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ULTRASONIC STUDIES OF SUBSTITUTED SOME PYRAZOLINE AND ISOXAZOLINES IN DIOXANE-WATER AND DMF-WATER MIXTURE

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ABSTRACT

Ultrasonic velocity of pyrazoline like HBMPMPPZOLINE and isoxazolines like HCMPMPIZOLINE and HBMPMPIZOLINE in dioxane-water and DMF-water mixture have been determined. From these measured values, apparent molal volume (ϕ_v), partial molal volume (ϕ^0_v), adiabatic compressibility $\phi_{K(s)}$, intermolecular free length (L_t) and relative association have been calculated at 305° K.

The observed and calculated values have been used to explain molecular association due to strong ion-ion interactions. The above study may be helpful in understanding the dynamics between metal ions and pyrazolines and isoxazolines.

KEYWORDS :

INTRODUCTION

In the recent years, ultrasonic waves have acquired the status of an important probe for the study of structure and properties of matter. In the field of technology, ultrasonic waves are being used for detection of flows, testing of materials, mechanical cleaning of surface etc. In medical sciences too, the ultrasonic waves are being used to diagnose bone fractures, cancer, tumors, foetal condition and in physiotherapy, bloodless surgery, gynecology etc. Present day applications of ultrasonic are emerging in the field of forensic science space research and in wars. Adiabatic compressibility and apparent molal compressibility have been used to study the relative association, specific constant factor and solvation number of the system. The study of molecular interactions in liquid provides valuable information regarding internal structures molecular association, complex formation internal pressure etc. Ultrasonic velocity and absorption studies in case of electrolyte solutions have led to a new insight into the process of ion association and complex formation.[1,1] Tabhane et.alhave investigated the cluster approach to thermodynamic behavior of ligand mixture of acrolein in methanol-cyclohexane and dioxane using Khasare's equation of state.[1] A.P. Mishra has studied the ultrasonic velocities of some bio-applicable system involving $ZnCl_2$, dextrose and methionine in water. The apparent and partial molal volume of electrolyte solutions has proved a very important tool in elucidating the structural interactions i.e. ion-ion, ion-solvent and solute-solvent interactions occurring in solutions. Partial molal volumes and adiabatic compressibility properties reflect the structural interactions with water molecules or organic solvent molecules and therefore some pyrazolines and isoxazolines are selected for these investigations.

Ultrasonic study of interactions in ternary solutions has been done by Pandey et.al. Aswar studied the interactions between bio-molecules involving Mg ion in aqueous solutions. The compressibility and apparent molal volume of any electrolyte in mixed organic solvents are found out earlier.[1] The compressibility and apparent molal volume of peptides in aqueous as well as water-organic solvent mixtures are studied by Khobragade et.al[1]. But compressibilities and apparent molal volumes of substituted pyrazolines and isoxazolines in water-organic solvent mixtures are not studied so far. Thus we herein present the ultrasonic systematic studies of substituted pyrazolines and isoxazolines in dioxane-water and DMF-water mixtures.

Experimental

Materials and Reagents

All analytical grade chemicals and solvents used were obtained from Merck, India. The distilled water used has a specific conductivity of about $1x10^{-6}$ ohm^{-1}cm^{-1}. Stock solutions of pyrazolines and isoxazolines were prepared in different percentage of dioxane-water and DMF-water mixtures. Ultrasonic velocity (2 MHz) was measured by single crystal path interferometer with an accuracy of 0.03%. The density measurements were carried out at 305° K.

