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Ultrasonic Investigation of Aqueous Ascorbic Acid in Koh At Temperature 308.15k

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ABSTRACT
For the study of molecular interaction of aqueous ascorbic acid in KOH solution using ultrasonic at temperature 308.15K, we measure three impartment parameters that are ultrasonic velocity (U), density (ρ) and viscosity (η). The measurement of ultrasonic velocity were carried out by using the ultrasonic pulse eco overlap (PEO) technique at frequency 5 MHz. The measurement of density has been carried out by using hydrostatic plunger method and viscosity by Oswald's viscometer. The temperature 308.15K have been kept constant using thermostat by circulating water. Experimental data have been used to calculate the thermo-acoustical parameters such as adiabatic compressibility (β), acoustic impedance (Z), free length (L_f), free volume (V_f) , wada's constant (β_m) and Rao's constant (R). These parameters have been used to give the interpretations of solute- solvent interaction of aqueous ascorbic acid and KOH molecules. This study also shows the nature of molecular interaction and complex formation in the given solution. It also provides important information regarding molecular properties of a mixture of solute and solvent.

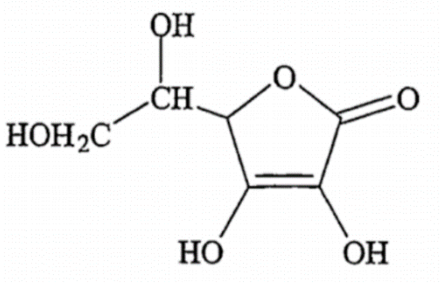
Keywords : Ultrasonic velocity, adiabatic compressibility, free volume, Wada's constant, Rao's constant and ascorbic acid.

I. INTRODUCTION

Ultrasonic method are based either on the determination of the characteristics of propagation (velocity or attenuation) or by the measurement of the reflection coefficients. In the ultrasonic based experimental devices, the measurement of the velocity and attenuation during the propagation allow to determine the physical properties of the medium.

The ultrasonic velocity, density, viscosity and other thermo acoustical parameters are very useful and helpful to study the nature of intermolecular forces in liquid mixtures and also give idea about association, dissociation and complex formation in a given mixture. [1-4]

Ascorbic acid is a colorless and water soluble vitamin. It is found in many plants and animals. Among plants, it is present in all fresh fruits and vegetables like tomatoes, melons, raw cabbage and green pepper. New potatoes contain relatively large amount of vitamin C. It is found in human milk is nearly 3 to 4 times more than cow's milk. However vitamin C is absent in fish, fats and oils [5-8]. The structure of ascorbic acid was established mainly by Haworth. The chemical formula of ascorbic acid is C6H8O6 and its molecular weight is 176.13. The structure of ascorbic acid is.



II. METHODS AND MATERIAL

The aqueous ascorbic acid solution (0.1M) was prepared using double distilled water. The solution of different concentration was prepared using 0.1M KOH solvent. The ultrasonic velocity for different concentration of aqueous ascorbic acid with KOH solutions measurement were carried out with a highly versatile and accurate 'pulse echo overlap technique (PEO) method by using automatic ultrasonic recorder (AUAR-102) and frequency counter. The frequency of the pulses was kept at 5MHz. The density and viscosity were measured using hydrostatic plunger method and Oswald's viscometer respectively. Temperature 308.15K is maintained using thermostatically controlled water circulation system with accuracy of 0.50C. The other thermo-acoustical parameters such as acoustic impedance, adiabatic compressibility, free length, free volume, Wada's constant and Rao's constant ware evaluated using ultrasonic velocity, density and viscosity. The formulae for calculation of various thermo-acoustical parameters are as fallows [9].

