A Study on Thermodynamic and Sound Parameters of 2-phenylaniline in Ether Media at Different Temperature

Paritosh L. Mishra[2], Urvashi P. Manik[3]

Department of Physics, Sardar Patel Mahavidyalaya, Chandrapur-442401, India

Abstract: *Ultrasonic velocity and density of 2-phenilaniline in Toluene as a function of concentration at different temperature can be used to obtain several acoustical and thermo-dynamical parameters. The thermodynamic or physical parameters that can be determined through these are like Acoustic impedance (Z), Intermolecular free length (L_f), Isothermal compressibility (kT_1) and (kT_2), Adiabatic compressibility (β), Surface tension (σ). These parameters play an important role in the phenomenon associated with intermolecular interactions and hence in sound transmission. In view of fact that, the ultrasonic characterization helps to understand the behavior of intermolecular interaction, strength as well as the nature of the liquid mixture. Ultrasonic sound transmission parameter is more concern relative to the molar sound velocity. Hence the study investigates the structural sense of the liquid mixture.*

Keywords: Toluene, 2-phenylaniline, density, velocity, adiabatic compressibility, free length, isothermal compressibility.

1. Introduction

As amino acids are the building blocks of the proteins their study provides important information, which can be related to the behavior of larger bio-molecules such as proteins. Moreover amino acids are important food additives and have many applications in the pharmaceutical industries. The structure of molecules and intermolecular interactions between the molecules can be well understood through various thermodynamic parameters calculated through velocity measurements.[1] The measured values of velocity along with the corresponding values of densities and viscosity through volumetric measurements help in calculating some more thermodynamic parameters which in turn may help in gathering information like stabilization parameter and so on.

A very few studies are available in literature survey reveals that few attempts [2-4] have been made to evaluate isothermal compressibility (k_T) for proposed system. Many other researchers [5-9] have determined the isothermal compressibility values aq. solutions of amino acids and have made an attempt by making the use of an ultrasonic technique to explore the behavior of some amino acids.[10-11] 2-phenylaniline is a solute, which can freely miscible in ether media. Very few attempts have been made to study the thermo-acoustic variation of 2-phenylaniline in ether media. The present study thus deals with the measurement of density and ultrasonic velocity for binary system formed by 2-phenylaniline and ether media.

In view of the fact that the ultrasonic studies are currently finding new applications in various disciplines of science, engineering and medicine, an attempt is made to carry out such study on amino acid taken up both as a function of concentration (in toluene) and temperature. We report in this paper the density and ultrasonic velocity values for the following systems were taken at 278.15K and 283.15K:
System I: Pure Toluene.
And System II: Toluene + 2-phenylaniline.

Such data are expected throw light on the interaction between molecules.

2. Materials and Methods

AR grade 2-phenylaniline (99.8%), was obtained from Himedia lab. pvt. ltd., Mumbai. Chemicals were used without further purification. The concentration of 2-phenylaniline in toluene was changed by weight. Ultrasonic velocity was measured by single crystal interferometer operating at frequency 2 MHz. The source of ultrasonic waves was a quartz crystal excited by a radio frequency oscillator placed at the bottom of a double jacketed metallic cylinder container. The cell was filled with the desired solution and water at constant temperature was circulated in the outer jacket. The cell was allowed to equilibrate for 30min. prior to making the measurements.

The densities of the solutions were determined accurately using 10ml specific gravity bottle and electronic balance. An average of triple measurements was taken into account. The experimental temperature was maintained constant by circulating water with the help of thermostatic water bath.

For the derivation of several acoustical and thermo-dynamical parameters the following defining relations reported in the literature are used:

(I) Adiabatic Compressibility: $\beta = 1/(C^2 d)$

(II) Intermolecular free length: $L_f = K (\beta)^{1/2}$

(III) Isothermal Compressibility: $k_{T1} = 1.33*10^{-8}/(6.4*10^{-4}C^{3/2}d)^{3/2}$

(IV) Isothermal Compressibility: $k_{T2} = 17.1*10^{-4}/(T^{4/9}C^2 d^{1/3})$

(V) Acoustic Impedance: $Z = Cd$

(VI) Surface Tension: $\sigma = (6.3*10^{-4}) dC^{3/2}$

Isothermal Compressibility values have been computed using the McGowan's [12] Expression, using the arbitrary constant in the denominator of McGowan's expression by a temperature term. Pandey et al[13] suggested a relation for the evaluation of isothermal compressibility.