The apparent molal volumes (ϕ_v) and apparent molal adiabatic compressibility $\phi_{K(s)}$ of pyrazolines and isoxazolines in solutions are determined from density **(ds)** and adiabatic compressibility (β_s) of solution using following equations

$$\phi_V = \left\{ \frac{(d_0-d_s) \times 10^3}{m\, d_s .\, d_0} \right\} + \frac{M}{d_s} \quad \text{---------- (1)}$$

Where M is molecular weight of the solute, m is the molality of solution, do is the density of the solvent and ds is the density of the solution.

$$\phi k_s = \left\{ \frac{(\beta_s d_0-\beta_0 d_s) \times 10^3}{m\, d_s .\, d_0} \right\} + \frac{\beta_s M}{d_s} \quad \text{------ (2)}$$

Where βs is the adiabatic compressibility of solution and β_0 is the adiabatic compressibility of solvent which can be calculated by

$$\beta_s = \frac{100}{U_s^2 \times d_s} \quad \text{------ (3)} \quad \text{for solution and}$$

$$\beta_0 = \frac{100}{U_0^2 \times d_0} \quad \text{------ (4)} \quad \text{for solvent}$$

Where U_s&U_0 are the ultrasonic velocities of ultrasonic waves in solution and solvent respectively.

Knowing βs, β_0 and molecular weight of pyrazoline and soxazolines, the values of ϕ_v and $\phi_{K(s)}$ are calculated. The values of ϕ_v and $\phi_{K(s)}$ are plotted against molality (m) of pyrazoline and isoxazolines. The curve represented the least square and ϕ_v and $\phi_{K(s)}$ can be given as

$$\phi_v = (\phi^0_v + S_v\, m) \quad \text{------ (5)}$$

$$\phi k_s = (\phi^0 k_{(s)} + Sk_{(s)}\, m) \quad \text{---- (6)}$$

Where $\phi^0_v = v^o$ and $\phi^0_{K(s)=K}{}^0$ are the infinite dilution partial molal volumes and adiabatic partial molalcompressibilities respectively. S_v and $Sk_{(s)}$ are the experimental slopes.

The $\phi_{K(s)}$ and ϕ_v values of pyrazoline and isoxazolines in two mixed solvents are calculated and given in Table 1 to 11.

The intermolecular free length (L_t), specific acoustic impendence (z) and relative association (R_A) are calculated by using the following relations

$$L_t = K \times (B_s)^{1/2} \quad \text{------ (7)}$$

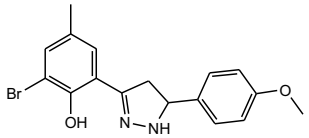
Where K is Jacobson's constant = 6.0186×10^4 and

$$Z = U_s \times ds \quad \text{----------(8)}$$

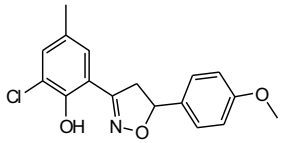
$$R_A = ds/d0\, (U_0/U_s)^{1/3} \quad \text{---------(9)}$$

The ligands used in these investigations are

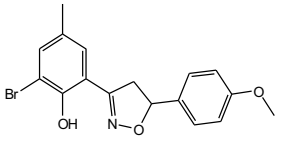
1) 3-{2-hydroxy-3-bromo-5-methyl-phenyl-5(4-methoxyphenyl)} pyrazoline



2) 3-{2-hydroxy-3-chloro-5-methyl-phenyl-5(4-methoxyphenyl)} isoxazolines



3) 3-{2-hydroxy-3-bromo-5-methyl-phenyl-5(4-methoxyphenyl)} isoxazolines



RESULTS AND DISCUSSION

The experimental and calculated values of ultrasonic velocities(U_s), densities (ds), adiabatic compressibilities (β_s),apparent adiabatic compressibility (ϕk_s), relative association (R_A), specific acoustic impendence (z), apparent molal volume (ϕ_v) and intermolecular free length (L_f) for pyrazolines and isoxazolines are tabulated in Table No. 1 to 12. These values have been used to discuss the interaction s of unlike molecules of solvent in presence of solute. The variation of ultrasonic velocity in solution depends on the intermolecular free length on mixing on the basis of a model for sound propagation proposed by Erying and Kincaid[1].

The graphs are plotted between ϕk_s versus mole fraction of organic solvent and are found to be linear over the entire range of mole fraction except one of the point. In each plot, one of the points is significantly away from the linearity. Therefore ϕk_s measurements for these organic substances are limited for those mole fractions where linearity is being followed and this seems the range of dilute solutions.