[1]. Ultrasonic velocity: $u = 2d / t$

Where, d = Separation between transducer & reflector

t = Traveling time period of ultrasonic wave

[2]. Density $\rho = \left(\frac{W_a - W_1}{W_a - W_w}\right) \times \rho_w$

Where, W_a = Weight of the plunger in air

W_1 = Weight of the plunger in the experimental liquid

W_w = Weight of the plunger in water

ρ_w = Density of water

[3]. Viscosity $\eta = \frac{\rho \times t_1}{\rho_w \times t_w} \times \eta_w$

Where, t_1 = Flow Time of experimental liquid

t_w = Flow Time of water

η_w = Viscosity of water

[4]. Adiabatic Compressibility: $\beta = [1 / u^2\rho]$

[5]. Acoustic impedance : $Z = u. \rho$

[6]. Intermolecular free length: $(L_f) = \frac{k}{u\,\rho^{1/2}}$

Where, k = Jacobson's constant = (93.875+0.345T) x10^{-8} (T is temperature)

[7]. Free volume : $(V_f) = M_w u / k \eta$

Where, k = Time independent constant = 4.28 x 10^9

M_w = molecular weight of solution

[8]. Wada's Constant : $(\beta_m) = (M_w/ \rho) \times \beta^{-1/7}$

[9]. Rao's Constant (R) = $(M_w/ \rho) \times u^{1/3}$

Table no. 1

Concentration	Ultrasonic Velocity (u) cm s^{-1}	Density (ρ) g cm^{-3}	Viscosity (η) Centi poise	Adiabatic compressibility (β x 10^{-11}) cm^2 $dyne^{-1}$	Acoustic impedance (Zx10^5) g cm^{-2} s^{-1}
0	152136	0.9982	0.7229	4.3283	1.5186
0.02	152503	0.9988	0.7203	4.3049	1.5232
0.04	152998	0.9994	0.7336	4.2745	1.5291
0.06	152610	1.0007	0.7289	4.2907	1.5272
0.08	152512	1.0012	0.7445	4.2941	1.5269
0.10	152525	1.0028	0.7431	4.2865hy	1.5295

Table no. 2

Concentration	Free length (L_f x 10^{-11}) cm	Free Volume (V_f X 10^{-8}) cm^3/Mole	Wada's constant (βm) $cm^{19/7}$/$dyne^{1/7}$	Rao's constant(R) $cm^{10/3}$/$s^{1/3}$
0	1.3167	1.8017	547.7697	967.1249
0.02	1.3131	1.7924	549.1654	969.6169
0.04	1.3085	1.7795	550.6970	972.3871
0.06	1.3109	1.7893	550.9898	972.6065
0.08	1.3115	1.7942	551.9597	974.2021
0.10	1.3103	1.7909	552.5293	975.0065

III. RESULTS AND DISCUSSION

The experimental data of ultrasonic velocity, density, viscosity, adiabatic compressibility and acoustic impedance of aqueous ascorbic acid with KOH at 308.15K, are recorded in table 1, and Intermolecular free length, free volume, Wada's constant and Rao's constant are given in table 2.

The variation of ultrasonic velocity and acoustic impedance with molar concentration are shown in figure (1) and figure (5). It is observed that ultrasonic velocity and acoustic impedance have non linear variations with increase in concentration having peak at 0.04 molar concentrations. Initially an increase in velocity with increase in molar concentration suggests increase in cohesive forces due to vitamin and KOH molecules interaction [**10**]. Then decrease in ultrasonic velocity after 0.04 molar concentration suggests breaking up of molecular bonds when the concentration of vitamin is more in the solution. This suggests the dissociation take place in the solution. When 0.01M KOH is added to aqueous ascorbic acid it form a induced dipole interaction with aqueous vitamin C and undergo association, But after 0.04 molar concentration dissociation take place because vitamin C is type of conjugate system hence it ultimately decomposed and undergo dissociation. The adiabatic compressibility has reverse trend as shown in figure (4).

Variation of density with molar concentration is shown in figure (2), which are increases after addition of vitamin in KOH solution. Increase in density due to the fact that numbers of vitamin molecules are added to the solution increase with increase in vitamin concentration [11].

Figure (3) gives the variation of viscosity of aqueous ascorbic acid solution with the molar concentration. Variation of viscosity is non linear with increase in molar concentration, which indicate that there is existence of strong molecular interaction in between vitamin and KOH molecules. [12].

The variation of free length and free volume with concentration as showed in figure (6) and figure (7). Free length and free volume decreases first and after 0.04 molar concentration increases. This shows that initially there is association take place with increase in molar concentration and after 0.04 molar concentration dissociation take place [13].

