

ULTRASONIC AND VISCOMETRIC BEHAVIOR OF 5-(2-HYDROXYPHENYL)-3-(3-NITROPHENYL)-4-(2-FUROYL) PYRAZOL WITH DIOXANE-WATER AND ACETONE-WATER MIXTURE AT 303.15 K

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ABSTRACT

In view of importance of substituted pyrazoles in human life the densities, ultrasonic velocities and viscosities of 5-(2-hydroxyphenyl)-3-(3-nitrophenyl)-4-(2-furoyl) pyrazol have been measured in different concentrations (0.01 to 0.1 mol/dm³) in 70% dioxane-water and 70% acetone-water mixtures at 303.15 K. The experimental data of sound velocities and densities of solutions in 70% dioxane-water have been used to calculate the various acoustical properties such as adiabatic compressibilities, apparent molal volumes, intermolecular free length, specific acoustic impedance, relative association etc. Also the effect of concentration of solute on viscosity has been studied in dioxane and acetone-water mixtures. From the viscosities and acoustical properties, the molecular interactions present in different solutions were studied. Appreciable molecular interactions have been observed between solute pyrazole and binary mixture of solvents, dioxane-water.

Keywords: ultrasonic velocity, viscosity, adiabatic compressibility, apparent molal volume

INTRODUCTION

Study of molecular interactions between solutes molecule and solvent media has got great importance in many fields of science including medicinal chemistry, industrial processes, biochemistry etc. The solute-solvent and solvent-solvent interactions can be studied by the measurement of relative viscosity and ultrasonic velocity of an electrolyte in solutions. This type of study helps us to understand the structure making and breaking properties of solutes. Ultrasonic waves, in recent years, have acquired the status of an important probe for the study of structure and properties of matter in basic science. The ultrasonic velocity and absorption studies in case of electrolyte solutions have led to new insight into the process of ion-association and complex formation¹⁻². Ultrasonic parameters are being extensively used to study molecular interactions in pure liquids³⁻⁵, liquid mixtures⁶⁻⁸ and electrolytic solutions⁹. Prigogine et al¹⁰ have shown that the excess parameter such as excess volume V^E give interaction on the relative strength of A-A, A-B and B-B interactions in the mixture of A and B liquids. The apparent and partial molar volumes of electrolyte solutions have proved a very important tool in elucidating the structural interactions i.e. ion-ions, ion-solvent and solute-solvent interactions occurring in solution.

Pyrazoles gained importance due to analgesic, antipyretic and anti-inflammatory activities¹¹ in view of the importance of pyrazoles in present investigation, for the better understanding of the behaviour of 5-(2-hydroxyphenyl)-3-(3-nitrophenyl)-4-(2-furoyl) pyrazol in mixed solvents, the densities, ultrasonic velocities and viscosities have been studied at 303.15K.

EXPERIMENTAL

The solvents used were of AR grade and were purified by standard methods. The compound, 5-(2-hydroxyphenyl)-3-(3-nitrophenyl)-4-(2-furoyl) pyrazol (HPNPFP) was recrystallized before use.

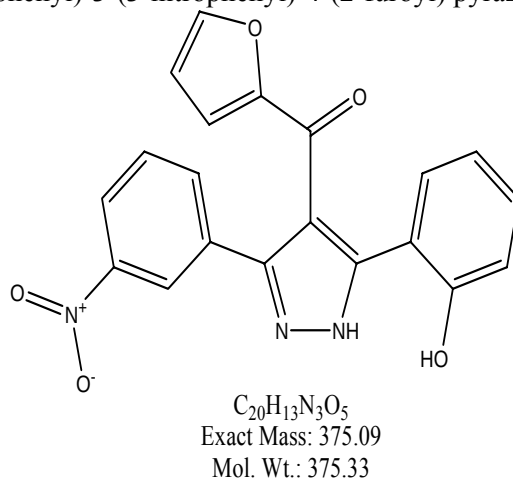
Weighing was done on electronic balance. The densities of solutions were determined by three different bicapillary Pyknometers ($\pm 0.2\%$) having a bulb volume of about 10 cm^3 and capillary having an internal diameter of 1 mm and calibrated with deionised doubly distilled water at 303.15°C . Pyknometers were standardized by the standard procedure.

The viscosities were measured by means of Ostwald's Viscometer ($\pm 0.11\% \text{ kg/m.s}$), which was kept in equilibrium with elite thermostatic water bath ($\pm 0.1^\circ\text{C}$). The ultrasonic velocity of each solution and solvent was obtained by using variable path, single crystal interferometer (Mittal Enterprises, Model F-81) with accuracy of $\pm 0.03\%$ and 2 MHz frequency. A special thermostatic arrangement was made for density and ultrasonic velocity measurements. For each measurement, sufficient time was allowed to attain thermal equilibrium in thermostat. All the calculations were done in Excel programme on departmental computer.

