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Determination of Acoustic Parameters of Gibberellic Acid by Using Ultrasonic Interferometer

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Abstract
Density and ultrasonic velocity are measured for gibberellic acid a plant hormone over concentration range from 0.05 M to 0.01 M in 50%,45%, 40% and 35% ethanol-water at T= 303K. Measured values are used to determine adiabatic compressibility, apparent molal volume, apparent molal compressibility, acoustic impedance and relative association. These acoustical parameters explained different solute- solute and solute-solvent interaction taking place in the solutions.

Keywords: Gibberellic acid, Density, Ultrasonic velocity, Acoustic parameters, Different Interaction.

INTRODUCTION

By using ultrasonic interferometer different acoustical parameters are evaluated. The apparent molal volume has proved to be a simple and convenient tool for studying solute-solute and solute-solvent interactions in binary system [1].Ultrasonic velocity and density has been measured by using dimethyl sulphoxide at 300 K and determined ultrasonic velocity, adiabatic compressibility, relative association and specific acoustic impedance[2] Density, ultrasonic velocity and viscosity for ternary system 3-methoxy phenol, 1-pentanol and n-hexane, NN Dimethyl formamide,1-pentanol and n-hexane, 2-methoxy phenol,1-pentanol and n-hexane were measured at 303-313 K[3]. From density, viscosity and velocity calculated acoustic and thermodynamic properties adiabatic compressibility, acoustic impedance, free length, internal pressure using Jone-Dole equation [4].Density and velocity data were used to determine partial molar volume, isentropic compressibility and partial molar isentropic compressibility of glycine betaine in aqueous and aqueous potassium chloride or magnesium chloride solutions at 288.15-318.15 K[5].Density and velocity for six binary system of protic ionic liquids in toluene and dodecane were measured at various concentrations of protic ionic liquids at 293.15-328.15 K and at 0.1 MPa.[6]. Interactions of the chloramphenicol with glycine and its dipeptide in aqueous medium were evaluated from density and velocity measurements at 288.15-318.15 K at experimental pressure 0.1MPa.[7]. Densities and ultrasonic velocity for six binary mixtures of protic ionic liquids trihexyl ammonium butanoate, trihexyl ammonium hexanoate and trihexyl ammonium octanoate in toluene and dodecane were measured at 293.15-328.15 K and at 0.1 MPa[8]. Density, ultrasonic velocity and viscosity of streptomycin sulphate in water and in 1% and 2% L-asparagine or L-glutamine in water solvents were measured at 293.15-318.15 K [9].Density, ultrasonic velocity and viscosities of isoniazid in water and in aqueous–D-glucose or D-sucrose solvents were measured at 293.15-318.15 K and at atmospheric pressure[10]. Densities and ultrasonic velocity for D (+)-glucose and D (−)-fructose in 0.5 - 2.0 mol /kg aqueous solutions of diammonium hydrogen phosphate were measured at 288.15 - 318.15 K and pressure 0.1 M Pa[11].Density and ultrasonic velocity of liquid mixtures of hexylene or propylene and aqueous glutaraldehyde solutions, respectively, in the ranges from 0.01 - 0.04M at 293.15 - 308.15 K[12].Density ultrasonic velocity for binary liquid mixtures of the benzyl alcohol with three 2-alkoxyalcohols [2-methoxyethanol, 2-ethoxyethanol, and 2-butoxyethanol] at 298.15-308.15 K under 0.1 MPa[13].Densities and speeds of sound for pure and the binary mixtures of mono ethanolamine and 1-alcohols (1-propanol, 1-butanol, 1-pentanol and 1-hexanol) were measured at 298.15–318.15 K and all composition range [14].

MATERIALS AND METHODS

The ligands used for acoustic parameters measurement is gibberellic acid purchased from reputed company and purified by known method. All the chemicals used are of analytical grade. The density measurements are made by using density bottle. All the weighing is made on digital weighing balance with an accuracy of + 0.0001 gm. The ultrasonic measurement are carried out by using (Mittal Enterprises, ultrasonic Interferometer) with frequency 2MHz. In the present work, a steel cell fitted with a quartz crystal of variable frequency is employed. Measurement is carried out at constant temperature by using thermostat. The instrument is calibrated by measuring ultrasonic velocity of water at 25^0C.

RESULT AND DISCUSSION

Ultrasonic velocity is measured by using ultrasonic interferometer of frequency 2 MHz The ultrasonic waves of known frequency produced by a quartz crystal due to piezoelectric effect. When the state of acoustic resonance is reached due to the formation of standing waves, an electrical reaction occurs on the generator driving the quartz plate and its anode current becomes maximum. The micrometer is slowly moved until the anode current meter on a high frequency generator shows a maximum. The distance thus moved by the micrometer gives the values of wavelength.

The distance traveled by micrometer screw to get one maximum in ammeter (D) is used to calculate wavelength of ultrasonic wave using following relation:

$2D = \lambda$ (1)

Where, λ is wavelength and D is distance in mm. From the knowledge of the wavelength, the ultrasonic velocity can be obtained by the relation:

Ultrasonic velocity (U) = λ x Frequency x 10^3 (2)

"Using the measured data some acoustical parameters can be calculated using the standard relations. The adiabatic compressibility" [15-16] of solvent and solution can be calculated by using equations:

Adiabatic compressibility of solution (βs) = 1/ Us2 x ds (3)

Adiabatic compressibility of solvent ($\beta 0$) = 1/ U_0 2 x d_0 (4)

"The apparent molal volume (ϕ_v) and apparent molal compressibility (ϕ_K) are given by following equations.

