# Ultrasonic and surface tension Studies of maltose in aqueous medium and 5 % non-aqueous medium at 318.15K

**Javed khan[1], Madhuri bhise [2]**

**[1-2]Govt. Viderbha Institute of Science and Humanity, Amravati (India)**

***ABSTRACT***

Density , ultrasonic velocity and surface tension were measured for maltose solution in aqueous medium and non aqueous medium having the higher concentration 0.1-0.9 M at 318.15 k. From the experimental data adiabatic compressibility(β,), free length, acoustic impedance, were calculated. .From the data it is observed that the density and ultrasonic velocity acoustic impedence and relative association increases with increase the concentration of solute while adiabatic compressibility and free length deceases. Surface tension increased with increased concentration indicating that existence of large attractive intermolecular forces .The intermolecular interactions have been observed , which suggest the solute-solvent interaction.

**keywords -** Density ultrasonic velocity surface tension ,adiabatic compressibility, free length, acoustic impedence, , ethanol water maltose .

## I. INTRODUCTION

The study of carbohydrates and saccharides has become a subject of of increasing interest becouse of the multidimensional, physical, biomedical and industrially useful properties of these compounds[1-2].Maltose has more number of hydroxyl groups.There has been considerable interest in the effect of hydrogen bonding solutes on solute-solvent bonding in water[3],on solute-solute interaction in aqueous solutions[4] and on solvent structure in mixed aqueous solutions [5]. Density, Ultrasonic velocity and suface tension studied in aqueous solutions and non aqueous solution of different percentage of ethanol (5%,10%) of maltose provide the useful information in understanding the behavior of liquid systems, due to intramolecular and inter molecular association, complex formation and related structural changes affect the compressibility of the system . In recent years, determinations of ultrasonic velocity and absorption coefficient have provide the technique for studying molecular and structural properties of liquids .R. Palani et ,al have studied the ultrasonic studies of amino acids in aqueous sucrose solution at different temperatures [6]. J.D. Pandey et,al [7] have studied the thermodynamics of adenine base in dioxane-water mixtures from ultrasonic viscosity and volumetric studies at 20,25,30,and $35^0$ c . S.A shah .et,al [8] studied the thermodynamic parameters and ultrasonic studies of intermolecular interactions in some carbohydrates at 298.15 k.I.D. Watson studied the thermodynamic behavior of solutions.Is a generalized approach fessible. Many researchers have studied the thermodynamics of binary mixtures amide-water[9-11],alcohol-water[12]. Hence acoustical study by the measurement of density and ultrasonic velocity of aqueous and non-aqueous systems at 318.15 k temperatures with different concentrations of solute and in different percentage of ethanol have been done. In recent years, ultrasonic velocity and absorption studies in case of electrolyte solutions have led to new insight into the process of ion-association and complex formation. Density, ultrasonic velocity and viscosity measurements of pharmacologically significant drugs in methanol at 25°C have been studied by D. V. Jahagirdar et al [13].the study of molecular interactions in liquid mixtures provides an important insight into the conformational stability and unfolding behavior of globular proteins [14]. Most of biochemical processes takes place in aqueous medium therefore studies on thermodynamic properties of biological molecules in aqueous solutions are important No significant work has been reported on the ultrasonic and surface tension studies of maltose in aqueous medium and different percentage of ethanol- water medium, which will furnish the information about molecular interactions between two solvents with different percentage in the presence of solute . Hence the present work is undertaken to the systematic study of the volumetric and acoustical behavior and surface tension of the maltose in aqueous medium and non aqueous medium of concentration range 0.1-0.9 M at 318.15 k.

