

## Study of acoustical properties of 1-carboxamido-3-(2-hydroxy-5-methylethylphenyl)-5-phenylpyrazole in aqueous-nonaqueous solvents

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### ABSTRACT

The acoustical properties 1-Carboxamido-3-(2-hydroxy-5-methylethylphenyl)-5-phenylpyrazole have been investigated at different concentration in 70% dioxane-water and acetone-water mixture. Different acoustic/thermodynamic parameters such as adiabatic compressibility ( $\beta_s$ ), apparent molar adiabatic compressibility ( $\Phi_k$ ), apparent molar volume ( $\Phi_v$ ), intermolecular free length ( $L_f$ ), specific acoustic impedance ( $Z$ ), and relative association ( $R_\lambda$ ) have been calculated using ultrasonic velocity ( $U$ ) and density ( $d$ ) values at 34.5°C.

**Key words:** Acoustical, aqueous, Non-aqueous solvents.

### INTRODUCTION

The vibrational waves of frequency above hearing range of normal ear are referred as ultrasonic waves. Ultrasonic technique reveals very weak intermolecular interactions due to its useful wave length range. Moreover, ultrasonic parameters are directly related to a large number of thermodynamic parameters. Since various molecular theories of liquid state are based on thermodynamic considerations, ultrasonic parameters are directly related to a large number of thermodynamic considerations, ultrasonic abortion study and ultrasonic velocity determination provide means to study them. Compressibility and apparent molar volumes of many electrolytes in mixed organic solvents were found our earlier<sup>1</sup> sound velocity is a thermodynamic function from which other thermodynamic properties of electrolyte solution are determined<sup>2-4</sup>.

In recent years ultrasonic velocity studies in many of the aqueous and non-aqueous electrolytic solution have led to new insight into the progress of ion-ion and ion-solvent interactions<sup>5-6</sup>. Rambabu *et al.*,<sup>7</sup> have determined the sound velocity and isentropic compressibility of 1,2-dichloroethane with isomeric and branched alcohol. Nikam *et al.*,<sup>8</sup> have investigated the adiabatic compressibility, apparent molar compressibility, intermolecular free length, specific acoustic impedance, relative association and solvation number of monochloroacetic acid in aqueous acetone mixture.

In present work the different acoustic/thermodynamic parameters such as adiabatic compressibility ( $\beta_s$ ), apparent molar adiabatic compressibility ( $\Phi_k$ ), apparent molar volume ( $\Phi_v$ ), intermolecular free length ( $L_f$ ), specific acoustic impedance ( $Z$ ), and relative association ( $R_\lambda$ ) of 1-

Carrbaxamido-3-(2-hydroxy-5-methylethyl phenyl)-5-phenylpyrazole have been investigated at different concentration in 70% dioxane-water and acetone-water mixture.

### EXPERIMENTAL

1-Carboxamido-3-(2-hydroxy-5-methylethylphenyl)-5-phenylpyrazole have been were syntesysed in laboratory, their purity was checked by IR, NMR and m.p. Acetone and dioxane was purified by Vogel's standard method<sup>9</sup>. The solutions of different concentration were prepared by using double distilled water and purified acetone and dioxane.

A pycnometer mounted in temperature controlled bath 30°C-35°C the accuracy of  $\pm 0.01^\circ\text{C}$  was used for density measurements. Ultrasonic interferometer from Mittal Enterprises, Model F-80 with accuracy of  $\pm 0.03\%$  and frequency 2MHz were used for the measurement of ultrasonic velocities in different solutions. The sound velocities of 1-Carrbaxamido-3-(2-hydroxy-5-methylethyl phenyl)-5-phenylpyrazole were measured in concentration rang of  $10 \times 10^{-3}$  to  $7 \times 10^{-3}$  and in 70% dioxane-water mixture and 70% acetone-water at a known temperature.

### RESULTS AND DISCUSSION

Different acoustic/thermodynamic parameters such as apparent molar volume ( $\Phi_v$ ), and

apparent molar adiabatic compressibility ( $\Phi_k$ ), have been calculated from density ( $d_s$ ) and adiabatic compressibility ( $\beta_s$ ) of solution using equation,

$$\Phi_v = (M/d_s) + (d_0 - d_s) \times 10^3 / m \times d_s \times d_0$$

and

$$\Phi_k = [1000 (\beta_s d_0 - \beta_0 d_s) / m \times d_s \times d_0] + \beta_s \times M / d_s$$

where  $d_0$  is the density of solvent,  $m$  is molarity,  $M$  is molecular weight of solute,  $\beta_0$  is adiabatic compressibility of solvent and  $\beta_s$  is adiabatic compressibility of solution.  $\beta_s$  is calculated from ultrasonic velocity using the equation<sup>10</sup>

