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Volumetric and Viscometric studies for aqueous solution of Methyl Ester Glyphosate at different temperatures

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Abstract

Ultrasonic velocity, density and Viscosity of Methyl Ester Glyphosate in aqueous solution is measured by ultrasonic interferometer, specific gravity bottle and Ostwald's viscometer respectively, for different concentrations at various temperatures. Acoustical parameters such as Acoustics impedance, adiabatic compressibility, Intermolecular free length, Relaxation time, Ultrasonic attenuation and Relative Strength were calculated by the experimental values. Acoustic and thermodynamic parameters were calculated and analysed by using these fundamental parameters.

Introduction

Ultrasonic technique has provided an important approach to parameters for a binary or ternary solvent or pure solvent system. A significant number of studies have been carried out on this specific technique, but there is still a wide range of studies [1-7]. It teaches us about the formation of complex compounds. This is the ternary and binary mixture of glyphosate methyl ester, water and methanol. This particular mixture is used in agriculture as a pesticide. This study is interpreted in terms of molecular interactions in the chemical system. With the help of ultrasonic velocity and viscosity of the mixture, other derived parameters such as adiabatic compressibility(β), relaxation time(τ), ultrasonic attenuation(α), acoustic impedance(Z) have been measured[8-11]. The intermolecular free length has been calculated with Jacobson's temperature dependent relation. The relaxation strength is calculated using Schaaf's limiting value for liquids. The trends of these define behavior and nature of a system more accurately [11-14]. Proteins are linear macromolecules of one or more chains of amino acid residue and have a complex structure. There are about 20 amino acids which are the basic building blocks of all the organisms. Because of their complicated nature, its direct study is not possible. .The fundamental structural units of proteins are amino acids and peptides. So by studying the nature of amino acids and peptides; we gain large amount of information of proteins. Ultrasonic study of amino acids in aqueous solution of non electrolytes and electrolytes provides important

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information of media. Glyphosate [N-(phosphonomethyl)glycine] is the most used herbicide in whole world [14-19].

Experimental

Chemicals

In this experimental work methyl ester of glyphosate is used with water and methanol. Methyl Ester of Glyphosate having molecular weight of 183.07grams is mixed with distilled water having molecular weight of 18.00grams and methanol having molecular weight of 26.00grams is used.

Measurements

To calculate velocity, ultrasonic velocity and viscosity at different concentration of dipeptides in DMSO. The basic parameters (density viscosity and ultrasonic velocity) will be calculated specific gravity bottle (10 ml) and Oswald viscometer respectively. The other parameters as intermolecular free length, relaxation time, acoustic impedance, Vander wall's constant ultrasonic attenuation, adiabatic compressibility, Wada's constant, relative association, and free volume and internal pressure will be computed by basic parameters.

Ultrasonic velocity:

The ultrasonic interferometer is a device for determining the ultrasonic velocity in liquids with a large accuracy. The principle used for measuring the velocity (v), based on the exact calculation of wavelength in a medium. Then the wavelength is calculated as:

$$\lambda = {}^{2d}/_{n} \quad (1)$$

$$U = f \times \lambda \quad (2)$$

Density:

Density of liquid mixtures, pure liquid and solution can be calculated using relative measurement method. The density of liquid has measured by a bottle of 10ml specific gravity at different concentration. The bottle of specific gravity with liquid deep at a temperature precise water bath. The measured density is measured with a formula,

$$\rho_1 = \left(\frac{w_2}{w_1}\right)\rho_2 \quad (3)$$

Viscosity:

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The viscosity of a mixture has measured by using an Ostwald's viscometer. Viscosity can be calculated by relation:

$$\eta_{2=}\eta_1(t_2/t_1)(\rho_2/\rho_1) \quad (4)$$

Where, η_1=viscosity of water, η_2= experimental liquid's viscosity, t_1= time of flow of the water , η_2= experimental liquid's viscosity, t_2= flow of experimental liquid, ρ_1 = Water's density, ρ_2 = experimental liquid's density.

