STUDY OF PHYSICAL PROPERTIES OF POLAR NONPOLAR BINARY MIXTURES.

Dr. A.G. Patil

Department of Physics Vivekanand Arts Sardar Dalipsing Commerce and Science College, Aurangabad, (M.S.) - 431004, India.

ABSTRACT

The ultrasonic velocity (U), density (ρ) and compressibility (β) of polar-nonpolar binary liquid mixtures of Nitro methane (NM) with Toluene at 293K have been measured and studied. From this data, thermodynamic parameters have been calculated such as excess velocity, excess acoustic impedance and excess adiabatic compressibility. The results have been interpreted in terms of molecular interaction between polar and non-polar binary mixtures.

***Keywords**: Density, Viscosity, Binary Interaction, Excess parameters.*

1. INTRODUCTION

Acoustic studies have many applications in characterizing the physicochemical behavior of liquid mixtures. Such characterization plays vital role in the study of molecular interaction. These studies as a function of concentration are useful in gaining an insight into the structure and bonding of associated molecular complexes and other molecular processes. Further, they play an important role in many chemical reactions due to their ability to undergo self-association with manifold internal structures [1-2].) are useful in Ultrasonic velocity (U) and density (ρ) the calculation of acoustic impedance, adiabatic compressibility and their respective excess parameters which are essential in deciding the type of intermolecular interaction taking place between component liquids. The excess parameters of binary liquid mixture reflect difference in molecular size, shape and interaction of the two components. One can get information for the long range and short range intermolecular forces which are responsible for the molecular interactions. Binary systems involving polar and non-polar components have been studied by many researchers [3-5]. However, not much attention is paid towards the system involving Nitromethane (NM) and Toluene. NM being a polar in nature has an ability to get associated with any other polar or non-polar components [6-10]. For the system under study, experimental ultrasonic velocity and density are reported at 293 K for the binary mixture of NM and Toluene over entire range of composition. The experimental data along with the derived parameters

2. EXPERIMENTAL DETAILS

2.1 Chemicals- For the present study Nitromethane and Toluene used are of HPLC grade (minimum assay of 99.9%) and obtained from MERK. Both the liquids used without further purification.

2.2 Mixture Preparation- The liquid mixtures of different composition were prepared in air tight stopper bottles by measuring appropriate volumes of each component at atmospheric pressure.

2.3 Density Measurement- The densities of pure liquids and binary mixtures carried out by portable digital density meter (ModelDMA-35, Anton Paar). This digital density meter uses the vibrating u-tube principle to calculate the density of the sample. The required quantity of sample is 2ml. The accuracy of the instrument used is 0.0001 g/cm3± The various pure liquids of known density used for calibration of the instrument.

2.4 Ultrasonic Velocity Measurement- The ultrasonic velocity measurements are studied using ultrasonic interferometer (Model- F-05, Mittal enterprises, New Delhi). It is single crystal ultrasonic interferometer for liquids, operating at 2MHz fixed frequency. The required amount of the sample is approximately 10 cc. The sample cell of the instrument is double-walled, and electronically operated programmable constant temperature water bath used to circulate water through the double walled sample cell containing the experimental liquid at the desired temperature. The calibration of the instrument performed by using the double distilled water and some pure liquids of known values of ultrasonic velocity, and found to be in good agreement with standard values. The temperature of the sample measured by using the digital thermometer (Fisher Scientific) of the range -50°C to 0.01K.±150°C, of very precise accuracy.

The general formula for calculating the excess parameters is as given below

$$A^E = A_m - (x_1 M_1 + (1 - x_1) M_2)$$

Where, A^E is the excess parameter such as excess density x_1 mole fraction.

And the excess parameters are fitted by the Redlich-Kister polynomial equation [8] of third order and this equation is given by

$$A^E = x_1 x_2 \sum_{i=0}^{n} A_i (1 - 2x_2)^i$$

Where x_i is the mole fraction of pure component 1 and 2.

RESULT AND DISCUSSION

The variation of ultrasonic velocity (U) and density (ρ) with change in mole fraction of NM is presented in the TABLE 1.

TABLE 1.