Linear pattern of the graphs is observed in dioxane-water and DMF-water as shown in graph no. 1 to 3. The plot between ϕ_v and mole fraction of organic solvents are shown in graph no. 4 to 6 and shows that ϕ_v values varies inversely with percentage / mole fraction of organic solvent.

The plot between $\phi k_s$and mole fraction of organic solvents indicates that ϕk_svalues increases with increasing percentage / mole fraction of organic solvent. Pankanti and Jahagirdar have investigated apparent molal compressibility for amino acids in dioxane-water and acetone-water media. It is observed that ϕk_sdecreases up to 40% organic solvent-water mixture.

Present work reveals the increase in (ϕk_s)values above 70%organic solvent –water mixture (Table 1 to 12). This fact shows that ϕk_sincreases at higher percentage of organic solvent –water mixture. This suggests that loss of compressibility of water due to electrostatic forces in the vicinity of ions causing electro-strictive hydration of ions. The apparent molal volume (ϕ_v) has been calculated from density data of solution using equation (2). The data obtained are in well agreement with Messon equation as the plot of ϕ_v against $(c)^{1/2}$ or mole fraction is linear. The ϕ_v values of substituted pyrazoline and isoxazolines are found to increase with increasing percentage of organic solvent –water mixture. Das studied the apparent molal volume (ϕ_v) of univalent ions up to 30% dioxane-water mixture and reported that ϕ_v values of these ions increases with increase in dioxane content in dioxane-water mixture. In the present investigation it is found that the values of ϕ_v values are higher in dioxane-water mixture as compared to DMF-water mixture due to decreasing dielectric constant of medium. It can be explained by postulating that the [polar –OH group interact with the surrounding organic solvent-water mixture through dipole-dipole interaction in such away that the surrounding water losses its own compressibility to certain extent.

The $\phi°k_s$values are found to be decrease in the following order of organic solvent-water mixture – dioxane-water DMF-water, which suggest that pyrazoline and isoxazolines are extensively hydrated in dioxane-water mixture than DMF-water mixture. This can be explained on the basis of higher polarity of dioxane-water mixture than DMF-water mixture. Dipole induced- dipole interactions between unlike molecules are more in dioxane-water mixture.

In the present investigation, the values of L_t, R_A and Z are also evaluated (Table 1 to 12). It could be seen from above table that intermolecular free length increase linearly with increasing concentration of pyrazoline and isoxazolines. This indicates that there are significant interactions between ions and solvent molecules suggesting structure-promoting behaviour of added electrolyte molecule. This may also imply that decrease in number of free ions showing the occurrence of ionic association due to strong ion-ion interactions. Relative association (R_A) is influenced by two factors- 1) the breaking up of solvent molecules on addition of electrolyte to it. And 2) the solvation of ions that simultaneously present the former resulting in decrease and later increase of relative association. The increase of R_A with concentration suggest that solvation of ions predominates over the breaking up of solvent aggregates (water-water, water-dioxane and water-DMF) on addition of pyrazoline and isoxazolines. It is observed from the table that there is linear variation of R_A signifies the weaker association between solvent and solute molecules.

Table No. 1 Ultrasonic velocities (U_s), densities (ds), adiabatic compressibilities (β_s) and intermolecular free length (L_t) at different concentrations of ligand in different percentage of dioxane-water mixture at 303 K.

System L_1 (HBMPMPZOLINE) 3-{2-hydroxy-3-bromo-5-methyl-phenyl-5(4-methoxyphenyl)} pyrazoline
Ultrasonic frequency: 2MHz Temperature: 303 K Medium : Dioxane-water

