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Acoustic Study of Aqueous Polyethylene Glycol

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Abstract: ***Using measured values of ultrasonic speed, density and viscosity different acoustical parameters have been calculated like acoustic impedance and ultrasonic absorption. The speed of ultrasonic waves has been measured in aqueous solution of polyethylene glycol at 1 MHz frequency. Measurements were carried out at temperature 35ºC, at different concentration range 0.3% to 1.0%. By using these values intermolecular interactions are discussed.***

Keywords: ultrasonic velocity, acoustic impedance and ultrasonic absorption.

1. Introduction

The density, viscosity and ultrasonic velocity are important parameters of pure liquids as well as liquid mixtures are useful for design of design of separation equipment. Ultrasonic velocity has been successfully used to study[1-5] binary liquid mixtures and molecular interactions present between the components of the mixtures. Solute – solvent interactions are of great importance in biological chemistry, physical chemistry, surface chemistry, environmental chemistry and geochemistry. Polyethylene glycol may be used as a flocculant to clarify water and thus has a potential for practical use[6].It is used to make detergents, soaps, plasticizers, ointments etc. S. Grace et. al has studied molecular interaction in polyethylene glycol with ethanol[7]. S. J. Kharat[8]has also ultrasonic study of aqueous solutions of sodium acetate at different temperature. From literature survey it is revealed that are few reports of PEG-200 therefore PEG-200 is used in present investigation.

2. Experimental Details

In the present investigation liquid polyethylene glycol of molecular weight approximately 200 is used. The solutions were prepared by adding known volume of polyethylene glycol to fixed volume of water and stirring under reflex, until a clear solution was obtained. The concentration range studied in the solution is 0.3%- 1.0% (v/v). Different acoustical parameters like acoustic impedance and ultrasonic absorption were calculated at different concentration like 1.0%, 0.8%, 0.6%, 0.5%, 0.4% and 0.3% at temperatures 35ºC at 1MHz frequency by using ultrasonic interferometer with reproducibility of ±0.4m/s at 250C. The temperature of the solution has been kept constant by circulating water from the thermostatically controlled (±0.10C) water bath. The densities were measured with a pre-calibrated density bottles using water bath thermostated at 350C. The viscosity of the mixtures was determined by using Ostwald's viscometer, which was kept inside a double-walled–jacket, in which water from thermostat water bath was circulated. The inner cylinder of this double-wall-glass jacket was filled with water of desired temperature so as to establish and maintain the thermal equilibrium. The accuracy in the viscosity measurements is within ±0.5%. These parameters are calculated by using standard relations[9].

Table 1: Density ($x10^3 Kgm^{-3}$) at 35^0C temperature and concentration at 1MHz for PEG

Concentration	*Density*
1.0	1.508
0.8	1.43
0.6	1.009
0.5	0.958
0.4	0.982
0.3	0.978

Table 2: Viscosity (Pa.s) at 35^0 C temperature and concentration at 1MHz for PEG

Concentration	*Viscosity*
1.0	0.598
0.8	0.348
0.6	0.351
0.5	0.228
0.4	0.148
0.3	0.093

Table 3: Ultrasonic velocity (ms^{-1}) at 35^0C temperature and concentration at 1MHz for PEG

Concentration	Ultrasonic velocity
1.0	1628.1
0.80	1619.4
0.60	1595
0.50	1593.2
0.40	1586
0.30	1585.8

Table 4: Acoustic impedance ($x10^3 kgm^2s^{-1}$) at 35^0C temperature and concentration at 1MHz for PEG

Concentration	*Acoustic impedance*
1.0	2455.7
0.80	2314.9
0.60	1609.8
0.50	1526.8
0.40	1556.8
0.30	1550.9

Table 5: Ultrasonic absorption ($x10^{-15} s^2 m^{-1}$) at 35^0C temperature and concentration at 1MHz for PEG

Concentration	Adiabatic compressibility
1.0	2.427
0.80	1.509
0.60	2.256
0.50	1.549
0.40	0.995
0.30	0.628

3. Result and Discussion

In the present work density, viscosity and ultrasonic velocity have been measured at different temperature and concentration of polyethylene glycol, which is shown in Table-1, 2, and 3 respectively. By using these values for PEG-200, acoustic impedance and ultrasonic absorption have been calculated and the results have been presented in Table-4 and 5 respectively. The variations of these parameters at 350C temperature and concentration have been shown in Fig.1-Fig.5 respectively.

Table-1 and Fig.1 represent the variation of density with concentration at 350 C temperature. Density increases with increase in concentration at 350 C. It may be due to electro striction in that solution. This electro striction decreases the volume and hence increases the density as a number of solute molecules increase the electro striction and density. It is evident from Table-2 and Fig.2 that, viscosity increases with increase in concentration of PEG-200 at 350C. The variations of ultrasonic velocity at 350 C temperature with concentration have been shown in Table-3 and Fig. 3. Ultrasonic velocity increases with increase in concentration of PEG. This behaviour is in agreement with the behavior reported by earlier workers[10]. This indicates interactions between PEG and solvent molecules. The increase or decrease in value of ultrasonic velocity with composition indicates interactions between contributing molecules. It is observed from Fig.4 and Table 4 that acoustic impedance increases with increasing concentration at 350 C. Table -5, Fig. 5 shows the variation of ultrasonic absorption with concentration at 350 C temperature. Ultrasonic absorption increases with increase in concentration. This may be due to as per kinetic theory of fluid.

4. Conclusion

The variation of acoustic impedance and ultrasonic absorption has been studied at different concentration at 350 C. This in turn helpful in its uses in Pharmaceuticals.

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