for ligand indicating the compactness of medium and after dissolution of solute due to the closer packing of molecules inside the shell more clinging is occurring. The negative values of φv for the system indicate the existence of smaller solute-solute interactions. As concentration decreases, the values of φv is also decreases for all the ligands. In ethanol at 303 K in different concentration the values of φv is in the order of - **Ligand L_2 > Ligand L_3 > Ligand L_4**

Intermolecular free length: (L_f)

It is one of the important acoustic properties to study the intermolecular interactions. It could also be seen that intermolecular free length (L_f) decreases with decrease in concentration of ligands. This may be due to the stronger interaction between ions and solvent molecules suggesting a structure promoting behaviour of the added solute. This may also imply that decrease in number of free ions showing the occurrence of ionic association due to strong ion-ion interactions. At 0.05 M concentration the $\mathbf{L_f}$ values of ligands is in the order of - **Ligand L_2 > Ligand L_3 > Ligand L_4**

Relative association: (R_A)

Relative association is an acoustic property of understanding interaction, which is influenced by two opposing factors; (i) breaking of solvent structure on addition of solute to it, and (ii) solvation of the solutes that are simultaneously present by the free solvent molecules.

At 0.05 M concentration the $\mathbf{L_f}$ values of ligands is in the order of - **Ligand L_2 < Ligand L_3 < Ligand L_4**

The values of relative association (RA) decrease with decrease in concentration of ligands. The values of (R_A) increase with decrease in concentration for ligand L_3. This may be due to the fact of different electron withdrawing substituents present in different ligands.

Specific acoustic impedance: (Z)

Specific acoustic impedance is the complex ratio of the effective sound pressure at a

point to the effective particle velocity at that point. The specific acoustic impedance (Z) increases with decrease in concentration of ligands. At 0.05 M concentration the $\mathbf{L_f}$ values of ligands is in the order of -

Ligand L_2 < Ligand L_3 < Ligand L_4

The values of Z are continuously decreasing on changing the structure of ligand. The specific acoustic impedance depends upon the various structure of the liquid and the molecular packing in the medium.

