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Study of Molecular Interactions of Aqueous Cellobiose

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Abstract: ***The ultrasonic velocity, viscosity and density measurements were carried out in the binary mixture of aqueous cellobiose solution at a frequency of 5MHz and at temperature of 298K. The Pulse Echo Overlap technique has been used for the measurement of ultrasonic velocity. These measured value of ultrasonic velocity, viscosity and density are utilised to evaluate the other acoustical parameters such as adiabatic compresibility (β_a),*** free length (L_f), ***acoustic impedence*** (Z), ***internal pressure*** (P_i), ***free volume*** (V_f) etc. ***These parameters suggest the intermoecular interaction among the interaction solute and solvent molecules.***

1. Introduction

Ultrasonic waves provide valuable information about the structure of solids, liquids. By ultrasonic velocity measurements, the molecular interactions in pure liquids, aqueous solutions and liquid mixtures have also been studied. It provides a powerful, effective and reliable tool to investigate properties of solutions of polymers, carbohydrates, amino acid, vitamins etc. However, little work has been done for aqueous carbohydrate[1].

The study carbohydrate in water is of fundamental importance for biological reasons. In this paper, cellubioseis selected for study of molecular interactions**.** Cellobiose is a disaccharide. Cellobiose, a reducing sugar, consists of two glucose molecules linked by a β bond; it can be hydrolyzed to glucose enzymatically or with acid[2].The study of intermolecular interaction has inspired many researchers and extensive investigations have been carried out in both binary and ternary liquid systems by using various methods like Infrared, Raman effect, Magnetic suseptibility, Nuclear magnetic resonance and Ultrasonic methods.Ultrasonic method is non distuctive technique. Using the ultrasonic methods, though extensive work has been done in recent years to measure the non-linear properties and predict the intermolecular interaction of the binary systems, there is no sufficient data available on the binary mixture of cellubiose and water. Hence, an attempt has been made to investigate the inter molecular interaction by evaluating the physical and chemical parameters using Pulse Echo technique in the binary mixtures of aqueous cellubioase solutionl.Carbohydrates play an important role in animal and plant life. Understanding the behavior of aqueous carbohydrates solution is of almost important in biology, medicine and understanding the taste quality exhibited by them [3.]

2. Experimental Details

Aqueous solutions of cellubiose under test (AR grade)in the concentration range of 0.00M to 0.1M, under the investigation are prepared by dissolving known amount of cellobiose in the doubled distilled water. The ultrasonic velocities and amplitude of echoes in aqueous cellubiose at various concentration range of 0.00M to 0.1M and at temperature 298K are measured by a MHF-400 high frequency pulser-receiver(Roop telesonic ultrasonix limited Mumbai) at frequencies of 5MHz .The density (ρ), and viscosity (η) are measured by pyknometer method andOswald viscometer respectively. Using the measured data, acoustic parameters namely adiabatic compressibility (βa) free length L_f (m) , acoustic impedence (Z) , internal pressure(P_i),free volume (V_f) etc are calculated by using the standard formulae[4].The behavior of various acoustical parameters are represented graphically at different concentrations and temperature of 298K..

3. Results and Discussion

Fig. 1 to 6. shows the graphs between the ultrasonic velocity & related acoustical parameters with molar concentration at 298 K and at fixed frequency of 5 MHz. From Fig. 1 to 3,the ultrasonic velocity, adiabatic compressibility and free length shows nonlinear variation with increase in molar concentration this is due to the complex formation and molecular association between interacting molecules of cellubiose and water[5]

The ultrasonic velocity shows peak at 0.06 M concentration whereas adiabatic compressibility and free length shows dip at 0.06 M concentration .This indication strong association can occur at this concentration due to formation of hydrogen bond between molecules of cellubiose and water.