215

International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064, Impact Factor (2013): 4.438
www.ijsr.net

The values of various physical parameters as a function of temperature of System I.

T(K)	C (ms^{-1})	d (kg/m^3)	$\beta \times 10^{-11}$ (m^{2}N^{-1})	L$_f$ (A^0)	K$_{T1} \times 10^{-12}$ (m^{2}N^{-1})	K$_{T2} \times 10^{-12}$ (m^{2}N^{-1})	Z$\times 10^{-6}$ (Rayls)	σ (kg/m^{2}sec)
278.15	1389.006	881.23	58.8169	0.458905	84.31	75.78	1.2240	28739.95
283.15	1377.547	879.63	59.9083	0.467495	86.13	76.48	1.2205	28333.49
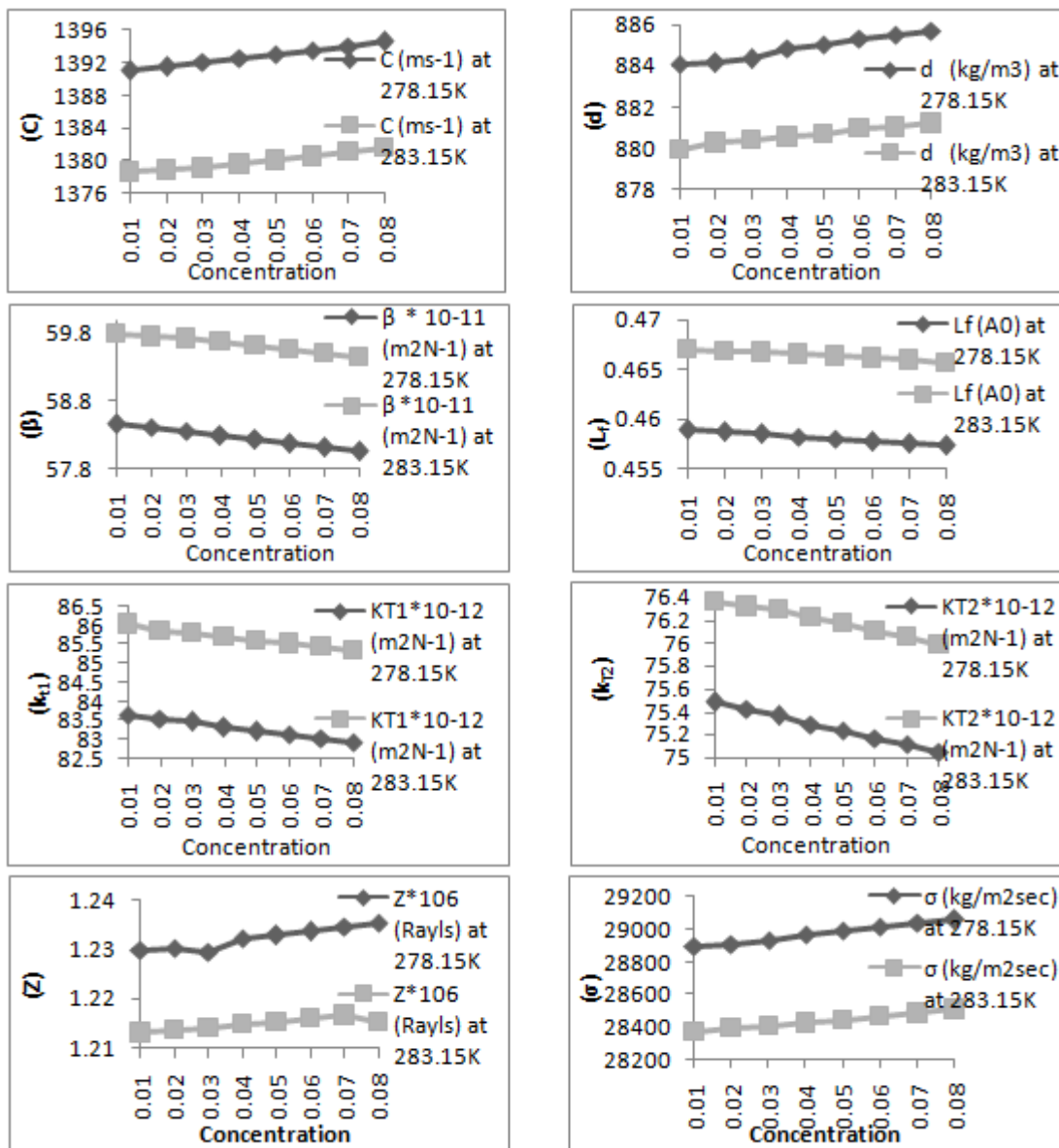
3. Results and Discussion