## II. RESEARCH AND METHODOLOGY

All the chemicals were A.R. grade maltose from Merck chemicals purity of 99.98% ethanol from S.D. fine chemical minimum assay of 99.9% which are used without further purification .The purities of the chemicals were checked by density determination at 318.15 k the uncertainty is less than $\pm 1\times10^{-4}gcm^{-3}$.The water used for the preparation of solution was double distilled .The molar aqueous and non Aqueous solution of maltose, 5%, ethanol-water system were prepared by utilizing digital electronic balance [Model-HR300 japan] of concentration 0.1-0.9 M

at temperature 318.15 K. The ultrasonic velocities through pure solvent and their mixtures were measured using single crystal variable path ultrasonic interferometer operating at 2 MHz The densities of aqueous and non-aqueous solution of maltose were measured by utilizing specific gravity bottle by relative measurement method with accuracy of ±0.1 $kgm^{-3}$. The viscosities were measured with the help of of Ostwald's viscometer which was kept in equilibrium with elite thermostat water bath (± 0.1°c).maltose solution of different concentration were prepared in aqueous medium and non aqueous medium 5%, ethanol-water medium at 318.15 k. For each measurement sufficient time was allotted to attend thermal equilibrium in thermal state.

## III. RESULTS AND DISCUSSION

The following equation is utilized to measure ultrasonic velocity is;

$$u = v\lambda \quad \text{———} \quad (1)$$

Where 'u' ultrasonic velocity and 'λ' wavelength.

The compressibility and ultrasonic velocities have been closely studied by a large number of researcher [15, 16]. The adiabatic compressibility was calculated from Newton-Laplace equation;

$$\beta = \frac{1}{\rho \times u^2}$$

Where ρ = density

Intermolecular forces which is important to determine the properties of liquids of attractive and repulsive forces' [17]. The intermolecular free length ($L_f$) is calculated by means of the following equation;

$$L_f = K\sqrt{\beta} \quad \text{------(3)}$$

Where K = Jacobson constant.

The acoustic impedance (Z) of equation is given by the following equation.

$$Z = u \times p \quad \text{———(4)}$$

The relative association ($R_A$) was measured by means of following equation;

$$R_A = \left(\frac{\rho}{\rho_0}\right)\left(\frac{u_0}{u}\right)^{1/3} \quad \text{---------- (5)}$$

Where $\rho_0$, ρ = density of solvent and solution respectively.

$u_0$,u = ultrasonic velocity of solvent and solution respectively.

Surface tension (σ) were calculated by means of following formula.

$$\sigma = (6.3\times10^{-4})\rho U^{3/2} \quad \text{----------(6)}$$

Where U is ultrasonic velocity and ρ is the density of the solution.

The measured values of density and ultrasonic velocity of water and maltose compared with their literature values at 318.15 k are in good accordance.It could be seen from table (1)

Table 1. Measured values of density (ρ) and ultrasonic velocity (u) of water and maltose solution compared with their literature values at 318.15K.

| Liquid | Density Kg. $m^{-3}$ | | Ultrasonic velocity $m.s^{-1}$ | |
|---|---|---|---|---|
| | Expt. | Lit. | Expt. | Lit. |
| Dist. Water | 990.0 | 990.2[14] | 1537.3 | 1536.36[14] |
| Maltose+water | 1.0048 | ---- | 1548.8 | ---- |

The measured data of density, ultrasonic velocity, free length, acoustic impedance at 318.15 K of concentration range 0.1-0.9 M in aqueous medium and 5% non aqueous medium are shown in table (2) (3) and variation of ultrasonic velocity, Vs concentration is shown in fig (1) . It is observed that with increased in concentration of solute , the density, ultrasonic velocity, increased while adiabatic compressibility and free length is given in the table (2), and (3) decreases and variation of free length Vs concentration at temperature 318.15 k is shown in fig (2). The linear increase of p and u with concentration of solute indicating increase of cohesive forces due to the strong molecular interactions. Indicating that presence of powerful dipole-dipole interaction between the solute and solvent [18]. The adiabatic compressibility, free length in aqueous medium is shown in table (2) and in 5% non aqueous medium it shown in table (3 ) it decreased with increased in concentration and percentage of ethanol. Suggesting that strong interaction between maltose and ethanol molecule.. According to an earlier model proposed by [19], ultrasonic velocity decreases with increase in free length and vice versa. This is also in accordance with the expected molecular interaction between the solute-solvent, increases in compressibility.

The acoustic impedance z increases with increased in the concentration of solute in aqueous medium and increased in the percentage of ethanol indicating that solute-solvent interaction are strong and they behave as structure makers as shown in table (2, &3,) . The nonlinear behavior further suggests the possibility of molecular interaction between solute and solvent through hydrogen bonding. Surface tension increases as the concentration of maltose and percentage of ethanol inceases as shown in table (3).Suggesting the cohesive forces increases.

