Measurement of density, velocity and viscosity of glyphosate with water at various frequencies

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Abstract

The Density(ρ), viscosity(η) and ultrasonic velocity(U) of glyphosate with water have been measured on different temperatures ranges from (303, 313, 323, 343) K for different concentrations (0.05%, 0.10%, 0.15%, 0.20%, 0.25%, 0.30%, 0.35%, & 0.40%) at 1MHz, 2MHz, 3MHz and 5MHz respectively. The specific gravity bottle, Ostwald's viscometer and quartz crystal interferometer were used to determine density (ρ), viscosity (η) and ultrasonic velocity (U) respectively. These experimental parameters are compared with each other at different frequencies.

Keywords: Glyphosate, effect of temperature, effect of concentration, effect of ultrasonic frequency, ultrasonic velocity, viscosity.

1. 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 [1-11]. It teaches us about the formation of complex compounds. The knowledge of the structure of mixed solvent systems becomes an essential prerequisite to interpret and to understand the interaction patters between ions, ions-pairs and ionic aggregate and bulking solvent.

This study is fruitful for the understanding of macroscopic structure between solute- solute and solute-solvent interaction. It is used in a wide variety of reactions including, electrophilic substitution, nucleophilic substitution, oxidation and reduction. The nature and relative strength of the molecular interaction between the components of the liquid mixtures have been successfully investigated by the ultrasonic method [12-17].

Experimental

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.

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:

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

$U = f \times \lambda$ (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:

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.

3. Result and Discussions:

i.Different frequency by varying temperature

The density of a given solution increases with increase in concentration of Glyphosate in distilled water [18]. Here density directly depends on the solute molecules. According to Kinetic theory of gases the volume is directly proportional to temperature. Also density is the ratio of mass to volume. Hence density is inversely proportional to temperature. So, at the same concentration the density decreases as the temperature increases from 303 K to 333 K respectively[19-22]. The density is independent on ultrasonic frequency as shown from table 1 to table 4.

Table 1: Experimental values of Density, viscosity and ultrasonic velocity with varying concentration & temperature at 1 MHz

Concentration (%)	Temperature (K)	Density ρ (kg/m^3)	Viscosity η (Ns/m^2)	Velocity u (m/s)
0.05	303	1001.9674	0.816647	1418.9474
	313	998.0499	0.614995	1417.8947
	323	993.5396	0.521285	1416.8421
	333	988.4258	0.410026	1415.7895
0.10	303	1007.7105	0.842973	1426.6316
	313	1002.9870	0.629521	1423.1579

	323	999.1206	0.529901	1422.1053
	333	994.4803	0.420319	1420.0000
0.15	303	1011.9970	0.862258	1431.5789
	313	1007.8827	0.642035	1430.5263
	323	1003.9988	0.540108	1429.4737
	333	999.1324	0.429237	1427.3684
0.20	303	1016.6997	0.884464	1437.8949
	313	1012.5709	0.654507	1435.7895
	323	1008.3809	0.548206	1434.7368
	333	1003.0435	0.449236	1432.6326
0.25	303	1020.5285	0.902409	1442.1053
	313	1016.8027	0.666768	1441.0526
	323	1012.3496	0.555167	1440.0000
	333	1007.3662	0.459933	1438.9474
0.30	303	1026.3132	0.925895	1446.5789
	313	1021.4909	0.682601	1445.2632
	323	1016.5664	0.564230	1444.2105
	333	1010.7009	0.466729	1443.1579
0.35	303	1028.3132	0.947177	1451.5789
	313	1024.2707	0.698318	1450.5263
	323	1019.9976	0.571941	1449.4737
	333	1014.5297	0.482614	1447.3684
0.40	303	1030.7246	0.969234	1458.9474
	313	1026.4281	0.712609	1456.8421
	323	1021.7753	0.582632	1454.7368
	333	1015.5177	0.491032	1452.6316