The variation of Wada's constant and Rao's constant with concentration is shown in figure (8) and (9). It is observed that Wada's constant and Rao's constant increase with increasing molar concentration. This indicates that there is strong molecular interaction between solute and solvent molecules due to hydrogen bonding and ion-covalent interaction.

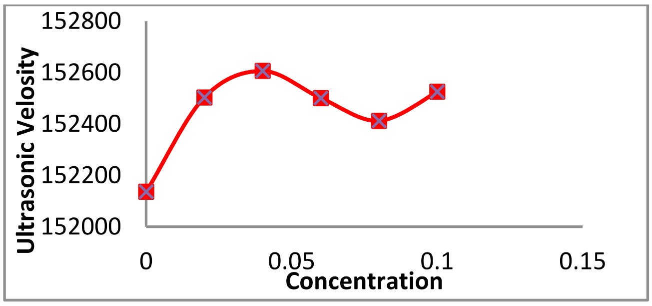


Fig 1: Variation of Ultra. Velocity with Conc.

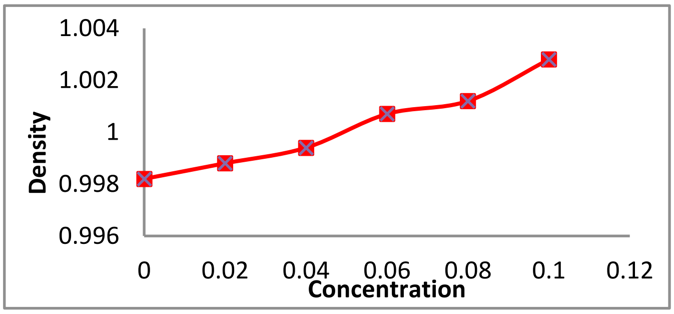


Fig. 2 : Variation of Density with concentration

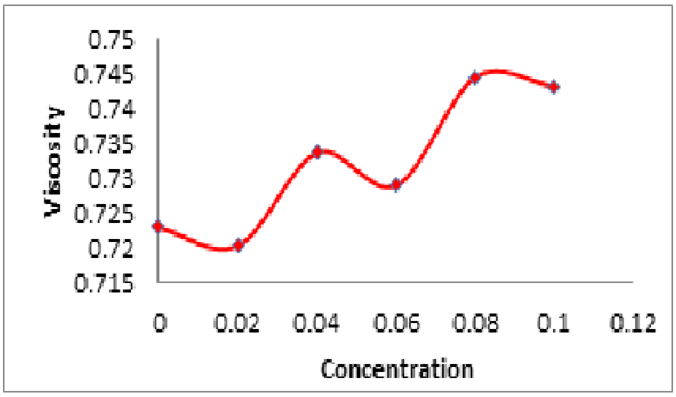


Fig 3: Variation of Viscosity with Concentration

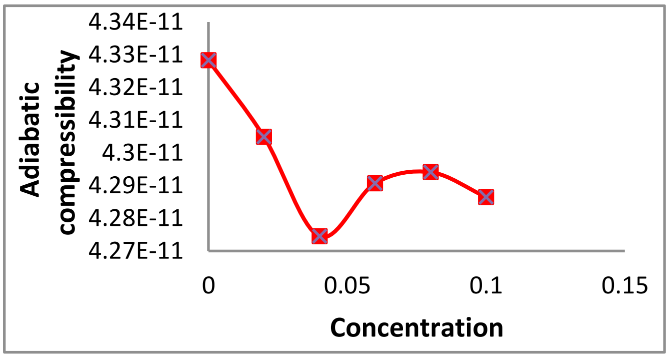


Fig 4; Variation of Adia. Compressibility with con.

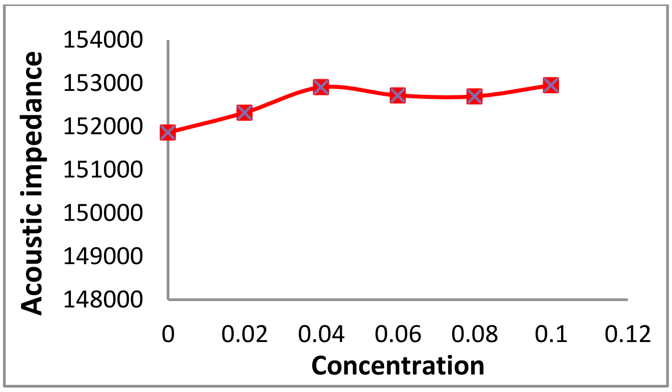


Fig 5 :Variation of Acoustic Impedance with conc.

