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Ultrasonic investigation of ferrous ammonium sulphate in aqueous galactose solution at 288.15k and 293.15k

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ABSTRACT

The study of Acoustic and sound parameter of Ferrous Ammonium Sulphate using ultrasonic study in aqueous Galactose solution has been carried out at different temperature at 288.15K and 293.15K. Using measured value of Density (ρ), Ultrasonic velocity (U), Viscosity (η) and acoustic and thermodynamic parameters such as Intermolecular Free length (L_f), Gibb's Free energy (ΔG) , Ultrasonic attenuation(α), Adiabatic compressibility (β_a) , Relaxation Time (τ), Isothermal Compressibility (β_i) Relative association (RA) can be calculated. The variation of parameter with respect to the molarities has been explained on the basis of solute-solvent interaction and structure forming tendency of solute in the solvent.

Keyword: Ferrous Ammonium Sulphate, Galactose, Ultrasonic Velocity, Density, Attenuation Constant.

INTRODUCTION

In recent years ultrasonic technique has become a powerful tool in providing information about molecular behaviors of liquid and solids owing to its ability of characterizing physio-chemical behaviors of the liquid mixtures.[1-2] The rapid development of ultrasonic technique and the introduction of new material for producing powerful ultrasonic vibrations have opened up wide field of research and technical application in physics, chemistry, biology, medicine, agriculture and technology.[1-3] The variation of ultrasonic velocity and other related parameters throw some light on structural changes and intermolecular interaction associated with the mixture having weakly interacting components and strongly interacting components. [4]

An ultrasonic velocity study provides a lot of information of molecular interactions. Ultrasonic wave propagation affects the physical properties of the medium and furnish information on intermolecular interaction the liquid and liquid mixture.[3] Studies on ultrasonic velocity, viscosity, density, acoustic and thermodynamics parameters and their deviation in binary system have been the subject of many investigation on different system reveal specific interaction between the molecules of component of liquid mixture.[1-3].

Ultrasonic velocity and related thermodynamic parameters help us for characterizing thermodynamic and physic-chemical aspects of pure, binary and ternary liquid mixture like molecular association and dissociation.[4,5] There is significant information of ternary liquid mixtures on the physic-chemical behavior of ultrasonic wave propagation and has an influence on the physical properties of the medium.[6] The sign and extent of nonlinear deviations ideal behavior as a function of composition and temperature may be associated to the presence of strong or weak interaction between unlike molecules of liquid mixtures.[7]

The fertilizer grade contain 14% ferrous iron, 7%nitrogen & 16% sulfur. It is also known as MOHOR is used mostly in the soils where iron is deficient and mostly in the soil it control the growth color of grass. Ferrous ammonium sulfate (anhydrous) is a compound of ammonium, iron, and sulfate in which ratio of ammonium to iron (2+) to sulfate ions is 2:1:2 . It is a metal sulfate, an iron molecule entity and an ammonium salt. It contain an iron (2+). It is used in medicine, chemical analysis and metallurgy. so the above work is useful in all aspect.

METHODOLOGY

The velocity of ultrasonic wave of L-Alanine in aq. urea has been measure, using 2 MHz frequency ultrasonic interferometer with high degree of accuracy. The measuring cell of interferometer is specially designed double walled vessel with provision for temperature constancy. The densities of solutions are measured using a 10ml specific gravity bottle. The specific gravity bottle with the experimental liquid is immersed in a temperature controlled water bath. The viscosities of solutions are measured using as Ostwald viscometer which is calibrated with double mark. The viscometer with the experimental liquid is immersed in a temperature controlled water bath. The time flow of solution was measured using stop watch.

DEFINING RELATIONS

From the experimental values, the derived parameters are calculated on the basic of formulas as given below.

1. Adiabatic compressibility (β_a) = $1/u^2\rho$ …($N^{-1}m^2$)
2. Relaxation Time (τ) = $\frac{4}{3}\eta_s\beta_a$ ..... (s)
3. Isothermal Compressibility (β_i)= $\Upsilon.\beta_a$ ……(m^2N^{-1})
4. Ultrasonic attenuation (α) = $w^2\tau/2u$ ……($s.m^{-1}$)
5. Gibb's free energy (ΔG) = kT ln (kT)/h.($K.J.mol^{-1}$)
6. Relative association (RA) = $(\rho/\rho_0)\ (u_0/u)^{1/3}$
7. Free Length (L_f)= K (β_a) $^{1/2}$…….(m)

RESULTS AND DISCUSSION

The experimentally measured values of ultrasonic velocity (U), density (ρ) , viscosity (η) and thermodynamic parameters free length (Lf), relaxation time (τ), relative association (RA), Gibb's free energy (ΔG), ultrasonic attenuation (α), adiabatic compressibility (βa), isothermal compressibility (βi) of ternary liquid solution at 288.15K and 293.15K are presented.

