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INVESTIGATIONS IN ACOUSTIC PARAMETERS OF DIFFERENT CHLORO
SUBSTITUTED AZETIDIN-2-ONE AT DIFFERENT CONCENTRATION AND
TEMPERATURE IN 90% (ETOH+WATER) SOLVENT
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ABSTRACT
Ultrasonic velocity and density measurements have been carried out for solutions of 3-Chloro-4(4-hydroxyphenyl)-1-(4-nitrophenyl)azetidin-2-one (C1) and 3-Chloro-1-(4-hydroxyphenyl)-4-phenylazetidin-2-one(C3) in ethanol and water solvents at 303.15 K. This data have been used to determine various acoustic/thermodynamic parameters viz. adiabatic compressibility ($\beta_s$), apparent molar compressibility ($\phi_a$), apparent molar volume ($\phi_v$), intermolecular free length (Lf), relative association (RA) and specific acoustic impedance (Z). Molecular solute-solvent, solute- solute interactions in the system is determined by these properties.

Keywords: Ultrasonic velocity, Acoustical properties, Molecular interactions, 3-Chloro-4(4-hydroxyphenyl)-1-(4-nitrophenyl)azetidin-2-one (C1) and 3-Chloro-1(4-hydroxyphenyl)-4-phenylazetidin-2-one(C3).

I. INTRODUCTION
Ultrasonic techniques are used to study the physico-chemical studies of a system and molecular interactions occurring in EtOH-Water mixtures. S. V. Tambakhe et al. carried out conductometric and ultrasonic studies of substituted aryl bithioura in binary solution at 300K temperature[1]. H P Dahikar et al. carried out molecular interaction study of $\beta$- benzoyl propionic acid in ethanol at 298K using acoustic parameters[2].Molecular and intermolecular interaction investigated by using ultrasonic interferometry by R D Isankar et al. [3]. Ultrasonic, velocity, viscosity and density of alcohol in n-hexane at various temperatures in the range of 303.15 - 318.15K was observed by Santhi et al.[4]. M. K. Praharaj et al. was studied the thermodynamic and transport properties of ternary liquid mixture at different frequencies[5]. G. Nath have investigated interaction in the binary mixture of acetone with bromobenzene and chlorobenzene by computing the various acoustic parameters such as acoustic impedance (Z), isentropic compressibility ($\beta_s$), intermolecular free length (Lf) and their excess values at different frequencies (1 MHz, 3 MHz and 5 MHz) using a multi frequency ultrasonic Interferometer over the entire range of mole fraction at temperature 303.16 K[6].The acoustical properties like adiabatic compressibility ($\beta_s$), apparent molar volume ($\phi_v$), apparent molar compressibility ($\phi_k$), intermolecular free length (Lf), specific acoustic impedance (Z) and relative association (RA) of some substituted pyrazoles viz. [5-(2-hydroxyphenyl)-3-(pyridin-3-yl)-4-(benzoyl)]-pyrazol, [5-(2-hydroxyphenyl)-3-(3-nitrophenyl)]-pyrazol, and [5-(2-hydroxyphenyl)-3-(3-pyridinyl)]-pyrazol have been calculated from measured sound velocities (U) and densities (d) of their solutions of 0.01M concentrations in different percentage of dioxane-water mixture at 298.15 K was determined by Deosarkar et al [7]. Viscometric, refractometric and interferometric measurements of synthesized N-(4-hydroxy-6-methyl-1,3,5-triazin-2-yl)-N'-phenylthiocarbamidine have been investigated at 25°C in 60% dioxane-water system at various concentrations by A. M. Kshirsagar et al.[8]. Alambé et al. have been investigated density (d), acoustical parameters such as adiabatic compressibility ($\beta_s$), apparent molar volume ($\phi_v$), apparent molar compressibility ($\phi_k$), intermolecular free length (Lf), relative association (RA) and specific acoustic impedance (Z) and ultrasonic velocity (U) values in the solvent CCl₄ containing 2-hydroxy substituted chalcone dibromide using 0.01 M concentration at 297 K [9]. Acoustic properties of substituted chalcone dibromides using 0.01 M concentration in ethanol at 303K were studied by Watane et al. [10]. Interaction between solute-solute and solute-solvent interaction of substituted imidazolinoine in 70% (DMF+water) solvents by measuring ultrasonic velocity and density in different concentration of solute at 298K was determined by Wadekar et al. [11]. Pathare et al. have been carried out Ultrasonic velocity and density measurement
of chalcone - 3-bromo-2-hydroxy-5- methyl-4-chloro chalcone in dioxane-water mixture in the various concentration and in different percentages of dioxane-water mixtures[12]. Acoustical parameters, Density, ultrasonic velocity of pure dioxane (Dx) and Substituted Coumarins in different percent of Dx–water mixture have been investigated by A. U. Mandakmare et al. at 303.15 K [13]. Wadekar et al. investigated the acoustical properties of substituted 2-oxo-2-H-chromene-3-carboxyldrazide derivatives in 70% DMF-water at 305K[14]. Bante et al. have determined ultrasonic behaviour of some chalcones of p-chlorobezaldehyde, salicylaldehyde, & benzaldehyde and also their mixtures[15]. R Trabelsi et al have been measured ultrasonic velocity in isobutyric acid - water binary mixtures over the temperature range from 300.15 to 313.15 K[16]. Ultrasonic velocity and density measurements of 2-hydroxy - 5- bromo - N – (m - hydroxyphenyl) - chalconeimines in dioxane – water mixtures, in the concentration range 1×10^-2 -5×10^-2 - mol dm^-3 and in different percentage of dioxane water mixtures have been studied by Patil et al. [17]. S. Aswale et al. investigated in acoustic parameters of substituted thiocarbamidoacetophenones[18]. Nehete et al. was carried out ultrasonic behavior and study of molecular interaction of Schiff base ligand in different percentage of ethanol-water mixture at 303 K [19].