$$\beta_s = 100 / U_s^2 \times d_s$$

where  $U_s$  is the ultrasonic velocity in the solution in m/s.  $\beta_s$  is in  $\text{bar}^{-1}$   $F_k$  is in  $\text{cm}^3 \text{mol}^{-1} \text{bar}^{-1}$ . The other parameters such as intermolecular free length ( $L_t$ ), specific acoustic impedance ( $Z$ ) and relative association ( $R_A$ ) also calculated by using equation

$$L_t = K \sqrt{\beta_s}$$

$$Z = U_s \times d_s$$

$$R_A = d_s / d_0 (U_0 / U_s)^{1/3}$$

**Table 1a: The values of ultrasonic velocity ( $U_s$ ), density ( $d_s$ ), adiabatic compressibility ( $\beta_s$ ) 1-Carboxamido-3-(2-hydroxy-5-methylethylphenyl)-5-phenylpyrazole in dioxane-water mixture at  $34.5^\circ \pm 0.01^\circ\text{C}$**

Concentration Mole Lit <sup>-1</sup> (m)	$U_s$ m/sec	( $d_s$ ) g.cm <sup>-3</sup>	( $\beta_s$ ) bar <sup>-1</sup>	$L_t$ (Å)
$10 \times 10^{-3}$	1257.59	1.04015	$6.2463 \times 10^{-5}$	$4.7565 \times 10^2$
$9.5 \times 10^{-3}$	1273.59	1.0445	$5.9003 \times 10^{-5}$	$4.6229 \times 10^2$
$9.0 \times 10^{-3}$	1305.59	1.0501	$5.5847 \times 10^{-5}$	$4.4975 \times 10^2$
$8.5 \times 10^{-3}$	1369.59	1.0509	$5.0710 \times 10^{-5}$	$4.2853 \times 10^2$
$8.0 \times 10^{-3}$	1401.59	1.0519	$4.8375 \times 10^{-5}$	$4.1858 \times 10^2$
$7.5 \times 10^{-3}$	1425.59	1.0522	$4.6747 \times 10^{-5}$	$4.1148 \times 10^2$
$7.0 \times 10^{-3}$	1441.59	1.0524	$4.7506 \times 10^{-5}$	$4.0687 \times 10^2$

$d_0 = 1.0469 \text{ gm.cm}^{-3}$ ,  $U_0 = 1327.99 \text{ m.sec}^{-1}$ ,  $M. Wt = 293.00 \text{ gm}$   
 $\beta_0 = 5.4143 \times 10^{-5} \text{ bar}^{-1}$ ,  $K = \text{Jacobson's constant } (6.0186 \times 10^4 \text{ at } 34.5^\circ\text{C})$

Where K is Jacobson's constant and its value is ( $6.186 \times 10^4$  at  $34.5^\circ\text{C}$ ). The variation of ultrasonic velocity in a solution depends on the intermolecular free length on mixing. On the basis of a model for sound propagation proposed by Eyring and Kincaid<sup>11</sup>.

**Table 1b: The value of apparent molal volume ( $\Phi_v$ ), apparent molar adiabatic compressibility  $\Phi_k(s)$ , relative association ( $R_A$ ) and specific acoustic impedance (Z) have been calculated at at  $34.5^\circ \pm 0.01^\circ\text{C}$  in dioxane-water mixture**

Concentration Mole Lit <sup>-1</sup> (m)	$\Phi_v$ cm <sup>3</sup> /mol <sup>-1</sup>	$\Phi_k$ cm <sup>3</sup> /mol <sup>-1</sup> bar <sup>1</sup>	( $R_A$ )	Z sec <sup>-1</sup> gcm <sup>-3</sup> ×10 <sup>-3</sup>
10×10 <sup>-3</sup>	955.9524	0.68395	1.01134	1.3076
9.5×10 <sup>-3</sup>	541.0093	0.52509	1.01168	1.3303
9.0×10 <sup>-3</sup>	-14.7846	0.18001	1.00872	1.3711
8.5×10 <sup>-3</sup>	-119.2723	-0.39173	0.99352	1.4394
8.0×10 <sup>-3</sup>	-259.2949	-0.70104	0.9865	1.4714
7.5×10 <sup>-3</sup>	-333.3420	-0.95728	0.98155	1.5001
7.0×10 <sup>-3</sup>	-404.950	-0.16976	0.97808	1.5172