Result and Discussions:

Table 1: Experimental values of η, ρ & U with varying concentration & molality at 298K at 2 MHz

Conc. (%)	Molality	Ultrasonic Velocity(U)	Density (ρ)	Viscosity(η)
0.0	0.0000	1342	1.014	0.9501
0.0	0.0983	1520	1.0191	0.9824
0.0	0.1488	1311	1.0216	1.0100
0.0	0.1993	1550	1.0191	1.0400
0.1	0.0000	1650	0.9972	1.0984
0.1	0.0983	1750	1.0045	1.0513
0.1	0.1488	1660	1.0061	1.1777
0.1	0.1993	1688	1.0093	1.0425

Table 2: Experimental values of η, ρ & U with varying concentration & molality at 303K

(%)	Molality	Velocity (U)	Density(ρ)	Viscosity(η)
0.0	0.0000	1440	1.0037	0.8414
0.0	0.0983	1600	1.0075	0.8783
0.0	0.1488	1400	1.0094	0.9000
0.0	0.1993	1640	1.0072	0.9200
0.1	0.0000	1412	0.9840	1.1828
0.1	0.0983	1511	0.9934	1.1658

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0.1	0.1488	1398	0.9934	1.2392
0.1	0.1993	1444	0.9972	1.1571

Table 3: Experimental values of η, ρ & U with varying concentration & molality at 308K

Conc. (%)	Molality	Velocity(U)	Density(ρ)	Viscosity(η)
0.0	0.0000	1520	0.9977	0.7921
0.0	0.0983	1650	1.0001	0.8271
0.0	0.1488	1520	1.0036	0.8400
0.0	0.1993	1650	0.9989	0.8500
0.1	0.0000	1440	0.9784	0.9062
0.1	0.0983	1703	0.9871	0.8816
0.1	0.1488	1548	0.9864	1.0116
0.1	0.1993	1642	0.9908	0.8522

Table 4: Experimental values of Z, β & free length (L_f) at different concentration & molality at 298K

Concentrating (%)	Molality	Impedance (Z)	Adiabatic compressibility (β)	Free length (L_f) $\times 10^{-6}$
0.0	0.0000	1360.7880	3.68	3.77
0.0	0.0983	1549.0320	3.25	3.54
0.0	0.1488	1339.3176	3.53	3.69
0.0	0.1993	1579.6050	3.48	3.66
0.1	0.0000	1098.4000	3.68	5.25
0.1	0.0983	1351.3000	3.25	4.53

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0.1	0.1488	1177.7000	3.61	5.21
0.1	0.1993	1342.5000	3.48	4.82

Table 5: Experimental values of of Z, β & free length($L_{f)}$ at different concentration & molality at 303K

Con. (%)	Molality	Impedance (Z)	Adiabatic compressibility (β)	Free length ($L_{f)}$ $\times 10^{-6}$
0.0	0.0000	1360.7880	3.68	3.77
0.0	0.0983	1549.0320	3.25	3.54
0.0	0.1488	1339.3176	3.53	3.69
0.0	0.1993	1579.6050	3.48	3.66
0.1	0.0000	1445.3280	5.10	4.44
0.1	0.0983	1612.0000	4.41	4.13
0.1	0.1488	1413.1600	4.75	4.28
0.1	0.1993	1651.8080	4.61	4.22

Table 6: Experimental values of of Z, β & free length($L_{f)}$ at different concentration & molality at 308K

Con. (%)	Molality	Impedance (Z)	Adiabatic compressibility (β)	Free length ($L_{f)}$ $\times 10^{-6}$
0.0	0.0000	1516.504	4.43	4.14
0.0	0.0983	1650.165	3.37	3.61
0.0	0.1488	1525.472	4.23	4.04
0.0	0.1993	1648.185	3.74	3.80
0.1	0.0000	1516.504	4.93	5.94
0.1	0.0983	1650.165	3.49	5.12

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0.1	0.1488	1525.472	4.23	5.69

Table 7: Experimental values of relaxation time & attenuation with varying concentration, molality & temperature at 2 MHz

Con. (%)	Molality	Relaxation time(τ)	Attenuation(α/f^2) $\times 10^{-8}$	Relative strength
0.0	0.0000	5.163232933	0.89	1.0937
0.0	0.0983	5.702160000	1.20	1.0793
0.0	0.1488	5.654074667	1.01	1.0550
0.0	0.1993	6.933800000	1.12	1.0312
0.1	0.0000	6.236200000	0.89	1.0937
0.1	0.0983	6.484800000	1.20	1.0400
0.1	0.1488	6.112900000	1.01	1.0550

Table 8: Experimental values of relaxation time & attenuation with varying concentration, molality & temperature at 2 MHz

Con. (%)	Molality	Relaxation time(τ)	Attenuation(α/f^2) $\times 10^{-9}$	Relative strength
0.0	0.0000	4.666131120	6.45	0.8825
0.0	0.0983	4.257852587	5.13	0.9443
0.0	0.1488	4.757100000	6.73	1.0237
0.0	0.1993	4.821717333	5.65	0.9025
0.1	0.0000	5.259000000	6.45	0.8825
0.1	0.0983	4.534100000	5.13	0.9443