The variation in ultrasonic velocity of ternary mixture is depends upon concentration of solute and temperature. From fig.(1), ultrasonic velocity increases with increase in concentration this is due to the more compactness and thermal agitation of molecules of liquid mixture [8,9].

The variation in ultrasonic attenuation is the measure of spatial rate of decrease in strength of ultrasonic wave. From fig.(8) it is found that as temperature increases the ultrasonic attenuation goes on decreasing which confirms that the intermolecular distance increases and hence intermolecular free length is increases as temperature increases as shown in fig. (4). [6].

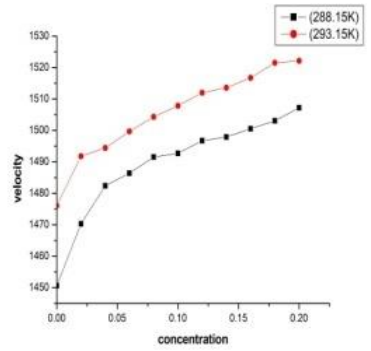

Fig 1 : Ultrasonic Velocity

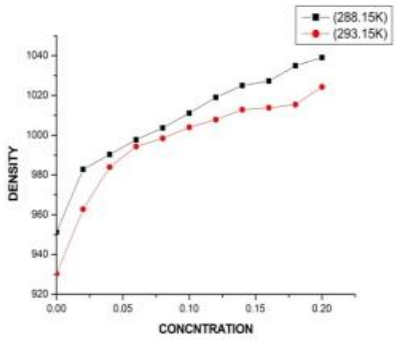

Fig 2 : Density

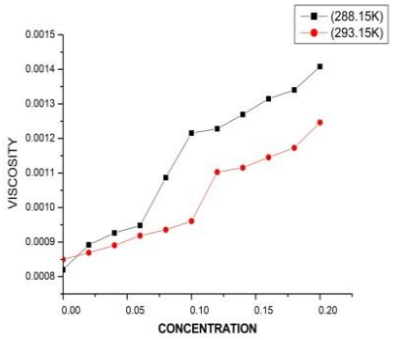

Fig 3: Viscosity

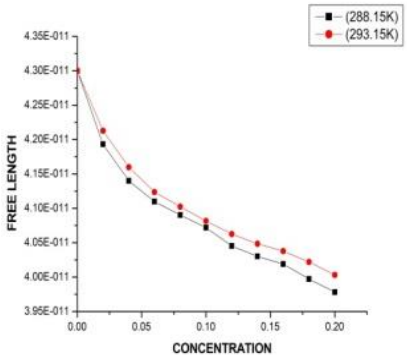

Fig 4: Free Length

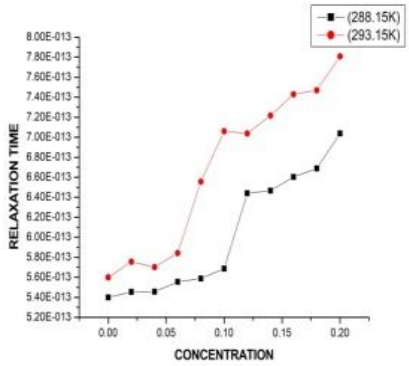

Fig 5: Relaxation Time

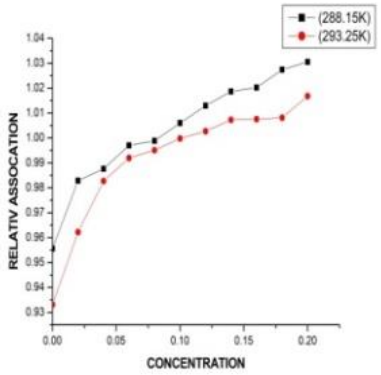

Fig6: Relative Association

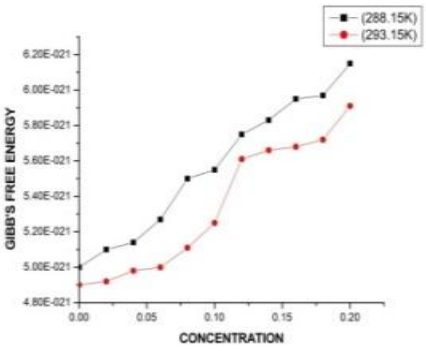

Fig 7: Gibb's Free Energy

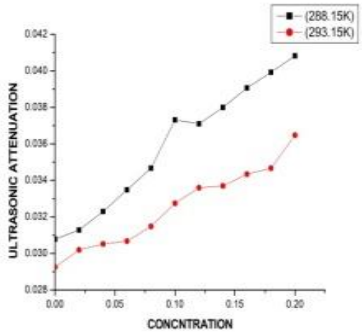

Fig 8: Ultrasonic Attenuation

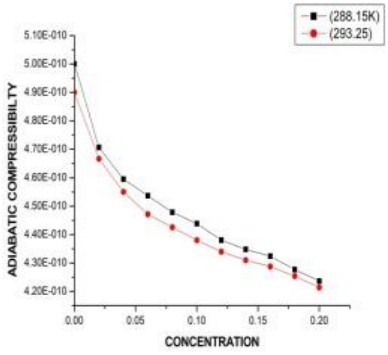

Fig 9: Adiabatic Compressibility

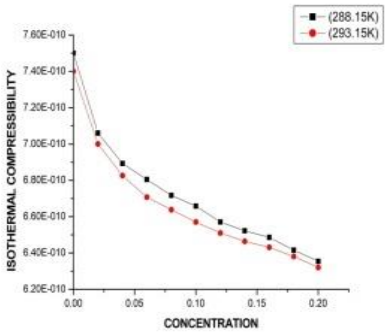

Fig 10: Isothermal Compressibility

The increase in density with molar concentration suggests that solute – solvent interaction exist between constituent molecules of the mixture. In other word increase in density indicates the structure making due to hydrogen bonding and association occur between constituent molecules of liquid mixture [5,9].

The increase in concentration decreases the intermolecular distance between two species so the free length goes on decreasing with increase in concentration[5]. due to the dipole and induced diple interaction, free length is increases with increase in temperature [10]. The increase in viscosity with increase in concentration suggest the increase in molecular interaction [1]. The relaxation time is depends upon viscosity. The almost similar pattern of behavior is seen in respect of relaxation time as that of viscosity. The increasing trend of relaxation time shows intermolecular interaction between molecules[10]. Decrease in relaxation time with increase in temperature this is due to the instantaneous conversion of excitation energy to translational energy as the temperature increases the relaxation time is decreases since the kinetic energy of molecules increases[11].