Volume farction of NM	Density **(g/cm^3)**	Viscosity **(cP)**
0	0.8660	0.55
0.1	0.8920	0.53
0.2	0.9177	0.54
0.3	0.9466	0.55
0.4	0.9721	0.57
0.5	1.0000	0.60
0.6	1.0262	0.62
0.7	1.0559	0.60
0.8	1.0790	0.61
0.9	1.1094	0.62
1	1.1364	0.67

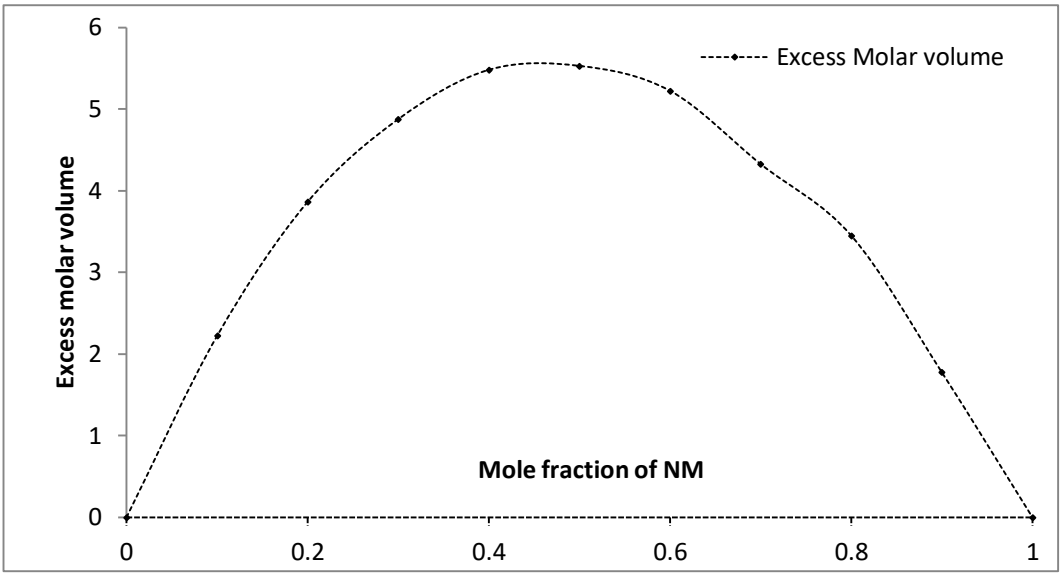

Fig 1- Excess Molar volume of NM + Toulene

Fig 1 gives excess molar volume of NM+Toulene. As concentration of NM increases excess molar volume becomes Positive. Positive values indicate that volume contraction takes place upon mixing due to cross association between dissimilar molecules. Positive values also attributed to weak bond interaction between unlike molecules.