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0.1	0.1488	5.219800000	6.73	0.8865
0.0	0.0000	4.821200000	5.65	0.9025

Table 9: Experimental values of relaxation time & attenuation with varying concentration, molality & temperature at 2 MHz

Con. (%)	Molality	Relaxation time(τ)	Attenuation($\alpha/f^{2)} \times 10^{-9}$	Relative strength
0.0	0.0000	4.67750892	8.16	0.9000
0.0	0.0983	3.71985468	6.75	1.0831
0.0	0.1488	4.73827200	7.27	0.9675
0.0	0.1993	4.24252000	6.16	1.0262
0.1	0.0000	5.94053000	8.16	0.9000
0.1	0.0983	5.12500000	6.25	1.0831
0.1	0.1488	5.69190000	7.27	0.9675
0.0	0.0000	5.14280000	6.18	1.0262

1. **Acoustics impedance**:

It is the resistance which is offered to the propagation of ultrasonic wave in a material,

$$Z = \rho \text{ x } U \quad (5)$$

This impedance is used for determining the acoustic reflection and transmission at the boundary of 2 materials having different acoustics impedances which is shown in **table 4, table 5 and table 6** respectively for temperature 298 K, 303 K and 308 K.

2. **Adiabatic compressibility:**

It is defined as fractional decrease in volume per unit increase of pressure, when no heat flows out or in for temperature which is shown in **table 4, table 5 and table 6** respectively for temperature 298 K, 303 K and 308 K.

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This can be determined by density of medium and speed of sound using equations of Newton's which are:

$$\beta = {}^{1}/_{[\rho(U^2)]} \quad (6)$$

3. Intermolecular free length:

The distances between surfaces of neighbouring molecules that is given by:

$$L_f = K_\tau (\beta)^{1/2} \quad (7)$$

Their values are given in **table 4, table 5 and table 6** respectively for temperature 298 K, 303 K and 308 K.

4. Relaxation time:

Relaxation time for binary mixture is determined from the relation.

$$\tau = 4\beta\eta/3 \quad (8)$$

It can also be written as: $\tau = 4\eta/3\rho U^2$ (9)

The values of relaxation time are defined in **table 7, table 8 and table 9** respectively for temperature 298 K, 303 K and 308 K.

5. Ultrasonic attenuation:

Rate of decrease of energy when an ultrasonic wave is propagating in a medium termed as attenuation and depend upon the properties of medium. The sound attenuation increases with an increase in the frequency and generally proportional to the square of sound frequency and values are represented in **table 7, table 8 and table 9** respectively for temperature 298 K, 303 K and 308 K. So ultrasonic attenuation can expressed as:

$$(\alpha/f^2) = (8\pi^2\eta/3\rho U^2) \quad (10)$$

6. Relative Strength

It was calculated by:

$$R = 1 - (U/U_\infty) \quad (11)$$

In **table 7, table 8 and table 9** respectively the calculated values of relative strength is presented for temperature 298 K, 303 K and 308 K.

Where,

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w_1= weight of distilled water, w_2= experimental liquid's weight, ρ_1= Density of water, ρ_2= Experimental liquid's density, Z= Acoustic impedance, β=Adiabatc compressibility, L_f= Intermolecular free length, τ=Relaxation time, η=Viscosity of mixture, ρ=Density of mixture, U = Ultrasonic velocity in the medium, U_∞= Schaaf's limiting value taken as 1600m/s for all liquids, f = frequency of wave.

Conclusions

In order to find information on the molecular interaction between their constituent particles, a solution consisting of methyl ester of glyphosate as a solution with water and methanol as a solvent was chosen. Variation of experimentally obtained and derived parameters indicates the existence of molecular interaction at 2 MHz between the molecules of the solution. In all the cases the density, viscosity and ultrasonic velocity increases with the increase in methanol concentration but decreases with increase in temperature. The derived parameters such as Intermolecular Free length, adiabatic compressibility, and Relaxation time show opposite behavior with ultrasonic velocity. They decrease with increase in concentration of the solute but exhibits opposite trends with rise in temperature. The parameters such as ultrasonic attenuation and relaxation time decreases with increase in methanol concentration as well as temperature. Whereas the relaxation strength decreases with increase in concentration but increases with increase in temperature. Also the parameters such as acoustic impedance varies non linearly with the concentration indicates the presence of complex formation. Here the acoustic impedance varies inversely with temperature.

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