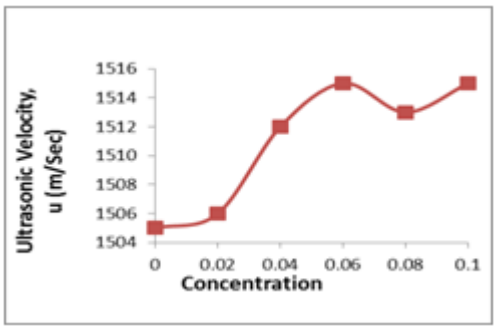

Figure 1: Variation of Ultrasonic velocity with Conc.

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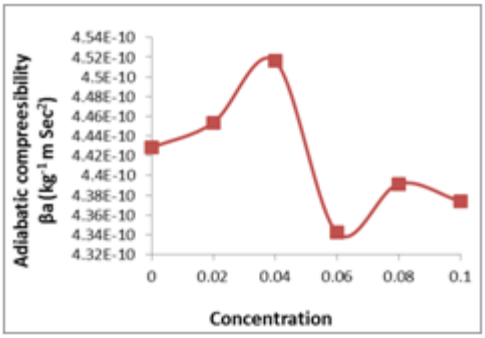

Figure 2: Variation of Adia. Comp. withconc

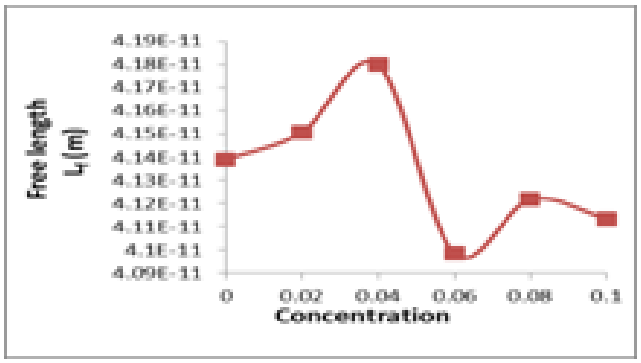

Figure 3: Variationof Free length with Conc.

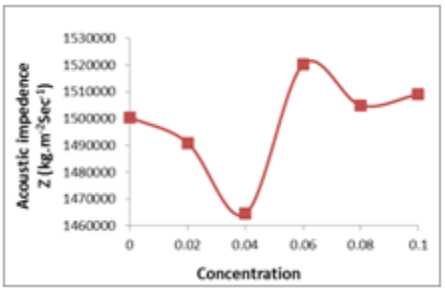

Figure 4: Variationof Acoustic impe. with Conc.

The acoustic impedande shows nonlinear variation with increase in molar concentration (Fig . 4) This indicates significant interaction between interacting molecules [6]. Fig. 5 & 6 shows the variation of internal pressure and free volume respectively with increase in molar concentration.These parameters shows opposite behaviour which indicates association among cellobiose and water molecules[7].

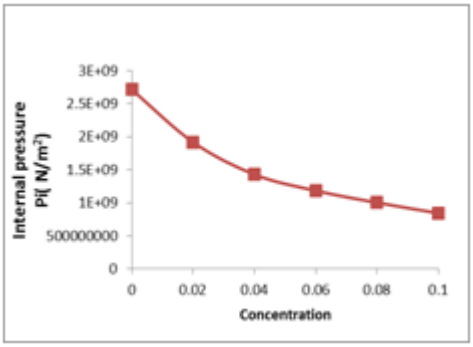

Figure 5: Variation of Internal Pressure with Conc.

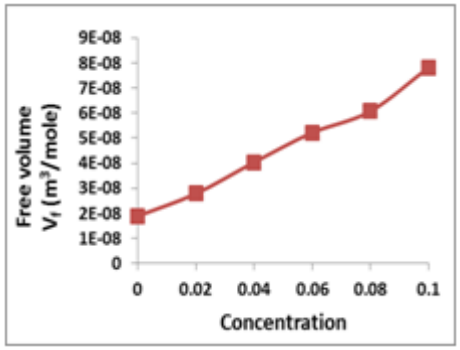

Figure 6: Variationof freeVolume with Conc

4. Conclusions

The nonlinear variation of thermo acoustic properties in aqueous cellubiose reflects the presence of intermolecular interaction between molecule of cellubiose and water.

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