II. METHOD & MATERIAL

All chemicals used to synthesize different chloro substituted azetidin-2-one are A.R. Grade in this present investigation attempt is made to understand behaviour of 3-Chloro-4(4-hydroxyphenyl)-1-(4-nitrophenyl)azetidin-2-one (C1) and 3-Chloro-1(4-hydroxyphenyl)-4-phenylazetidin-2-one(C5) For evaluating the acoustic properties. The very pure and analytical grade solvent and extra pure double distilled water is used. The densities of pure solvent and solutions are determined by using specific gravity bottle. The ultrasonic velocity measurements were made using a crystal controlled variable path ultrasonic interferometer.

III. CALCULATION

Adiabatic compressibility (β), Apparent molal volume (Φv), Apparent molal compressibility (Φks), Intermolecular free length (Lf), Specific acoustic impedance (Z) and Relative association (R) were calculated by using following equations

Adiabatic compressibility (βs) = 1/ U0^2 x ds …………………(3)
Adiabatic compressibility (β0) = 1/ U0^2 x d0 ………………… (4)
Acoustic impedance (Z) = Us x ds ……………………….. (5)

Where U0, Us are ultrasonic velocity in solvent and solution respectively, d0 and ds are density of solvent and solution respectively

\[ \phi_v = \frac{M/d_v}{M/d_o + \left\{ \left| d_o - d_v \right| 10^3 \right\} / md_o} \] ………….. (6) and

\[ \phi_{k(s)} = \frac{1000(\beta_o d_o - \beta d_s)/md_o}{\phi_v} + \left( \frac{\beta}{M/d_v} \right) \] ………….. (7)

where, d0 and ds are the densities of the pure solvent and solution, respectively. m is the molality and M is the molecular weight of solute. \( \beta_s \) and \( \beta_0 \) are the adiabatic compressibilities of pure solvent and solution respectively.

Intermolecular free length (Lf) = \( K \sqrt{\beta s} \) ………………….. (8)
Relative association (RA) = \( (d_s /d_0) x (U_0 /Us)^{1/3} \) ………………….. (9)
Solvation number (Sn) = \( \phi^s / \beta_0 x (M/d_0) \) ………………….. (10)

The value of Jacobson’s constant is calculated by using relation

\[ K = (93.875+0.375xT)x10^{-8} \] …………………..(11)

where T is temperature at which experiment is carried out.
which suggest the structure promoting behaviour in the

The apparent molar volumes (\(V_m\)) of solute. It is also observed that \(\psi_S\) in 90%EtOH may be due to departure of solvent molecules around the ions.