% Dioxane	Conc. in mol dm^{-3}	Ultrasonic velocities	Densities (ds) in g cm^{-3}	Adiabatic compressibilities (β_s)	Inter molecular free length (L_f)
95	9.5 X 10^{-3}	1411.2	1.0538	4.76 X 10^{-5}	4.15 X 10^{2}
90	9.0 X 10^{-3}	1427.2	1.0633	4.61 X 10^{-5}	4.08 X 10^{2}
85	8.5 X 10^{-3}	1457.6	1.0604	4.43 X 10^{-5}	4.00 X 10^{2}
80	8.0 X 10^{-3}	1469.0	1.0549	4.23 X 10^{-5}	3.91 X 10^{2}
75	7.5 X 10^{-3}	1507.2	1.0588	4.17 X 10^{-5}	3.88 X 10^{2}
70	7.0 X 10^{-3}	1535.0	1.0593	4.00 X 10^{-5}	3.80 X 10^{2}

Table No. 2 Apparent molal volume (ϕ_v), apparent adiabatic compressibility ($f\mathbf{k}_s$), specific acoustic impendence (z) and relative association (R_A) at different concentrations of ligand in different percentage of dioxane-water mixture at 303 K.

System L_1 (HBMPMPZOLINE) 3-{2-hydroxy-3-bromo-5-methyl-phenyl-5(4-methoxyphenyl)} pyrazoline
Ultrasonic frequency: 2MHz Temperature: 303 K Medium : Dioxane-water

Conc. in mol dm^{-3}	Apparent molal volume (ϕ_v)	Apparent adiabatic compressibility (ϕk_s)	Relative association (R_A)	Specific acoustic impendence (z)
9.5 X 10^{-3}	-692.0	-1.99 X 10^{-4}	1.0063	1.487 X 10^{3}
9.0 X 10^{-3}	-1695.6	-4.34 X 10^{-4}	1.0116	1.517 X 10^{3}
8.5 X 10^{-3}	-1515.5	-6.45 X 10^{-4}	1.0017	1.545 X 10^{3}
8.0 X 10^{-3}	-1011.7	-9.01 X 10^{-4}	0.9879	1.578 X 10^{3}
7.5 X 10^{-3}	-1181.9	-10.58 X 10^{-4}	0.9892	1.595 X 10^{3}
7.0 X 10^{-3}	-1788.2	-13.663 X 10^{-4}	0.9838	1.620 X 10^{3}

Table No. 3 Ultrasonic velocities (U_s), densities (ds), adiabatic compressibilities (b_s) and intermolecular free length (L_f) at different concentrations of ligand in different percentage of dioxane-water mixture at 303 K.

System L_2 (HCMPMPIZOLINE) 3-{2-hydroxy-3-chloro-5-methyl-phenyl-5(4-methoxyphenyl)} isoxazoline
Ultrasonic frequency: 2MHz Temperature: 303 K Medium : Dioxane-water

% Dioxane	Conc. in mol dm^{-3}	Ultrasonic velocities	Densities (ds) in g cm^{-3}	Adiabatic compressibilities (b_s)	Inter molecular free length (L_f)
95	9.5 X 10^{-3}	1374.4	1.0679	4.957 X 10^{-5}	4.237 X 10^{2}
90	9.0 X 10^{-3}	1409.6	1.0546	4.772 X 10^{-5}	4.157 X 10^{2}
85	8.5 X 10^{-3}	1476.8	1.0423	4.399 X 10^{-5}	3.991 X 10^{2}
80	8.0 X 10^{-3}	1539.2	1.0529	4.008 X 10^{-5}	3.810 X 10^{2}
75	7.5 X 10^{-3}	1569.6	1.0562	3.843 X 10^{-5}	3.731 X 10^{2}
70	7.0 X 10^{-3}	1596.8	1.0740	3.651 X 10^{-5}	3.636 X 10^{2}

Table No. 4 Apparent molal volume (ϕ_v), apparent adiabatic compressibility (ϕk_s), specific acoustic impendence (z) and relative association (R_A) at different concentrations of ligand in different percentage of dioxane-water mixture at 303 K.

