Study of Different Parameters for Binary Mixture of Liquid Using Ultrasonic Interferometer

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Abstract- *The binary mixtures of nitrobenzene with acetophenone containing different ultrasonic properties have been studied at room temperature at a fixed frequency of 2 MHz. The ultrasonic related physical parameters like velocity (U), density (ρ), viscosity (η),adiabatic compressibility (βad), free volume (vf), relaxation time(□),acoustic impedance (Z), Relative association (Ra), Rao's constant (R),Wada's_constant(W),isentropic_compressibility(Ks), molar volume, internal pressure, relaxation amplitude are determined. The result is interpreted in terms of molecular interaction such as dipole-dipole interaction through hydrogen bonding between components..*

Keywords- Ultrasonic Velocities, Acoustic impedance, Wada's and Rao's constants.

I. INTRODUCTION

The ultrasonic velocity measurements are tremendously complex. Molecular interactions can be used to provide qualitative information about the physical nature and strength of molecular interaction in the liquid mixtures [1, 4]. Ultrasonic velocity of a liquid is primarily related to the binding forces between the atoms or the molecules and has been adequately employed in considerate the nature of molecular interaction in pure liquids [5,6]. The variation of ultrasonic velocity and related parameters throw much light upon the structural changes associated with the liquid mixtures having weakly interacting components [7,8] as well as strongly interacting components.

The study of molecular is association in mixtures having. Exactinformation of thermodynamic mixing properties such as adiabatic compressibility, intermolecular free length, free volume, internal pressure and molar volume and has a great importance in theoretical and applied areas of research. Dipole-dipole, donor–acceptor and hydrogen bond formation forces may be observedNitrobenzene has higher dipole moment and dielectric constant values than those of chlorobenzene and bromobenzene. Nitrobenzene is supposed to be a relatively complex molecule and its non-ideality in all probability may be due to the polarity arisen out of nitro-group is concerned, it rotates freely along the C-N axis where it likely to give more flexibility to the interactions arising due to the two highly polar N→O bonds.

II .EXPERIMENTAL METHOD

In the present work, we have used chemicals, which are analytical reagent .The purities of the above chemicals were checked and were compared with available literature values. The binary liquid mixtures of different known composition were prepared by mole fraction basis. The density was determined using a specific gravity bottle by relative measurement method. The weight of the sample was measured using an electronic digital balance with an accuracy of ± 0.1 mg. An Ostwald's viscometer (10ml) was used for the viscosity measurement. An Ultrasonic Interferometer having a frequency of 2 MHz (Mittal Enterprises, New Delhi. Model: F-81) has been used for velocity measurement.

Table:1 it is shows that the equitation of all the physical parameters

$\beta = \frac{1}{U^{2\rho}}$	$Vm = \frac{m}{\rho}$
$Vf = \left(\frac{MeffU}{K\eta}\right)^{3/2}$	$W = \frac{Meff}{\rho}.\beta\text{-}1/7$
$T = \frac{4}{3}\eta\beta$	$R = = \frac{Meff}{\rho}.U\,1/3$
$Z = U.\rho$	$\Pi i = bRT(\frac{K\eta}{U})(\frac{\rho^{\frac{2}{3}}}{Meff^{7/6}})$
$Ra = (\frac{\rho}{\rho 0})(\frac{U}{U0})1/3$	$\Delta G = KT\ln(\frac{KTT}{h})$
$Ks = \frac{1}{U\rho}$	$\frac{\propto}{f^2} = \frac{8\Pi^2\eta}{3\rho U^3}$

Adiabatic compressibility were considered from the speed of sound (U) and the density of the medium (ρ)using Newton and Laplace equation.The acoustic impedance is the product of the velocity of ultrasound in a medium and its

density.The study of sound propagation both the hydrodynamic treatment and relaxation process yields that in the limit of low

Frequencies, sound velocity in a fluid medium is expressed as Isentropic compressibility, in this give rise the well-known Laplace's equation, where ρ Density of the medium and U is velocity. The importance of the isentropic compressibility is determining the physio-chemical behavior of liquid mixtures. The available volume is a direct measure of compactness and the strength of attraction between themolecules of a liquid or a mixture. It can be calculated from Schiff's relation.Rao's and Wada's constant are also derived and calculated. The relaxation amplitude can be calculated. Also we have a relation of internal pressure, K is temperature independent constant whose value is 4.28x109 in MKS system, b is a factor depending on packing pattern which is 1.78, R is the gas constant and T is temperature in K, η is the viscosity in Pascal, U is ultrasonic velocity in m/s, ρ is the density in Kg/m3 and Meff is the effective molecular weight, given by Meff = Σximi where x is the mole fraction and m is the molecular weight of the ith component. Here KT is the temperature dependent constant having a value of 199.53x10-8 in MKS system