**Table 2a:  $U_s$ ,  $d_s$ ,  $\beta_s$ ,  $L_t$ , values in acetone-water mixture at  $34.5^\circ \pm 0.01^\circ\text{C}$**

Concentration Mole Lit <sup>-1</sup> (m)	$U_s$ m/sec	( $d_s$ ) g.cm <sup>-3</sup>	( $\beta_s$ ) bar <sup>-1</sup>	$L_t$ (A°)
10×10 <sup>-3</sup>	1145.57	0.7842	$9.7124 \times 10^{-5}$	$5.9312 \times 10^2$
9.5×10 <sup>-3</sup>	1174.37	0.8076	$8.9742 \times 10^{-5}$	$5.7013 \times 10^2$
9.0×10 <sup>-3</sup>	1222.37	0.8220	$8.1483 \times 10^{-5}$	$5.4325 \times 10^2$
8.5×10 <sup>-3</sup>	1289.57	0.8383	$7.1699 \times 10^{-5}$	$5.0960 \times 10^2$
8.0×10 <sup>-3</sup>	1305.57	0.8601	$6.7111 \times 10^{-5}$	$4.9303 \times 10^2$
7.5×10 <sup>-3</sup>	1345.57	0.8738	$6.3180 \times 10^{-5}$	$4.7837 \times 10^2$
7.0×10 <sup>-3</sup>	1401.57	0.8856	$5.7457 \times 10^{-5}$	$7.5619 \times 10^2$

$d_0 = 0.8135$  gm.cm<sup>-3</sup>,  $U_0 = 1176.99$  m.sec<sup>-1</sup>, M. Wt = 293.00 gm

$\beta_0 = 7.2304 \times 10^{-5}$  bar<sup>-1</sup>, K = Jacobson's constant ( $6.0186 \times 10^4$  at  $34.5^\circ\text{C}$ )

**Table 2b:  $\Phi_v$ ,  $\Phi_k$ ,  $R_A$ , Z, values in acetone-water mixture at  $34.5^\circ \pm 0.01^\circ\text{C}$**

Concentration Mole Lit <sup>-1</sup> (m)	$\Phi_v$ cm <sup>3</sup> /mol <sup>-1</sup>	$\Phi_k$ cm <sup>3</sup> /mol <sup>-1</sup> bar <sup>1</sup>	( $R_A$ )	Z sec <sup>-1</sup> gcm <sup>-3</sup> ×10 <sup>-3</sup>
10×10 <sup>-3</sup>	5103.1579	3.5452	0.9720	0.8994
9.5×10 <sup>-3</sup>	1443.5795	2.3845	0.9928	0.9484
9.0×10 <sup>-3</sup>	-756.1353	1.1880	0.9959	1.0036
8.5×10 <sup>-3</sup>	-3794.710	-0.3592	0.9989	1.0813
8.0×10 <sup>-3</sup>	-7580.8139	-1.3241	1.0209	1.1230
7.5×10 <sup>-3</sup>	-10841.669	-2.1795	1.0266	1.1759
7.0×10 <sup>-3</sup>	-13831.939	-3.4008	1.0300	1.2413

It could be seen from Table that intermolecular free length decreases linearly on decreasing the concentration of solute in 70% dioxane-water and acetone-water mixture and hence ultrasonic velocity increases with the decreasing concentration of solute. This indicates that there is significant interaction between ion and solvent molecules, suggesting a structure promoting is behaviour of the added electrolyte. This may also imply that decrease in number of free ions, showing the occurrence of ionic association due to strong ion-ion interaction.

The decrease of adiabatic compressibility ( $\beta_s$ ) with decreasing concentration of solution may be due to aggregation of solvent molecules around ions<sup>12</sup>, supporting strong ion-solvent interaction.

It is observed from table that apparent molal volume decreases and apparent adiabatic compressibility decreases with decreasing the concentration. The positive values of  $F_k(s)$  show the strong electrostatic force in the vicinity of ions, causing electrostatic solvation of ions.

Relative association is influenced by two factors, (i) the breaking up of solvent molecules on additions of electrolytes to it, and (ii) the solvation of ion that are simultaneously present, the former resulting increase of relative association. The increase of ( $R_A$ ) in water-acetone mixture with decrease in concentration suggest that solvation of ions predominates over the breaking up to solvent aggregates (water-water, water-solvent) on addition of organic solute Patil and Kaulgud<sup>13</sup> have observed non-linear variation of sound velocity and compressibility with respect to mole-fraction.

It is also observed from table that there is linear variation of  $R_A$  and  $Z$  values with respect to the concentration of solution. The lower values of  $R_A$  signifies the weak association between the solvent and solute.

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