System L_2 (HCMPMPIZOLINE) 3-{2-hydroxy-3-chloro-5-methyl-phenyl-5(4-methoxyphenyl)} isoxazoline
Ultrasonic frequency: 2MHz Temperature: 303 K Medium: Dioxane-water

Conc. in mol dm^{-3}	Apparent molal volume (ϕ_v)	Apparent adiabatic compressibility (ϕk_s)	Relative association (R_A)	Specific acoustic impendence (z)
9.5 X 10^{-3}	-1127.2	-1.994 X 10^{-4}	1.0119	1467.72
9.0 X 10^{-3}	120.87	-3.400 X 10^{-4}	0.9909	1486.56
8.5 X 10^{-3}	1431.21	-7.194 X 10^{-4}	0.9643	1539.26
8.0 X 10^{-3}	290.25	-12.840 X 10^{-4}	0.9607	1620.02
7.5 X 10^{-3}	-107.50	-15.960 X 10^{-4}	0.9576	1657.81
7.0 X 10^{-3}	-2429.31	-20.537 X 10^{-4}	0.9576	1714.96

Table No. 5 Ultrasonic velocities (U_s), densities (ds), adiabatic compressibilities (β_s) and intermolecular free length (L_f) at different concentrations of ligand in different percentage of dioxane-water mixture at 303 K.

System L_3 (HBMPMPIZOLINE) 3-{2-hydroxy-3-bromo-5-methyl-phenyl-5(4-methoxyphenyl)}isoxazoline
Ultrasonic frequency: 2MHz Temperature: 303 K Medium: Dioxane-water

% Dioxane	Conc. in mol dm^{-3}	Ultrasonic velocities	Densities (ds) in g cm^{-3}	Adiabatic compressibilities (b_s)	Inter molecular free length (L_f)
95	9.5 X 10^{-3}	1398.40	1.0663	4.795 X 10^{-5}	4.167 X 10^{2}
90	9.0 X 10^{-3}	1422.40	1.0660	4.636 X 10^{-5}	4.097 X 10^{2}
85	8.5 X 10^{-3}	1470.40	1.0826	4.272 X 10^{-5}	3.933 X 10^{2}
80	8.0 X 10^{-3}	1497.60	1.0725	4.157 X 10^{-5}	3.880 X 10^{2}
75	7.5 X 10^{-3}	1518.40	1.0759	4.031 X 10^{-5}	3.821 X 10^{2}
70	7.0 X 10^{-3}	1555.20	1.0732	3.852 X 10^{-5}	3.735 X 10^{2}

Table No. 6 Apparent molal volume (ϕ_v), apparent adiabatic compressibility (ϕk_s), specific acoustic impendence (z) and relative association (R_A) at different concentrations of ligand in different percentage of dioxane-water mixture at 303 K.

System L_3 (HBMPMPIZOLINE) 3-{2-hydroxy-3-bromo-5-methyl-phenyl-5(4-methoxyphenyl)}isoxazoline
Ultrasonic frequency: 2MHz Temperature: 303 K Medium: Dioxane-water

Conc. in mol dm^{-3}	Apparent molal volume (ϕ_v)	Apparent adiabatic compressibility (ϕk_s)	Relative association (R_A)	Specific acoustic impendence (z)
9.5 X 10^{-3}	-718.05	-3.288 X 10^{-4}	1.0021	1440.00
9.0 X 10^{-3}	-740.56	-5.199X 10^{-4}	0.9964	1516.27
8.5 X 10^{-3}	-2543.11	-10.168X 10^{-4}	1.0010	1591.85
8.0 X 10^{-3}	-1586.06	-11.168 X 10^{-4}	0.9855	1606.17
7.5 X 10^{-3}	-2107.59	-14.207X 10^{-4}	0.9841	1633.34
7.0 X 10^{-3}	-1489.80	-17.494 X 10^{-4}	0.9737	1669.04

Table No. 7 Ultrasonic velocities (U_s), densities (ds), adiabatic compressibilities (β_s) and intermolecular free length (L_f) at different concentrations of ligand in different percentage of DMF-water mixture at 303 K.