Fig. 1
Plot between Ethanol Conc. Vs βs
Temp. 30°C

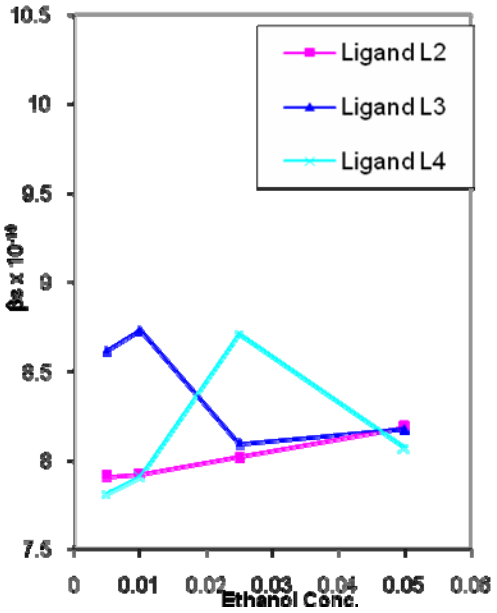


Fig. 2
Plot between ethanol conc. Vs ϕv
Temp. 30°C

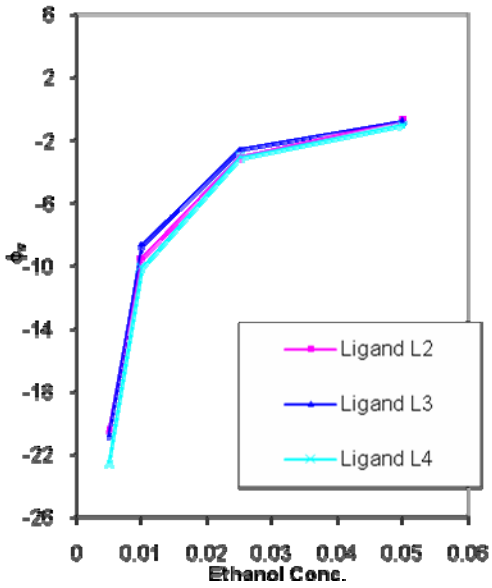


Fig. 3
Plot between ethanol conc. Vs ϕ_k
Temp. 30°C

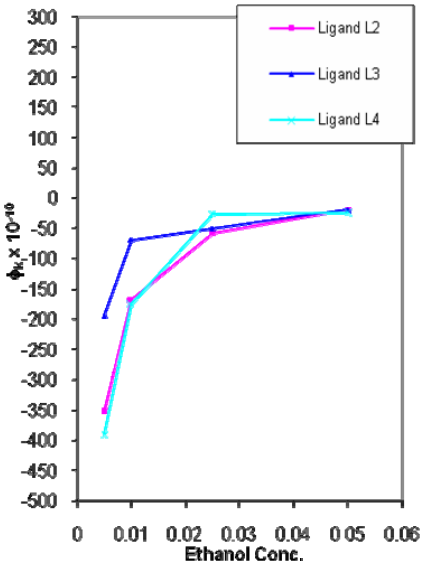
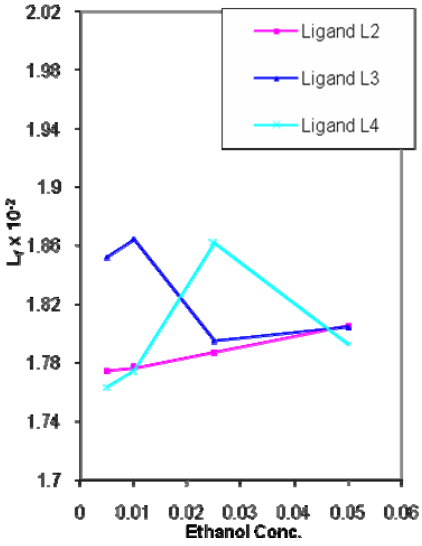
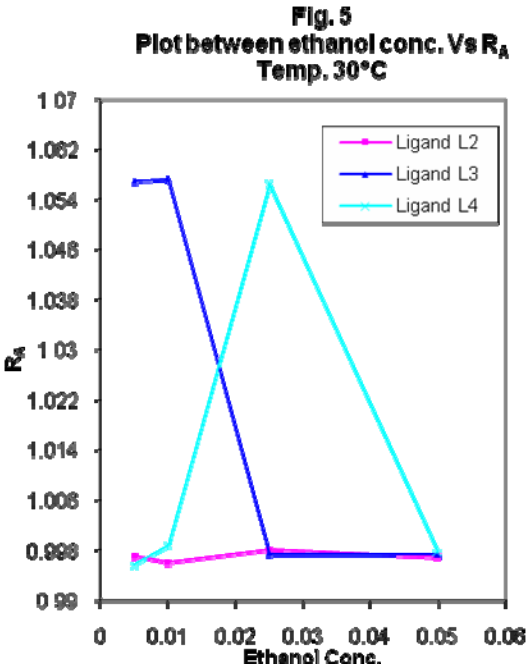
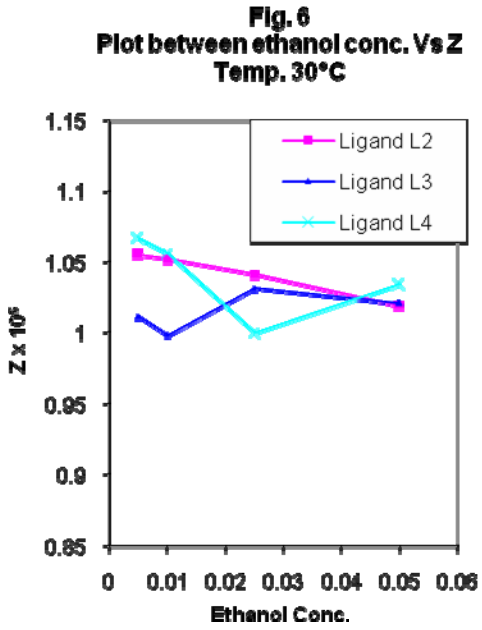


Fig. 4
Plot between ethanol conc. Vs L_f
Temp. 30°C







Conclusion

By using ultrasonic interferometric study β, φ_v, φ_k, L_f, R_A, Z etc. Acoustic properties are determined, which explain how these interactions occur and responsible for breaking and making of the structure in the solution. So in the present work these acoustic parameters were studied for synthesized ligands, which are used as solutes in the concentration range of 0.05M to 0.005 M using ethanol solvent at 300K.

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