RESULTS AND DISCUSSION

Densities, relative viscosities and various acoustic parameters have been studied for all the solutions and were calculated by using different equations¹² and are presented in Table (1 & 2). The relative viscosity increases with increase in the concentration of solute that may be attributed to increasing solute-solvent interactions. Viscosity in different concentrations of ligand solutions in various solvents have been studied by many workers¹³⁻¹⁴ and observed similar type of results.

The structure of 5-(2-hydroxyphenyl)-3-(3-nitrophenyl)-4-(2-furoyl) pyrazol (HPNPFP) is shown below:



It can be seen from Table (2) that the ultrasonic velocity decreases with increasing concentration of solute, which indicates the presence of molecular association between solute and solvent.

Table -1: Measured Viscosities of 5-(2-hydroxyphenyl)-3-(3-nitrophenyl)-4-(2-furoyl) pyrazol in 70% dioxane and 70% acetone at 303.15 K

c (mol/dm ³)	Dioxane		Acetone	
	$\rho \times 10^{-3} (\text{kg/m}^3)$	$\eta_r \times 10^3 (\text{kg/m.s})$	$\rho \times 10^{-3} (\text{kg/m}^3)$	$\eta_r \times 10^3 (\text{kg/m.s})$
0.01	0.8435	1.0588	0.8421	1.0776
0.02	0.8496	1.1257	0.8437	1.1707
0.04	0.8514	1.1809	0.8452	1.2360
0.05	0.8542	1.2443	0.8471	1.3022
0.06	0.8573	1.2887	0.8486	1.3609
0.08	0.8591	1.3447	0.8495	1.4047
0.10	0.8612	1.4080	0.8507	1.4349

Table -2: Measured ultrasonic velocity (U), density (ρ) and calculated values of various acoustic parameters for 5-(2-hydroxyphenyl)-3-(3-nitrophenyl)-4-(2-furoyl) pyrazol in 70% dioxane-water mixture at 303.15 K

c (mole/dm ³)	0.02	0.04	0.06	0.08	0.10
U (m/s ⁻¹)	1352	1341	1329	1309	1296
ρ (kg/cm ³) $\times 10^{-3}$	0.8496	0.8514	0.8573	0.8591	0.8612
ϕv (cm ³ /mole) $\times 10^2$	12.9508	8.0528	5.4605	4.8752	4.4794
$\phi k_{(s)}$ (cm ³ /mole.bar)	3.8158	1.9455	1.3121	1.0176	0.8324
β_s (bar ⁻¹) $\times 10^{-5}$	6.4392	6.5314	6.6041	6.7932	6.9133
R_A	0.9925	0.9973	1.0072	1.0145	1.0203
Z (cm/s.g ³) $\times 10^2$	11.4866	11.4173	11.3936	11.2456	11.1612
Lf (A ⁰) $\times 10^2$	4.8296	4.8641	4.8911	4.9606	5.0042