Table 2. Density and ultrasonic velocity adiabatic compressibility free length acoustic impedence values of maltose in aqeoues medium at 318.15 k.

| Concentration | ρ Kg. $m^{-3}$ | u $m.s^{-1}$ | β X $10^{-10}$ $m^2.N^{-1}$ | $L_f$ x $10^{-11}$ m | Z x $10^{-6}$ N. $m^{-2}$ |
|---|---|---|---|---|---|
| 0.1 | 1.0048 | 1548.8 | 4.1488 | 4.149 | 1556.234 |
| 0.2 | 1.0190 | 1549.1 | 4.0894 | 4.120 | 1578.533 |
| 0.3 | 1.0326 | 1550.3 | 4.0293 | 4.089 | 1600.84 |
| 0.4 | 1.0457 | 1552.1 | 3.9696 | 4.061 | 1623.031 |
| 0.5 | 1.0583 | 1553.2 | 3.9168 | 4.035 | 1643.752 |
| 0.6 | 1.0704 | 1556 | 3.8586 | 4.009 | 1665.542 |
| 0.7 | 1.0821 | 1558.1 | 3.8066 | 3.985 | 1686.02 |
| 0.8 | 1.0933 | 1562 | 3.7488 | 3.958 | 1707.735 |
| 0.9 | 1.1040 | 1564.6 | 3.7001 | 3.931 | 1727.318 |

Table 3. Density and ultrasonic velocity adiabatic compressibility free length acoustic impedence values of maltose in non aqueous (5% ) medium at 318.15 k.

| Concentration | ρ Kg. $m^{-3}$ | u $m.s^{-1}$ | β X $10^{-10}$ $m^2.N^{-1}$ | $L_f$ x $10^{-11}$ m | Z x $10^{-6}$ N. $m^{-2}$ |
|---|---|---|---|---|---|
| 0.1 | 1.0052 | 1554.2 | 4.1290 | 4.138 | 1562.282 |
| 0.2 | 1.0200 | 1555.3 | 4.0581 | 4.105 | 1586.406 |
| 0.3 | 1.0360 | 1556.7 | 3.9851 | 4.072 | 1612.741 |
| 0.4 | 1.0492 | 1558 | 3.9265 | 4.042 | 1634.654 |
| 0.5 | 1.0623 | 1559.1 | 3.8726 | 4.014 | 1656.232 |
| 0.6 | 1.0754 | 1561.1 | 3.8156 | 3.984 | 1678.807 |
| 0.7 | 1.0871 | 1566.2 | 3.7500 | 3.950 | 1702.616 |
| 0.8 | 1.1009 | 1569.3 | 3.6931 | 3.917 | 1727.642 |
| 0.9 | 1.1090 | 1574.4 | 3.6378 | 3.889 | 1746.01 |

Table 4. Surface tension of maltose in aqueouss and 5% non aqueous medium at 318k .

| Concentration | maltose+water | Maltose+water+ethanol 5 % |
|---|---|---|
| 0.1 | 3.8584 | 3.8801 |
| 0.2 | 3.9141 | 3.9324 |
| 0.3 | 3.9709 | 4.0087 |
| 0.4 | 4.0283 | 4.0649 |
| 0.5 | 4.0812 | 4.1200 |
| 0.6 | 4.1390 | 4.1788 |
| 0.7 | 4.1927 | 4.2450 |
| 0.8 | 4.2520 | 4.3116 |
| 0.9 | 4.3044 | 4.3646 |