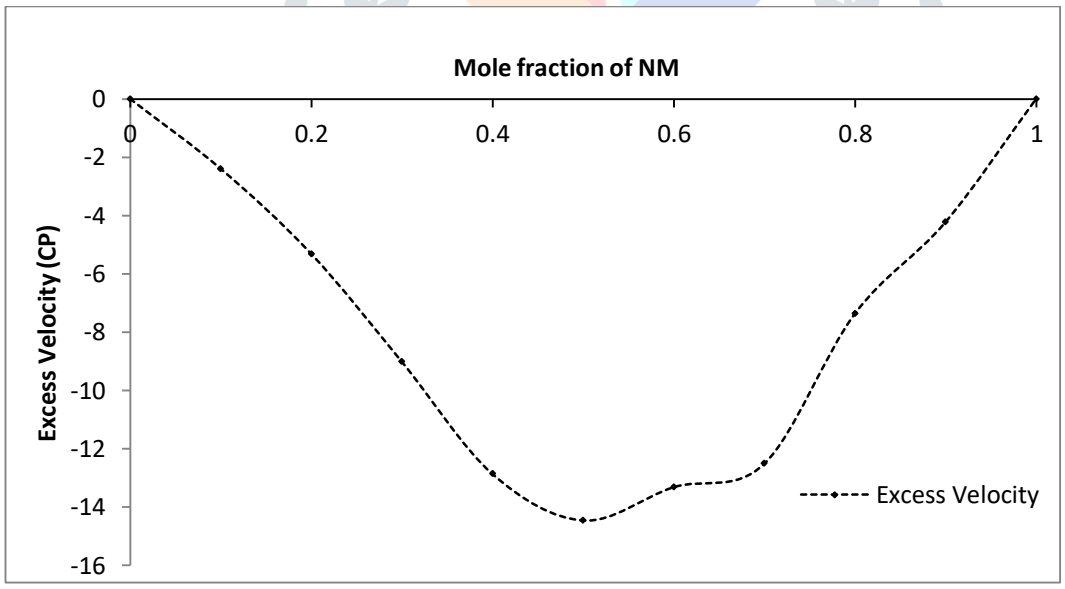

Fig 2- Excess Velocity of NM + Toulene

As shown in Fig 2 Excess Velocity becomes negative as concentration of NM increases. Negative deviation and non linear dependence suggests the presence of weak interaction between the components of the mixture negative excess velocity can be concluded as the formation of the structure. Weak interaction arise among the components of the mixture leading to the formation of molecular aggregates and less compact structure then sound will travel faster through the mixture by means of longitudinal waves and hence speed of sound with respect to linear behavior will be negative.

CONSLUSION

In this study, the measurement of density, viscosity, of NM + Toulene solution was studied in different concentrations at 293 K. The experimental data and contain valuable information regarding the solute-solvent interactions in the measurements, it can be concluded that the concentration of the NITROMETHANE affects the dipole interaction. In conclusion, the concentration, nature of the solvent, nature of the solute and its potion play an important role in determining the interactions occurring in the solutions.

REFERENCES

1. Ali A, Nain AK, Sharma VK, Ahmad S. Ultrasonic studies in binary liquid mixtures. Indian J. Phys. B. 2001;75:519–525.

2. Contil G, Gianni P, Lepori L, Matteoli E. Excess thermodynamic properties of asymmetric multicomponent mixtures: Predictive models and microscopic insight for the system nitromethane + iso-propanol + cyclohexane at 250C. Pure & App. Chem. 1995;67(11):1849-1854.

3. Anwar Ali, Anil Kumar Nain, Vinod Kumar Sharma, Shakil Ahmad. Molecular interactions in binary mixtures of iso-propanol with alkanols (C6,C8,C10): An ultrasonic and volumetric study. Ind J. Pure & Appl Phy. 2004;42:666-673.

4. Cezary M. Kinart, Wojciech J. Kinart, Aneta Cwiklinska. H-NMR spectral and dielectric behaviours of the 2-metoxynitromethane-isopropanol solvent system. Phys. Chem. Liq. 2002;40(2):191-201.

5. Silvia Terra Fontes, María Raquel Fernández, Fabrício Aulo Ogliari, Rodrigo Varella de Carvalho, Rafael Ratto de Moraes, Márcia Bueno Pinto, Evandro Piva. Iso-propanol as solvent in dental adhesives: Cytotoxicity and dentin bond stability. Clin Oral Invest. 2013; 17:237–242. DOI: 10.1007/s00784-012-0693-5

6. Singh M, Rathore P. Densities, viscosities and excess thermodynamic properties of ternary liquid mixtures of nitrobenzene with polar and non-polar so lvents at 298.15 K. Ind. J Chem. 2006;45:2650. 7. Susmita Kamila, Ganesh Durgachalam Natraj. Hetero-molecular associations in different polar and non-polar binary mixtures. Turk J Phys. 2012;36:422-429.

8. Palaniappan Lakshmanan, Mahendran Govindaswamy. Molecular interaction studies in binary mixtures containing aniline, toluene and n-butanol. Turk J Phy. 2011;35:303-310.

9. Manoj Ku. Praharaj, Abhiram Satapathy, Prativarani Mishra, Saramistha Mishra. Ultrasonic analysis of intermolecular interaction in the mixtures of benzene with N,N-dimethylformamide and cyclohexane at different temperatures. J. Chem. & Pharm. Res. 2013;5(1):49-56.

10. Resa JM, Gonzalez C, Concha RG, Iglesias M. Ultrasonic velocity measurements for butyl acetate + hydrocarbon mixtures. Phy. Chem. Liq. 2004;42:521-543