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INTERMOLECULAR INTERACTION BETWEEN POTASSIUM NITRATE AND WATER; AN ACOUSTICAL STUDY

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ABSTRACT: Measurements of ultrasonic velocity, density and viscosity have been measured for potassium nitrate solutions at different temperatures ranging from 283.15K to 298.15K under atmospheric pressure. Ultrasonic velocity has been measured using frequency interferometer at 2MHz. The experimental data has been further used determined acoustic and thermodynamic parameters such as acoustic impedance, internal pressure, relaxation time, and Gibb's Free Energy, and molar volume were calculated. The variation of this 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. From our study, it is quite clear that the variation of acoustic parameters with temperature and concentration indicated the existence of intermolecular interaction in the present system.

Key words: - Potassium nitrate, ultrasonic velocity, density, viscosity and acoustical parameters.

INTRODUCTION :

Ultrasonic is multifaceted non-fatal technique and highly beneficial for the exploration of various physical and chemical properties. Recent development have found use of ultrasonic energy engineering and agriculture medicine.[1] ultrasonic studies have vast application due to their ability to characterize the chemical behavior of solution.[2-3] Over the last few years ultrasound has commanding tool to provide useful information about the physio-chemical properties of liquid system .Ultrasonic wave frequency is more than 20 KHz up to several MHz which is beyond audible range. At low amplitude it gives valuable information. [4-5] Ultrasonic velocity and other thermodynamic parameters are used to study molecular interaction in pure, binary and ternary mixture, and it gives useful information about structure of molecule, inter and intra molecule interaction etc.[6-8]study of various molecule interaction in binary ternary mixture plays an important role in molecular science gives understanding of behavior of different liquid and there functional group. This information is very useful in design of industrial process and development. [9]

The study of propagation of ultrasonic wave through mixture is an effective mean of investigation of physical and chemical properties of medium. Salts have large effects on the structure and properties of proteins. Nitrogen increase deep green color in plants and cell and makes the cell wall thinner, Nitrogen increases the proportion or water and decreases calcium content in plant tissues.[10] Potassium nitrate is used in diuretic medicine, it also include as ingredient in tooth paste and it is also added with drugs for joint and back pain[11-12]

Hence present work mainly provides useful information on the measurement of velocity, density and viscosity values of KNO3 solution at different temperature and concentration. This information is useful to understand various biochemical reactions occurring in living organism.

MATERIAL AND METHOD:

AR grade of Potassium Nitrate having molecular weight 101.1032g/mol was obtained from

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HIMEDIA private ltd. The purity of compound is 99.99%.The various concentrations ranging from 0.01-0.10 mole/Kg were prepared from the standard formula and used on the day were prepared.

In the proposed work we have planned to carry out the measurement of Ultrasonic velocity at different solutions using digital Ultrasonic interferometer or pulse echo overlap technique with the function of concentration and temperature. The density measurement of solutions would be carried out using specific gravity density bottle respectively. The temperature variation of different samples will be maintained constant using a thermostatically controlled digital water bath with flowing water technique. The viscosity has been calculated with the help of Oswald's Viscometer.

DEFINING RELATION:

Using measured data, the following acoustical parameters have been computed using the standard relations,

Acoustic Impedance depends on density and velocity by the equation given as (Z) = uρ.....1

Internal Pressure π_i=bRT $[K\eta/U]^{1/2}$ $[\rho^{2/3}/M_{eff}]^{7/6}$

Where,b stands for cubical packing. Which is assumed 2 for all the liquids

Relaxation Time was calculated from the relation

$\tau = 4/3\ \eta_s \beta_a$ (s) 3

Surface tension it is given by the formula σ = $(6.3*10^{-4})\ \rho u^{3/2}$ $(N\backslash m^{-1})$..........4

Gibb's free energy can be calculated from acoustic relaxation time (τ)as follows,

$\Delta G= -K_BT \ln(h/TK_BT)$ ($Jmol^{-1}$).......5

Where K is Boltzmann constant ,T is absolute temperature and h is Plank's constants

RESULT AND DISCUSION:

In the present work density, velocity and viscosity have been measured at different temperature and concentration of potassium nitrate, which is shown in graph.