The Gibb's free energy increases with increase in concentration. Increase in Gibb's free energy indicates the shorter time for rearrangement of molecules. The Gibb's free energy increases with increase temperature as the temperature increases the relaxation time is decreases since the kinetic energy of molecules increases. Longer time is taken for rearrangement of constituent molecules and this suggest a decrease in Gibb's free energy [7].

The adiabatic compressibility is decreases with increase in concentration suggests the intermolecular interaction occurred between molecules resulting in the strong association between the constituent molecules of liquid [12,13]. It also gives the ease with which medium can be compressed. This indicates that medium appear to be more compact [4,7]. The compressibility of solvent is higher than that of solution and decreases with increase in concentration of solution [14] .

Relative association is depends upon two factors breaking of solvent structure on addition of solute and salvation of solute. The relative association goes on increasing with increase concentration resulting the close association of molecules[15].

The isothermal compressibility is goes on decreasing with increase in concentration. The decrease in kT values with increase in concentration indicates decrease in free volume [16]. Compressibility is determined the balance between attractive and repulsive forces. It decreases with pressure increase because the free volume between molecules decreases. The ratio of isothermal compressibility to adiabatic compressibility, determines the specific heat ratio, which is one of most important thermodynamic parameter [17].

CONCLUSION

The variation in thermodynamic parameters with molar concentration of Ferrous Ammonium Sulphate in aqueous Galactose solution provides useful information about the nature of intermolecular forces existing in mixture. The existence of solute-solvent interaction resulting in attractive forces promote the structure- making tendency. The ultrasonic velocity measurement in given mixture serves as a powerful probe in characterizing the physio-chemical properties of the mixture.

Conflicts of interest: The authors stated that no conflicts of interest.

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