\[\begin{array}{|c|c|c|c|c|c|c|c|c|}
\hline
\text{Temp.} & \text{Conc. Moles/lit} & \text{Average Velocity (U_s) m/sec} & \text{Density (ds) Kg m}^{-3} & (\beta_S) \times 10^{10} \text{m}^{-2} \text{N}^{-1} & (\psi_S) \text{m}^{3} \text{mole}^{-1} & (\phi_S) \times 10^{10} \text{m}^{-2} \text{N}^{-1} & (L_f) \times 10^{11} \text{m} & \text{RA} & \text{(Z)} \times 10^{5} \text{kg m}^{-2} \text{s}^{-1} & \text{Solvation number (Sn)} \\
\hline
293K & 0.1 & 1484.22 & 1050.13 & 4.3227 & 0.672 & 1.6005 & 4.2362 & 1.1565 & 15.58 & 0.5470 \\
& 0.075 & 1465.86 & 1046.03 & 4.4940 & 0.855 & 1.6482 & 4.2976 & 1.1567 & 15.33 & 0.5633 \\
& 0.05 & 1430.16 & 1042.02 & 4.6919 & 1.310 & 1.7398 & 4.4134 & 1.1618 & 14.90 & 0.5986 \\
& 0.025 & 1406.63 & 1038.02 & 4.8689 & 2.586 & 1.8065 & 4.4958 & 1.1638 & 14.60 & 0.6174 \\
\hline
298K & 0.1 & 1497.55 & 1050.08 & 4.2463 & 0.694 & 1.5816 & 4.2372 & 1.1636 & 15.72 & 0.5438 \\
& 0.075 & 1473.11 & 1045.36 & 4.4081 & 0.912 & 1.6431 & 4.3172 & 1.1684 & 15.39 & 0.5650 \\
& 0.05 & 1436.87 & 1041.95 & 4.6485 & 1.354 & 1.7343 & 4.4333 & 1.1706 & 14.97 & 0.5963 \\
& 0.025 & 1412.72 & 1037.33 & 4.8302 & 2.668 & 1.8033 & 4.5191 & 1.1720 & 14.65 & 0.6200 \\
\hline
303K & 0.1 & 1524.89 & 1049.72 & 4.0968 & 0.716 & 1.5345 & 4.1999 & 1.1645 & 16.00 & 0.5237 \\
& 0.075 & 1500.45 & 1044.69 & 4.2517 & 0.941 & 1.5936 & 4.2786 & 1.1652 & 15.67 & 0.5439 \\
& 0.05 & 1464.21 & 1040.87 & 4.4812 & 1.395 & 1.6813 & 4.3925 & 1.1704 & 15.24 & 0.5738 \\
& 0.025 & 1440.06 & 1036.64 & 4.6516 & 2.754 & 1.7464 & 4.4753 & 1.1722 & 14.92 & 0.5960 \\
\hline
\end{array}\]

In the present investigation different acoustic parameters such as adiabatic Compressibility (\(\beta_S\)), apparent molal volume (\(\Phi_V\)), apparent molal compressibility (\(\Phi_k(s)\)), acoustic impedance (\(Z_S\)), relative association (RA) and intermolecular free length (\(L_f\)) of the solutions in different concentration of different compound at 293k, 298k and 303 k which is presented in table 1 & 2. Existence of molecular association between the components of the liquid mixtures can be understood from the decrease in ultrasonic velocity (U) with decreasing concentration of compounds. The values of adiabatic compressibility (\(\beta_S\)) increase with decrease in the concentration of compounds and decreases with increasing the temperature which may be due to departure of solvent molecules around the ions. The apparent molal volumes (\(\psi_S\)) found to be increase with decrease in the concentration of compounds along with increasing the temperature. It is observed that (\(\phi_k\)) values and intermolecular free length (\(L_f\)) increase with decrease in the concentration of compounds, this may be due to the weak interaction between ions and solute molecules, which suggest the structure promoting behavior of solute. It is also observed that (\(\phi_k\)) values and intermolecular free
Ultrasonic velocity and related acoustical parameters at different
length (Lf) decreases with increasing the temperature. The values of relative association (RA) of compounds increase with decrease in the concentration of compounds but increases with increasing the temperature, which may be due to breaking up of solvent molecules on increasing the temperature. Specific acoustic impedance (Z) decreases linearly with decrease in concentration of compounds and increasing with increasing temperature.

V. CONCLUSION

Density, viscosity and ultrasonic velocity have been measured for different concentration of 3-Chloro-4(4-hydroxyphenyl)-1-(4-nitrophenyl)azetidin-2-one (C1) and 3-Chloro-1(4-hydroxyphenyl)-4-phenylazetidin-2-one(C2) at 293k,298k and 303 k. Ultrasonic velocity of synthesized molecule of different concentration depends on the intermolecular free length. It is also observed that continuous increase of adiabatic compressibility and free length is due to weak specific molecular interaction between compounds and solvent mixture molecules.

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REFERENCES