System L_1 (HBMPMPZOLINE) 3-{2-hydroxy-3-bromo-5-methyl-phenyl-5(4-methoxyphenyl)} pyrazoline
Ultrasonic frequency: 2MHz Temperature: 303 K Medium: DMF-water

% Dioxane	Conc. in mol dm^{-3}	Ultrasonic velocities	Densities (ds) in g cm^{-3}	Adiabatic compressibilities (β_s)	Inter molecular free length (L_f)
95	9.5 X 10^{-3}	1520.8	0.9867	4.381 X 10^{-5}	398.36
90	9.0 X 10^{-3}	1542.4	0.9912	4.240X 10^{-5}	391.90
85	8.5 X 10^{-3}	1611.2	0.9726	3.960X 10^{-5}	378.74
80	8.0 X 10^{-3}	1611.2	0.9950	3.871X 10^{-5}	374.46
75	7.5 X 10^{-3}	1628.8	0.9825	3.836X 10^{-5}	372.76
70	7.0 X 10^{-3}	1651.2	1.032	3.554X 10^{-5}	358.80

Table No. 8 Apparent molal volume (ϕ_v), apparent adiabatic compressibility (ϕk_s), specific acoustic impendence (z) and relative association (R_A) at different concentrations of ligand in different percentage of DMF-water mixture at 303 K.

System L_1 (HBMPMPZOLINE) 3-{2-hydroxy-3-bromo-5-methyl-phenyl-5(4-methoxyphenyl)} pyrazoline
Ultrasonic frequency: 2MHz Temperature: 303 K Medium: DMF-water

Conc. in mol dm^{-3}	Apparent molal volume (ϕ_v)	Apparent adiabatic compressibility (ϕk_s)	Relative association (R_A)	Specific acoustic impendence (z)
9.5 X 10^{-3}	149.02	-3.570 X 10^{-4}	0.9907	1500.47
9.0 X 10^{-3}	-381.1	-5.578X 10^{-4}	0.9906	1528.82
8.5 X 10^{-3}	1850.4	-8.354X 10^{-4}	0.9580	1567.05
8.0 X 10^{-3}	-3200.00	-11.160X 10^{-4}	0.9800	1603.24
7.5 X 10^{-3}	-305.82	-11.730X 10^{-4}	0.9642	1600.29
7.0 X 10^{-3}	-6338.08	-19.178X 10^{-4}	1.0906	1704.03

Table No. 9 Ultrasonic velocities (U_s), densities (ds), adiabatic compressibilities (β_s) and intermolecular free length (L_f) at different concentrations of ligand in different percentage of DMF-water mixture at 303 K.

System L_2 (HCMPMPIZOLINE) 3-{2-hydroxy-3-chloro-5-methyl-phenyl-5(4-methoxyphenyl)}isoxazoline
Ultrasonic frequency: 2MHz Temperature: 303 K Medium: DMF-water

% Dioxane	Conc. in mol dm^{-3}	Ultrasonic velocities	Densities (ds) in g cm^{-3}	Adiabatic compressibilities (β_s)	Inter molecular free length (L_f)
95	9.5 X 10^{-3}	1523.20	1.06790.9715	4.436 X 10^{-5}	4.008 X 10^{2}
90	9.0 X 10^{-3}	1560.00	1.0039	4.093X 10^{-5}	3.850 X 10^{2}
85	8.5 X 10^{-3}	1625.60	1.0129	3.735 X 10^{-5}	3.678 X 10^{2}
80	8.0 X 10^{-3}	1678.40	1.0232	3.461 X 10^{-5}	3.545 X 10^{2}
75	7.5 X 10^{-3}	1694.40	1.0253	3.397 X 10^{-5}	3.507 X 10^{2}
70	7.0 X 10^{-3}	1699.20	1.0261	3.375 X 10^{-5}	3.416 X 10^{2}

Table No. 10 Apparent molal volume (ϕ_v), apparent adiabatic compressibility (ϕk_s), specific acoustic impendence (z) and relative association (R_A) at different concentrations of ligand in different percentage of DMF-water mixture at 303 K.