Table 2: Experimental values of Density, viscosity and ultrasonic velocity with varying concentration & temperature at 2 MHz

Concentration (%)	Temperature (K)	Density ρ (kg/m^3)	Viscosity η (Ns/m^2)	Velocity u (m/s)
0.05	303	1001.9674	0.81665	1421.0526
	313	998.0499	0.61500	1416.8422
	323	993.5396	0.52129	1412.6316
	333	988.4258	0.41003	1408.4210
0.10	303	1007.7105	0.84297	1435.7894
	313	1002.9870	0.62952	1429.4736
	323	999.1206	0.52990	1423.1578
	333	994.4803	0.42032	1418.9474
0.15	303	1011.9970	0.86226	1450.5263
	313	1007.8827	0.64204	1444.2106
	323	1003.9988	0.54011	1435.7894
	333	999.1324	0.42924	1433.6842

0.20	303	1016.6997	0.88446	1465.2632
	313	1012.5709	0.65451	1463.1578
	323	1008.3809	0.54821	1454.7368
	333	1003.0435	0.44924	1448.4210
0.25	303	1020.5285	0.90241	1482.1052
	313	1016.8027	0.66677	1475.7894
	323	1012.3496	0.55517	1473.6842
	333	1007.3662	0.45993	1467.3684
0.30	303	1026.3132	0.92590	1503.1578
	313	1021.4909	0.68260	1496.8422
	323	1016.5664	0.56423	1492.6316
	333	1010.7009	0.46673	1490.5264
0.35	303	1028.3132	0.94718	1530.5264
	313	1024.2707	0.69832	1522.1052
	323	1019.9976	0.57194	1515.7894
	333	1014.5297	0.48261	1511.5790
0.40	303	1030.7246	0.96923	1555.7896
	313	1026.4281	0.71261	1551.5790
	323	1021.7753	0.58263	1538.9474
	333	1015.5177	0.49103	1532.6316

Table 3: Experimental values of Density, viscosity and ultrasonic velocity with varying concentration & temperature at 3 MHz

Concentration (%)	Temperature (K)	Density ρ (kg/m^3)	Viscosity η (Ns/m^2)	Velocity u (m/s)
0.05	303	1001.9674	0.816647	1424.2106
	313	998.0499	0.614995	1417.8948
	323	993.5396	0.521285	1408.4210
	333	988.4258	0.410026	1402.1052
0.10	303	1007.7105	0.842973	1458.9474
	313	1002.9870	0.629521	1452.6316
	323	999.1206	0.529901	1446.3158
	333	994.4803	0.420319	1436.8422
0.15	303	1011.9970	0.862258	1493.6842
	313	1007.8827	0.642035	1487.3684
	323	1003.9988	0.540108	1477.8948
	333	999.1324	0.429237	1468.4210
0.20	303	1016.6997	0.884464	1518.9474
	313	1012.5709	0.654507	1512.6316
	323	1008.3809	0.548206	1503.1578
	333	1003.0435	0.449236	1496.8422
0.25	303	1020.5285	0.902409	1563.1578
	313	1016.8027	0.666768	1556.8422

	323	1012.3496	0.555167	1547.3684
	333	1007.3662	0.459933	1531.5750
0.30	303	1026.3132	0.925895	1601.0526
	313	1021.4909	0.682601	1591.5790
	323	1016.5664	0.564230	1582.1052
	333	1010.7009	0.466729	1575.7894
0.35	303	1028.3132	0.947177	1638.9474
	313	1024.2707	0.698318	1632.6316
	323	1019.9976	0.571941	1623.1578
	333	1014.5297	0.482614	1610.5264
0.40	303	1030.7246	0.969234	1676.8422
	313	1026.4281	0.712609	1667.3684
	323	1021.7753	0.582632	1657.8948
	333	1015.5177	0.491032	1648.4210