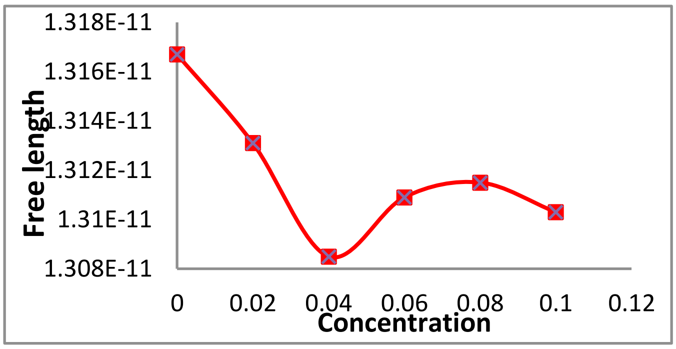


Fig6:Variation of Free length with conc.

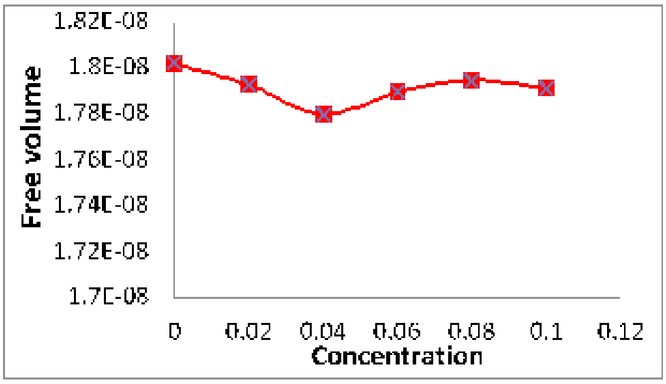


Fig 7: Variation of Free volume with Con.

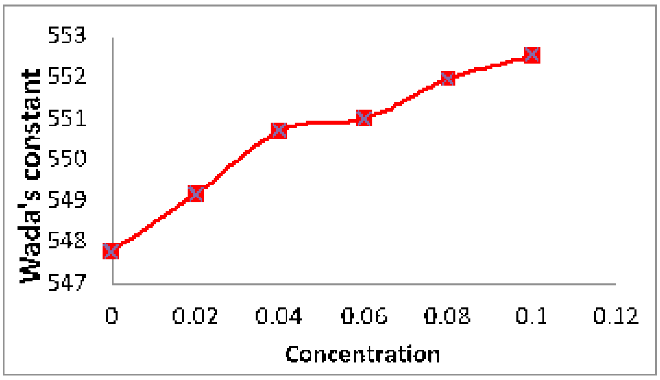


Fig. 8 : Variation of Wada's constant with con.

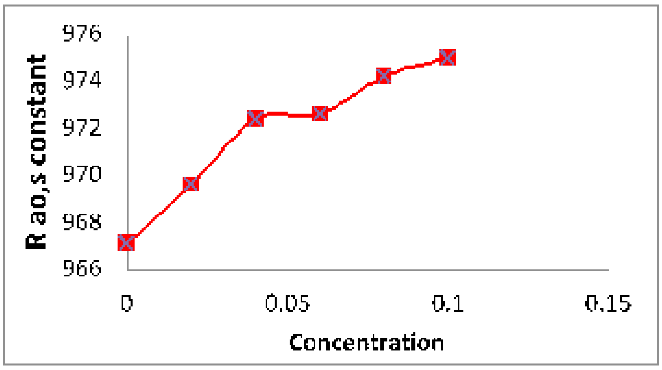


Fig 9: Variation of Rao's constant with Concentration

IV. CONCLUSION

Ultrasonic velocity, density and viscosity of different concentration of aqueous ascorbic acid with KOH are measured at 308.15K and thermo-acoustical parameters are calculated. The non linear variation in ultrasonic velocity and other acoustical parameters indicates that there is a strong molecular interaction between vitamin C and KOH molecules with complex formation take place at 0.04 molar concentrations.

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