The plot of velocity of potassium nitrate with water at different temperatures are shown in fig 4.1.It is observe that ultrasonic velocity are found to increase with increase in molar concentration of potassium nitrate. This increasing trend suggests a moderate strong electrolytic nature in which solute tends to attract the solvent (aqueous potassium nitrate) molecules. Thus molecular interaction is responsible for the observed increase in density, viscosity and ultrasonic velocity. [1] The increase in ultrasonic velocity with concentration in any solution indicates the presence of solute solvent interaction. The increase in ultrasonic velocity with rise in concentration for the present system conform the greater molecular association.[13]

From Fig4.2 it can be noticed that density of potassium nitrate increases with increase in concentration of solution; whoever it falls with increase in temperature. This result is obvious as the volume of solution increases with rise in temperature, and mass of solution increases with increase in concentration this result suggest a solute-solvent interaction exist between KNO_3 and water. In other words increase in density may be interpreted to the structure maker....of..2solvent due to H-bonding.[14-15]

Viscosity of potassium nitrate solution increases with increase in concentration and decreases with increase in temperature. Increase in viscosity of solution with concentration suggests the strong interaction of solute and solvent molecule. With the rise in temperature (fig4.3) molecules in solution acquires more and more thermal energy. The motion of molecules increases at the expense of cohesive force acting between the molecules. Since the solution faces lesser resistance to flow, the viscosity of the solution will decrease.[16]

Experimentally determined values of acoustic impedance, (z) Gibb's free energy of potassium nitrate solution shows in (fig4.4and 4.8) increase with increase in concentration this is due to the addition of solute. The increase in Gibb's free energy potassium nitrate solution suggests the greater association among the component of the mixture. As temperature increases, the thermal motion of the particle increases and medium become loosely packed. The rupture of such a bonds becomes easy. Hence temperature increases Gibb's free energy of potassium nitrate solution also increases [17]

From fig(4.5) It is observe that the internal pressure increases with increase in concentration, this type of variation might to be due to increase of cohesive force and solute-solvent interaction in solution. It indicates the formation of hydrogen bonding in between the solute-solvent molecule. Decrease in internal pressure with rise in temperature reduces the solute solvent interaction.[4]

Surface tension is used to study the surface composition of aqueous solution of the mixture. The variation of surface tension shows in fig (4.6) there occurs attractive interaction between the two solutions. A surface tension of a liquid mixture is not a simple function of surface tension of a pure liquid. As interface there is migration of species having lowest surface tension.Their migration of interface result in a liquid face rich in the component with the lowest surface tension. Surface tension increases with addition of solute.

Relaxation time is the time taken for the excitation energy to appears as translational energy and it depends on temperature and impurities. The relaxation time (fig 4.7) shows regular decrease showing evidence of dipole-dipole type of interactions.[18-19]

CONCLUSION:

In this study, the Ultrasonic velocity and acoustical parameters of potassium nitrites solution was studied in different concentrations at various temperature .The experimental Ultrasonic Velocity data and other acoustical parameters contain valuable information regarding the solute solvent interactions in the aqueous solutions. Based on other measurements, it can be conclude that the concentration of the potassium nitrate affects the dipole-dipole interaction and also affects the dielectric constant of the solution. The concentration of the potassium nitrate decreases the chain interaction in the binary solution.

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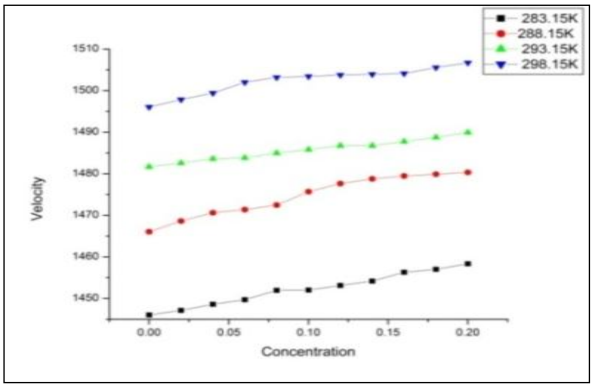
Graph: Graphical representation of Potassium Nitrate at temperature 288.15k,288.15K, 293.15K 298.5K respectively