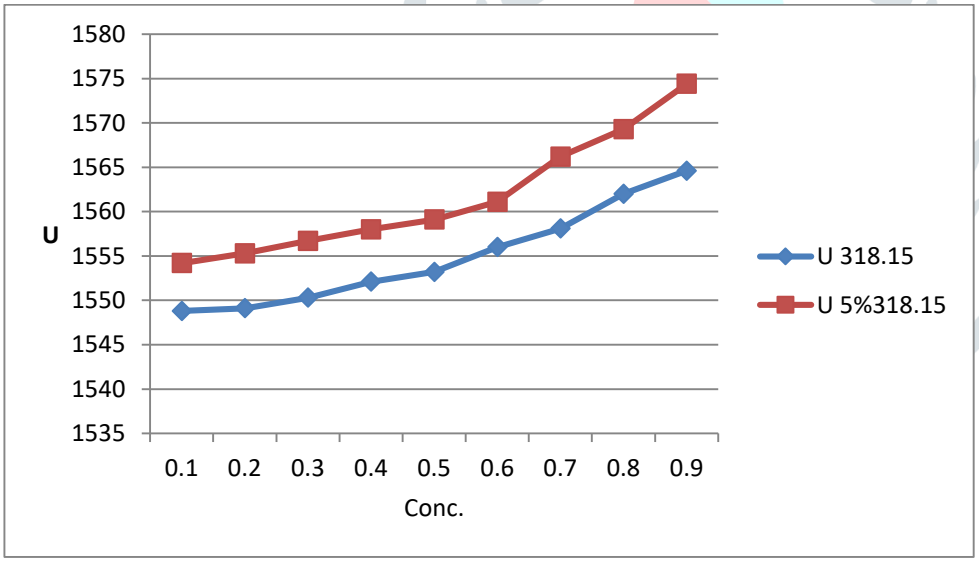


Fig-1 Variation of ultrasonic velocity Vs concentration of maltose in aqueous and non aqueous medium(5%,) at 318.15 k.

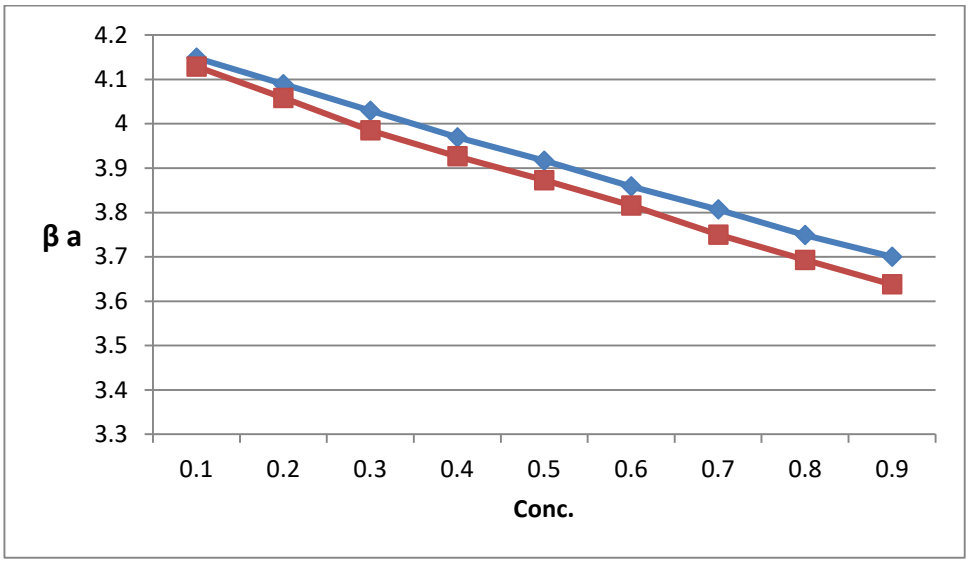


Fig-2 Variation of adiabatic compressibility Vs concentration of maltose in aqueous and non aqueous medium(5%,) at 318.15k.