The analysis of the data in case of solute molecules in a solvent can be carried out by noting variation with respect to the observations and analysis made for pure solvent. Thus in the present study the studies on Toluene were also carried out along with the 2-phenylaniline. The variation of the physical parameters as a function of concentration as well as temperature in the case of 2-phenylaniline dissolved in toluene can be explained. The measured values of 'C' and 'd' at different temperatures in the case of toluene molecules and the values of derived sound parameters are listed in the table.

It is clear from the data of table-1 that the parameters 'C', 'd', 'β', 'L$_f$', 'Z', 'kT$_1$' and 'kT$_2$' fluctuates. The parameter β, L$_f$, kT$_1$ and kT$_2$ increases with increase in temperature and

sound impedance parameter (Z) fluctuates and the values centre's around 1Rayl. Some of the trends of variation can be conveniently explained on the basis of L$_f$ values. The increase in the values of L$_f$ with temperature implies that the mean distance between the molecules increases thereby decreasing the potential energy of interaction between them thus, leading to the decrease in 'C' and 'd'. The increase in the value of β with temperature is obvious since 'C' and 'd' decrease with increase in temperature. The increase in the value of the adiabatic compressibility is an indication of weak interaction between the molecules of the components.[14]

The toluene was chosen as the solvent as it is a well tested solvent in which the 2-phenylaniline was found to be solvable. The graph shows the behavior of various physical parameters as a function of temperature as well as concentration of the molecules of 2-phenylaniline (i.e.

System II). It is observed that as the concentration of the solute component increases, the values of C, d increases and those of β, L_f, k_{T1} and k_{T2} exhibit decreasing trend. The decrease in the value of 'L_f' with the increase in the solute component means the distance between the molecules in the mixture decreases and thereby increasing the potential energy of the interaction between the molecules which leads to observed increase in the value of C.

The overall trend in the isothermal compressibility has been found to be decreasing with increase in concentration. The decrease in k_T values with increase in concentration seems to be the result of corresponding decrease in free volume. The increase variation of surface tension with concentration of solute also indicates the significant associative interaction in the solution.

4. Conclusion

The nonlinear variation of ultrasonic velocity and related parameters with molar concentration and temperature of 2-phenylaniline in toluene may be due to the molecular association. This shows the formation of hydrogen bonding in the molecules and the tendency of solute-solvent interaction.

Reference

[1] Franks F., in Biochemical Thermodynamics, MN Jones(ed.), Elsevier: Amsterdam 1988.
[2] Pandey JD and Misra K. Acoust. Lett., 1983, 6, 148.
[3] Despande DD and Bhatgadde LG., J. Phys. Chem., 1963, 72, 261.
[4] Bhatgadde LG, Oswal S and Prabhu CS., J. Chem. Eng. Data, 1971, 19, 469.
[5] Mendonca AFSS, Dias SMA, Dias FA, Barata BAS and Lampreia IMS., Fluid Phase Equilb., 2003, 212, 67.
[6] Sarvazyan AP, Kharakoz DP and Hemmas P., J. Phys. Chemm., 1979, 83, 1796.
[7] Hain AW, Hoiland H and Hedwig GR, Phys. Chem. Chem. Phys., 2000, 2, 4850.
[8] Milero FJ, Ward GK, Lepple FK and Hoff EV, J. Phys. Chem., 1974, 78,1636.
[9] Pandey JD, Chaturvedi BR and Pant N, Acoust. Lett., 1980, 4, 92.
[10] Shakeel Ahmad S, Khalil A Nasir and Rabina Saleem, Pak. J. Sci. Ind. Res., 2004, 47(5), 349.
[11] Prakash O, Prasad S, Pandey SV and Prakash S, Ind. J. Pure and Appl. Phy., 2010, 95.
[12] McGowan JC, Nature (London), 1966, 210, 43, 36.
[13] Pandey JD, Vyas, Pramana, J. Phys., 1994, 43, 36.
[14] 14.Rao Ramma, J. Chem. Phys., 1941, 9, 68.