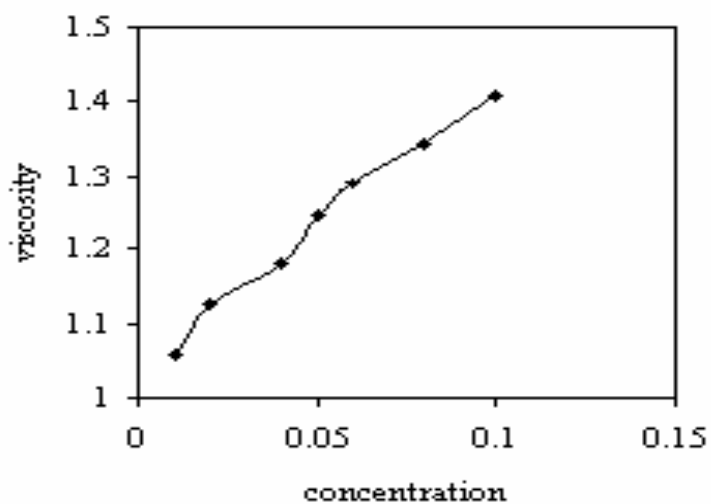


Fig.-1: Viscosity versus concentration in dioxane

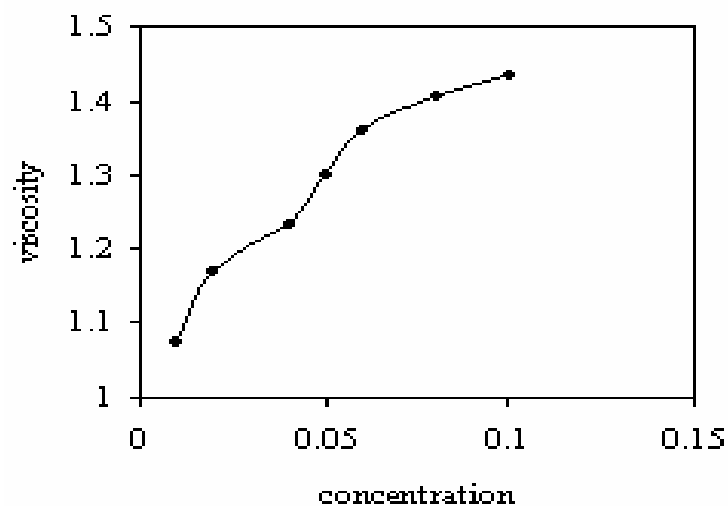


Fig.-2: Viscosity versus concentration in acetone

Agrawal et al¹⁵ have studied the densities, ultrasonic velocities and viscosities of substituted flavone, isoxazole and pyrazole in 70% acetone-water mixture in different concentrations, ultrasonic investigation on aqueous α -amylase at 298 K have been studied by S. Nithiyantham¹ and L. Palaniappan¹⁶. The values of $\phi k(s)$ in different concentrations found to be decreasing with increase in the concentration of solute. The positive values of $\phi k(s)$ show the strong electrostatic force in the vicinity of ions, causing electrostatic solvation of ions¹⁷. From the plot of $\phi k(s)$ versus $\sqrt{C}$ the infinite dilution apparent molal adiabatic compressibility $\phi^0 k(s)$ was determined as an intercept of the line and it was found to be 5.7198.

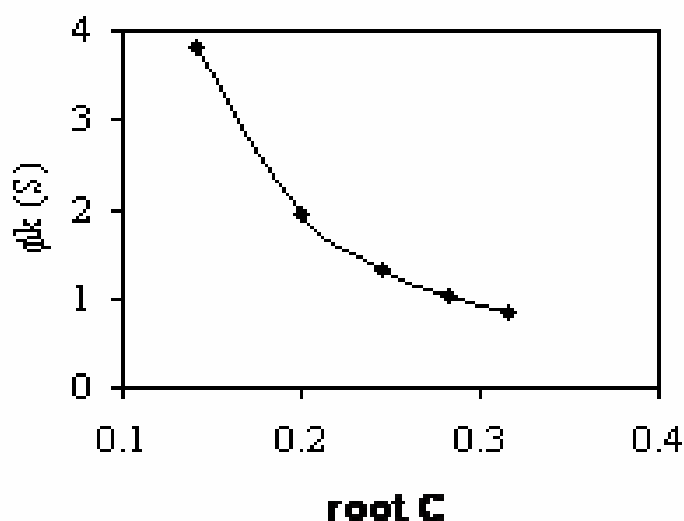


Fig.-3: $\Phi k(S)$ versus root C in 70% dioxane-water

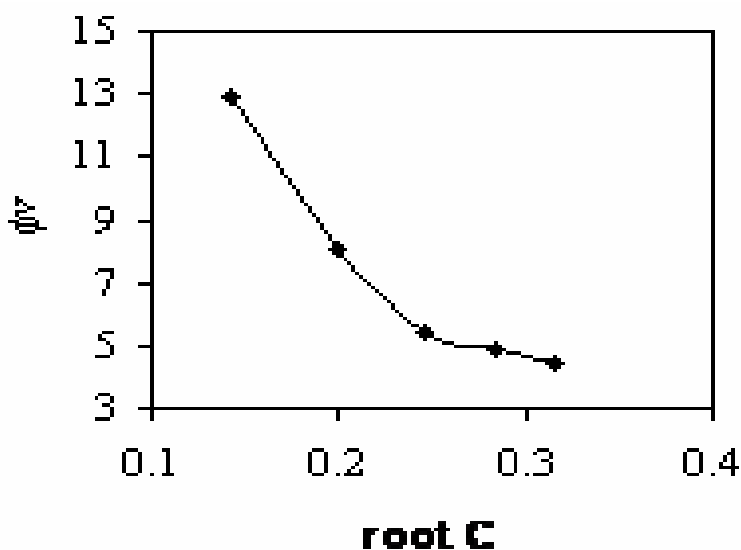


Fig.-4: $\Phi v(S)$ versus root C in 70% dioxane-water

The apparent molal volumes (ϕv) are found to decrease with increase in concentration of solute; L_f increases on increasing the concentration of solute hence decrease in ultrasonic velocity with the concentration. This indicates that there is a weak interaction between ion and solvent molecules, suggesting a structure non-promoting behaviour of the added solute. The increase of β_s with the

concentration may be due to the departure of solvent molecules around the ions¹⁸ due to weak ion-solvent interactions. The increase of R_A with concentration suggests that solvation of ions predominates over the breaking up of the solvent aggregate on addition of solutes. Acoustic impedance (Z) decreases with increase in concentration.

CONCLUSIONS

1. Molecular interactions are present between the solute and solvent mixture
2. Solute-solvent interactions are more favorable than other interactions

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Erratum

A typographical error due to an oversight has been inadvertently submitted by the authors and the same has been published in the research paper entitled, **“One pot templateglyoxal”**, RJC, Vol.1, No.2, 349-354 (2008) by D.P. Singh, R. Kumar, V. Malik and K. Kumar. Readers, please consider this data as ‘deleted’ after admitting mistake by the authors and publishing this Erratum. Thank You.