Fign4.1Variation of velocity with concentration

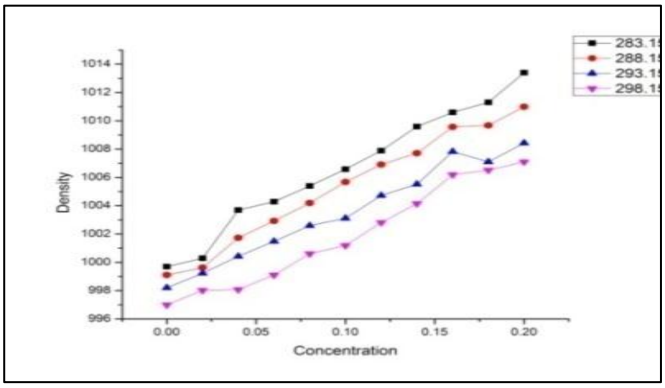


Fig4.2Variation of density with concentration

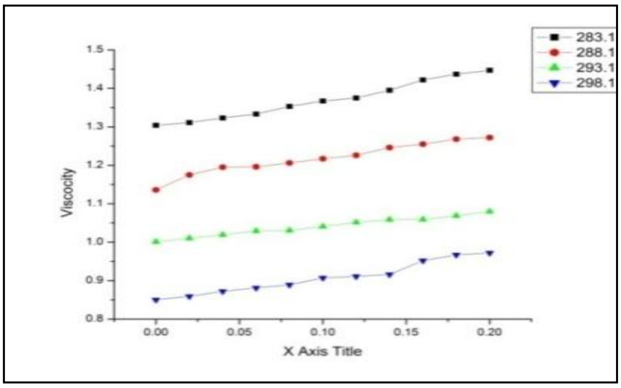


Fig4.3Variation of viscosity with concentration

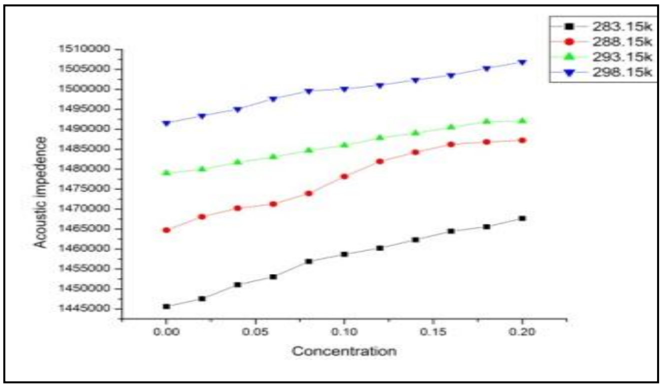
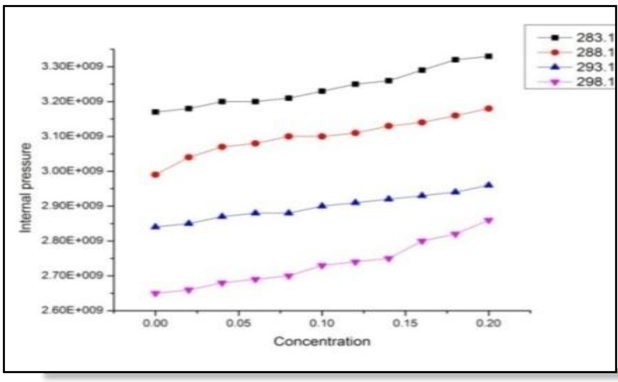


Fig4.4Variation of acoustic impedance with concentration



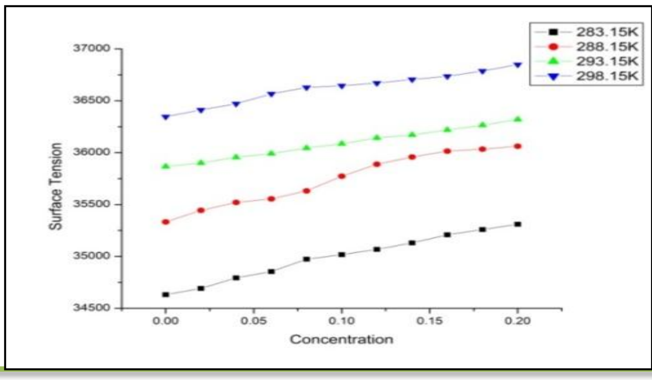


Fig4.5Variation of internal pressure with concentration

Fig4.6Variation of surface tension with concentration

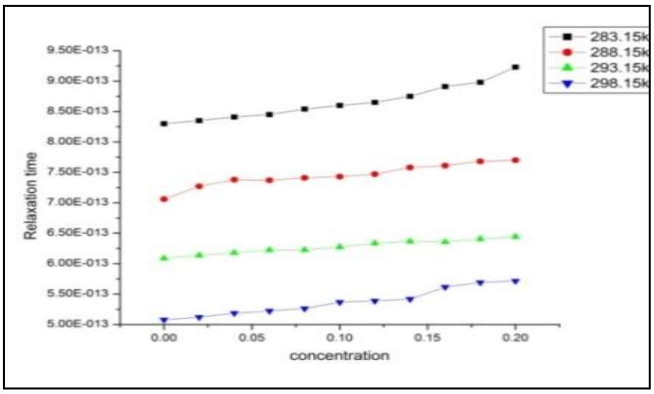


Fig4.7Variation of relaxation time with concentration

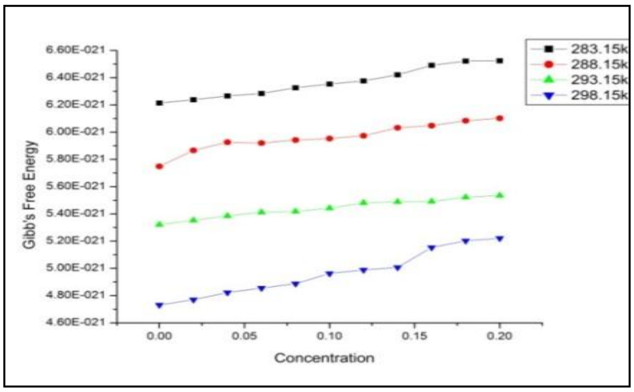


Fig4.8Variation of Gibb's free energy with concentration