Apparent Molar Volume (ϕ_v)

"The apparent molar volume is independent on ultrasonic velocity but depend on densities of solution and solvent, molecular weight of solute (M) and molality of solution (m). The apparent molal volume (ϕ_v) and apparent molal compressibility (ϕ_K) are given by the relation" [17-18],

$\phi_V = [1000(\rho_0 - \rho_s) / m\rho_0\rho_s] + (M/ \rho_s)$ ---------- (5)

$\phi_K = [1000 (\beta_s\rho_0 - \beta_0\rho_s) / m\rho_s\rho_0] + ((\beta sM/\rho_s)$---------- (6)

Where,

ρ_0 = density of pure solvent

ρ_s= density of solution

m = molality of solution

M = molecular weight of solute

β_0 = adiabatic compressibility of pure solvent and

β_s = adiabatic compressibility of solution

Relative association (R_A)

Relative association is given by the following equation,

$R_A = \rho_s / \rho_0 [V_0/V_S]^{1/3}$ ---------- (7)

Where, V_0 and V_s are ultrasonic velocities in a solvent and solution.

The acoustic impedance (Z) is calculated using equation:

Acoustic impedance (Z) = Us x ds ---------- (8)

Where, U_0 and Us are ultrasonic velocity in solvent and solution respectively.

d_0 and ds are density of solvent and solution respectively.

Table – 1 Acoustic parameters at different concentration of Gibberellic acid at 303K in Ethanol – Water.

Water-Ethanol Mix. %	Conc. C (Mole /lit)	Average Ultrasonic Velocity Us (m/sec)	Density d_s ($gm.cm^{-3}$)	Adiabatic compressibility βs (bar^{-1})	Apparent molal volume ϕ_V(cm^3mol^{-1})	Apparent molal Compressibility $\phi_{k(cm^3mol^{-1}bar^{-1})}$	Relative Association R_A	Acoustic Impedance ($msec^{-1}gcm^{-3}$)
50%	0.05	1447	0.931619	$4.88726x10^{-7}$	371.578	$-4.4x10^{10}$	1.007999	0.997973
	0.04	1447	0.931319	$4.92199x10^{-7}$	371.6524	$-5.5\ x10^{10}$	1.006864	0.99717
	0.03	1447	0.930771	$4.97867x10^{-7}$	371.8055	$-7.3\ x10^{10}$	1.005042	0.995953
	0.02	1447	0.930791	$5.06787x10^{-7}$	371.6329	$-1.1\ x10^{10}$	1.002069	0.992985
45%	0.05	1443	0.935306	$4.6\ x10^{-7}$	370.1841	$-4.3\ x10^{10}$	1.00597	0.999248
	0.04	1443	0.932063	$4.64\ x10^{-7}$	371.5297	$-5.4\ x10^{10}$	1.005285	1.002042
	0.03	1443	0.928652	$4.79\ x10^{-7}$	372.9971	$-7\ x10^{10}$	1.000462	1.000897
	0.02	1443	0.928606	$4.8\ x10^{-7}$	373.026	$-1x10^{11}$	1.000231	1.000716
40%	0.05	1432	0.949412	$4.7\ x10^{-7}$	364.6547	$-4.3\ x10^{10}$	1.004634	0.996539
	0.04	1432	0.946701	$4.74\ x10^{-7}$	365.732	$-5.3\ x10^{10}$	1.003942	0.998704
	0.03	1432	0.947469	$4.81\ x10^{-7}$	365.3608	$-6.9\ x10^{10}$	1.001395	0.995363
	0.02	1432	0.943487	$4.83\ x10^{-7}$	367.0198	$-1\ x10^{11}$	1.001163	0.999332
35%	0.05	1429	0.935927	4.95E-07	370.5833	$-4\ x10^{10}$	1.002327	1.02639
	0.04	1429	0.954251	$4.88\ x10^{-7}$	363.0891	$-5.1\ x10^{10}$	1.001398	1.005747
	0.03	1429	0.953837	$4.89\ x10^{-7}$	363.2996	$-6.8\ x10^{10}$	1.001165	1.00595
	0.02	1429	0.952793	$4.91\ x10^{-7}$	363.838	$-1\ x10^{11}$	1.000699	1.006584

CONCLUSION

Acoustic parameters are helpful to analyze interaction of gibberellic acid and solvent molecule in solution. Nature of molecular interaction are explained by measuring ultrasonic velocity and density of pure liquids and solution. Ultrasonic velocity is depending on concentration, (Table-1) shows variation of ultrasonic velocity with concentration. In concentrated solution the formation of hydrogen bond increases which gives packed structure and hence ultrasonic velocity increases. In concentrated solution cohesion brought about the association among the molecule and greater solute-solvent interaction. compressibility gives the ease with which medium can be compressed. As per general trend observed for electrolytic solution. In more concentrated solution more cohesion can be expected and this leads to decrease in adiabatic compressibility this leads to increases in ultrasonic velocity. The increase of adiabatic compressibility with decrease of concentration of solution molecule around ions supporting

weak ion-solvent interactions. The adiabatic compressibility value decrease with increasing concentration indicates formation of strong hydrogen bonding between solute and solvent. The concentration dependence of apparent molar volume is very useful tool in elucidating ion-ion interaction. Concentration increases, apparent molar volume decreases. Concentration dependence of apparent molar volume is important in illustrating solute-solvent interactions. The increase in the value of apparent molar compressibility with decrease in concentration shows weak electrostatic attractive force in the vicinity of ions causing electrostatic solvation of ions. Apparent molar compressibility is more in case of bulky substituents.

As the concentration decreases solvation number increases shows the variation of solvation number with concentration when solvation occurs the solvent molecule of ion-solvent complex may be more closely packed than in pure solvent.

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