Table 4: Experimental values of Density, viscosity and ultrasonic velocity with varying concentration & temperature at 5 MHz

Concentration (%)	Temperature (K)	Density ρ (kg/m^3)	Viscosity η (Ns/m^2)	Velocity u (m/s)
0.05	303	1001.9674	0.816647	1473.6842
	313	998.0499	0.614995	1463.1578
	323	993.5396	0.521285	1447.3684
	333	988.4258	0.410026	1426.3158
0.10	303	1007.7105	0.842973	1526.3158
	313	1002.9870	0.629521	1515.7894
	323	999.1206	0.529901	1494.7368
	333	994.4803	0.420319	1478.9474
0.15	303	1011.9970	0.862258	1573.6842
	313	1007.8827	0.642035	1563.1578
	323	1003.9988	0.540108	1547.3684
	333	999.1324	0.429237	1531.5790
0.20	303	1016.6997	0.884464	1621.0526
	313	1012.5709	0.654507	1605.2632
	323	1008.3809	0.548206	1594.7368
	333	1003.0435	0.449236	1584.2106
0.25	303	1020.5285	0.902409	1663.1578
	313	1016.8027	0.666768	1652.6316
	323	1012.3496	0.555167	1636.8422
	333	1007.3662	0.459933	1626.3158
0.30	303	1026.3132	0.925895	1726.3158
	313	1021.4909	0.682601	1710.5264
	323	1016.5664	0.564230	1694.7368
	333	1010.7009	0.466729	1673.6842
0.35	303	1028.3132	0.947177	1773.6842
	313	1024.2707	0.698318	1763.1578

	323	1019.9976	0.571941	1747.3684
	333	1014.5297	0.482614	1731.5790
0.40	303	1030.7246	0.969234	1815.7894
	313	1026.4281	0.712609	1805.2632
	323	1021.7753	0.582632	1794.7368
	333	1015.5177	0.491032	1778.9474

ii. **Comparison between viscosities versus concentration at different frequency by varying temperature**

The Viscosity is the property of fluid (liquid/gas) by virtue of which an internal frictional force comes into play when the fluid is in motion in the form of layers having relative motion[23]. It opposes the relative motion of the different layers. Viscosity is also called as fluid friction or viscous drag of fluid. The increase in viscosity indicates strong intermolecular force. The viscosity of the given solution increases with increase in concentration of Glyphosate in distilled water due to strong intermolecular force present between solute and solvent [24, 25]. But as the temperature increases from 303 K to 333 K the viscosity decreases due to weak intermolecular force [26]. The viscosity is independent on ultrasonic frequency as shown from table 1 to table 4.

iii. Comparison between ultrasonic velocities versus concentration at different frequency by varying temperature

According to Jacobson's intermolecular free length the molecules of liquid are assumed to be spherical and the average value of the distance in which the ultrasonic waves travel between two molecules is called the intermolecular free path length. As the intermolecular free length decreases the ultrasonic velocity increases that indicates the presence of solute and solvent interaction. With increase in concentration large numbers of molecules are available that transfer the energy to the neighboring molecules resulting an increase in ultrasonic velocity[27, 28]. At the same concentration the ultrasonic velocity decreases with increase in temperature[29]. With the rise in ultrasonic frequency the ultrasonic velocity increases as shown from table 1 to table 4..

4. Conclusion

The investigated solution consisting of Glyphosate as solute with water as solvent was choosen in order to obtain information about the molecular interaction between their constituiting particles. The density, viscosity and ultrasonic velocity of glyphosate-water increases with increase in concentration but decreases with increase in temperature. The increase in velocity with concentration suggests increase in cohesive forces of solvent molecules. The decrease of density and viscosity with temperature supports decrease in cohesive forces and thereby decrease in intermolecular free length. Also the density and viscosity of glyphosate-water is independent on frequency but ultrasonic velocity directly depends on frequency. The interaction between glyphosate-water decreases with increase in frequency.

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