System L_2 (HCMPMPIZOLINE) 3-{2-hydroxy-3-chloro-5-methyl-phenyl-5(4-methoxyphenyl)} isoxazoline
Ultrasonic frequency: 2MHz Temperature: 303 K Medium: DMF-water

Conc. in mol dm^{-3}	Apparent molal volume (ϕ_v)	Apparent adiabatic compressibility (ϕk_s)	Relative association (R_A)	Specific acoustic impendence (z)
9.5 X 10^{-3}	-1591.46	-0.4979	1.0065	1479.78
9.0 X 10^{-3}	-5402.90	-1.0717	1.0316	1566.08
8.5 X 10^{-3}	-6787.60	-1.5973	1.0268	1646.57
8.0 X 10^{-3}	-8564.20	-2.0686	1.0372	1663.31
7.5 X 10^{-3}	-9322.40	-3.3110	1.0283	1720.86
7.0 X 10^{-3}	-10128.53	-2.5122	1.0258	1738.62

Table No. 11 Ultrasonic velocities (U_s), densities (ds), adiabatic compressibilities (β_s) and intermolecular free length (L_f) at different concentrations of ligand in different percentage of DMF-water mixture at 303 K.

System L_3 (HBMPMPIZOLINE) 3-{2-hydroxy-3-bromo-5-methyl-phenyl-5(4-methoxyphenyl)}isoxazoline
Ultrasonic frequency: 2MHz Temperature: 303 K Medium: DMF-water

% Dioxane	Conc. in mol dm^{-3}	Ultrasonic velocities	Densities (ds) in g cm^{-3}	Adiabatic compressibilities (β_s)	Inter molecular free length (L_f)
95	9.5 X 10^{-3}	1510.4	0.9987	4.389 X 10^{-5}	398.72
90	9.0 X 10^{-3}	1588.8	1.0190	3.887 X 10^{-5}	375.23
85	8.5 X 10^{-3}	1641.6	1.0177	3.646 X 10^{-5}	363.41
80	8.0 X 10^{-3}	1678.4	1.0216	3.477 X 10^{-5}	354.89
75	7.5 X 10^{-3}	1699.2	1.0241	3.381 X 10^{-5}	349.95
70	7.0 X 10^{-3}	1652.8	1.0379	3.526 X 10^{-5}	357.38

Table No. 12 Apparent molal volume (ϕ_v), apparent adiabatic compressibility (ϕk_s), specific acoustic impendence (z) and relative association (R_A) at different concentrations of ligand in different percentage of DMF-water mixture at 303 K.

System L_3 (HBMPMPIZOLINE) 3-{2-hydroxy-3-bromo-5-methyl-phenyl-5(4-methoxyphenyl)}isoxazoline

Ultrasonic frequency: 2MHz Temperature: 303 K Medium: DMF-water

Conc. in mol dm^{-3}	Apparent molal volume (ϕ_v)	Apparent adiabatic compressibility (ϕk_s)	Relative association (R_A)	Specific acoustic impendence (z)
9.5 X 10^{-3}	-3208.40	-0.56171	1.0248	1508.43
9.0 X 10^{-3}	-5634.44	-1.2553	1.0283	1618.98
8.5 X 10^{-3}	-5832.45	-1.6011	1.0159	1670.65
8.0 X 10^{-3}	-6693.53	-1.9142	1.0122	1714.65
7.5 X 10^{-3-}	-7488.25	-2.1797	1.0106	1740.15
7.0 X 10^{-3}	-9908.96	-2.1974	1.0337	1715.44

Table No. 13 Limiting apparent molal volume (ϕ°_v) and limiting molal compressibility ($\phi^\circ k_s$) of different ligands in Dioxane-water and DMF-water mixture at 303 K.

Sr.No.	System	$\phi^\circ k_s$	ϕ°_v
1	L_1 (Dioxane-water)	-16.00	-2200.00
2	L_2 (Dioxane-water)	-22.50	------
3	L_3 (Dioxane-water)	-11.50	------
4	L_1 (DMF-water)	------	-7600.00
5	L_2 (DMF-water)	-3.70	-12000.00
6	L_3 (DMF-water)	-2.25	-10300.00

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