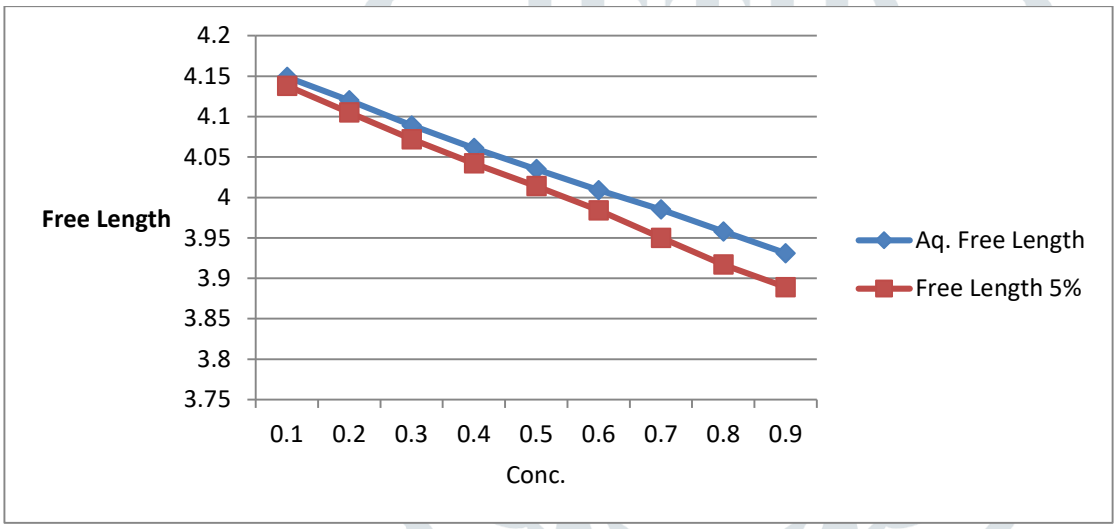


Fig-3 Variation of free length Vs concentration of maltose in aqueous and non aqueous medium(5%,) at 318.15 k.

**ACKNOWLEDGEMENTS**

We are thankful to Dr. Mrs. A. G Murugkar department of physics Dr. BAMU Aurangabad and Dr. M. L. Narwade, for their co-operation and valuable suggestion

**References**

[1] Goldberg R N and Tewari Y B,J phys Chem Ref Data 1989,18,809.

[2] Boerio Goates J,J Chem.Thermodynm.,1991,23(5),403-409.

[3]H.Hoiland and H.Holvik,J.Solution Chem.1978,7,587.

[4] J.J Savge and R.H. Wood,J.Solution Chem.,1976,5,57.

[5] R.L. Kay and T.L. Broadwater,J.Solution Chem.1976,5,57.

[6] R.Palani,S.Balakrishnan,G.Arumugam..j.Physical science,2011,22(11),131-141.

[ 7] J,D.Pandey,A.K..Puri and K.Misra, Thermodynamica Acta,1984,(74)313-322.

[8] S.A.shah,R.B.Lanjewar,sunitaM.gadegone., j.Dher2014(3)6,236-241.

[9] I.D.Watson, j.of molecular liquids,2003(103-104)133-141.

[10] P. Rajasekhar and k.s. Reddy, Thermochim,Acta,117(1987)379.

[11] F. kawaizaumi,, M. Ohno&Y.Miyahara,Bull.Chem.Soc.jpn,50(1977)2229.

[12]K.Subbarangaiah,N.M.Murthy&S.V.Subrahmanyam,Acustica,55(1985)105.

[13]O. Kiyaohara and G.C. Benson, j. solution Chem,10(1981)281.

[14] D.V. jahagirdar,B.R. Arbad, S.R.Mirgane.M.K.Lande&A.G.Shankarwar

, j.Mol.Liquids,75(1)(1998),33

[15] Roy MN, Sinha A, Sinha, B. J. Sol Chem 2005; 34(11): 1311-1325.

[16]Vasanthrani P, Kalaimagal K, Kannappan Asian J of App Sci 2009; 2(4): 96-100.

[17]Thirumaran S, George D. J Eng & App Sci 2009; 4(4): 1-11.

[18] Jacobson P. Acta Chem Scand 1952; 6:1485-1498

[19] H.J Mcskimin ,The J.of the Acoustical society of America ,37(27)1965.

[20]Kumar R, Mahesh R, Shanmugapriyan B, Kannappan V. . Ind Pure Appl Phys 2012; 50: 633-640

[21]Kincaid J F, Eyring H. J Chem Phys 1938; 6: 587-597

[22]Santosh M S, Bhat D K, Bhat A S. Volumetric and ultrasonic investigation of Glycylglycine in aqueous $FeCl_3$ solutions. J. Sol Chem 2010;39: 1763-1773