III .RESULTS AND DISSCUTION

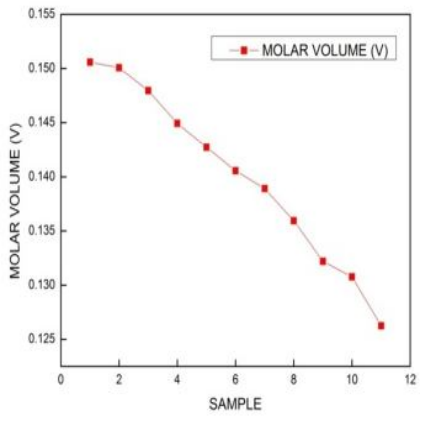

Fig:1Molar volume of sample respectively Nitrobenzene and Acetophenone

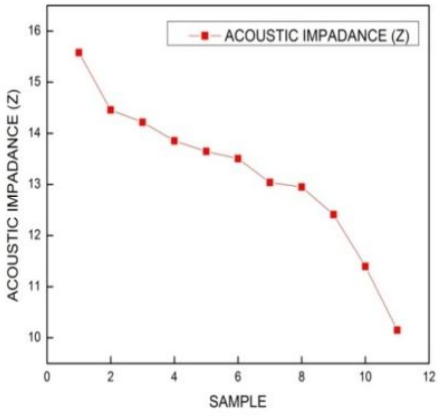

Fig:2Acoustic impedance change with respect to sample

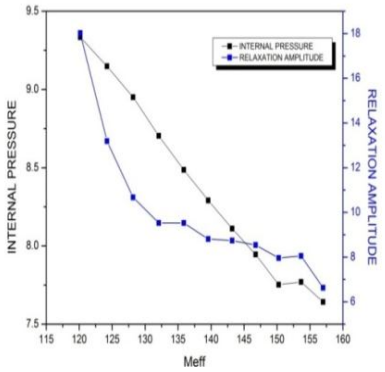

Fig:3Comparision of internal pressure and relaxatation amplitude with increasing order of the sample

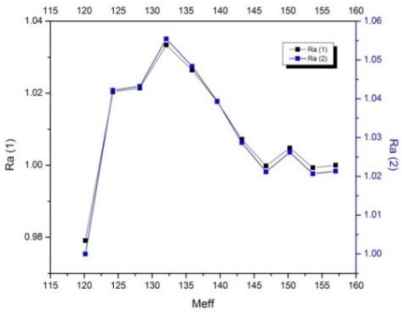

Fig:4Comparision of relative association with respect to the sample

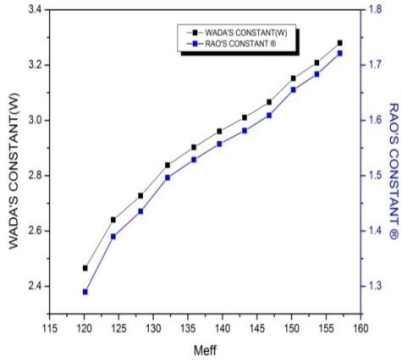

Fig:5 Comparison of Wada's and Rao's, constant with mass effective

It is seen that in the present systems the density (ρ) decreases with increasing concentrations of substitutedace to acetophenone. The variation of ultrasonic velocity in a mixture depends upon the increase (or) decrease of intermolecular free length after mixing the components. On the basis of a model, for sound propagation proposed by Eyeing and Kincaid, ultrasonic velocity should decrease, if the intermolecular free length increase and vice-versa. This is in fact observed in the present investigation for all the liquid systems. The perusal of figure 1one can notice that a qualitative picture ofmolar volume (Vm) values for all the liquid systems. The present study in figure 1shows that the values of molar volume for all the liquid systems are decrease. The factors responsible for volume contraction are (i) specific interactions between the component molecules and (ii) weak physical forces, such as dipole-dipole or dipole-induced dipole interactions or Van-der-waal's forces. The factors that cause expansion in volume are dispersive forces, steric hindrance of component molecules, unfavorable geometric fitting and electrostatic repulsion.Figure 2 shows that the relation between density and ultrasonic velocity called acoustic impedance. It is decreasing with the sample liquid.Figure 3 shows that acetophenone which is being a highly polar molecule (μ = 2.96) and it may enhance the polarities of the other liquid. The heteromolecular interaction between component molecules necessarily depends upon the net electron density in the ring. Further, these interactions seemed to depend on relative orientation of the two groups in the ring. As the separation between the two liquid increases, the intermolecular interaction is expected to decrease. Hence, internal pressure is increased with respect to the main substances and addition of ketons like acetophenoneandthe variation internal pressure may give some suitable information regarding the nature and strength of the forces existing between the molecules. In fact, the internal pressure is a broader concept and it is a measure of the totality of forces of the dispersion, ionic and dipolar interaction that contribute to be overall cohesion of the liquid systems. The present study shows that the internal pressure values (π) are increasing.Figure4 shows that relative association with respect to the sample, which is derive as Ra1 and Ra2 .and they both are decreasing and increasing respectively.Figure 5 shows it is the constant named by Wada's and Rao's, which both are decreasing by order.

Table 2 Measure density and calculated effective mass, acoustic impedance molar volume and internal pressure

SAMPLE	DENSITY kg/m3	Meff	(Z)	MOLAR VOLUME (V)	INTERNAL PRESSURE
1	1042.73	157.01	15.57	0.1505	7.6420
2	1023.97	153.66	14.45	0.1500	7.7698
3	1015.53	150.25	14.21	0.1479	7.7518
4	1012.72	146.77	13.85	0.1449	7.9459
5	1003.34	143.21	13.64	0.1427	8.1111
6	993.03	139.57	13.50	0.1405	8.2911
7	978.02	135.86	13.03	0.1389	8.4860
8	971.46	132.06	12.95	0.1359	8.7032
9	969.58	128.18	12.41	0.1322	8.9503
10	949.89	124.21	11.39	0.1307	9.1485
11	951.77	120.15	10.14	0.1262	9.3344

In table 3 shows density of binary mixture is measured and we are calculated relative associations, Wada's constant, Rao,s constant and relaxation amplitude of binary mixture

Table 3 Calculated relative associations, Wada's constant, Rao,s constant and relaxation amplitude of binary mixture

Ra (2)	WADA'S CONSTANT(W)	RAO'S CONSTANT ®	RELAXATION AMPLITUDE
1.0213	3.2800	1.7213	6.6279
1.0206	3.2083	1.6836	8.0522
1.0262	3.1518	1.6551	7.9554
1.0211	3.0657	1.6088	8.5370
1.0286	3.0102	1.5814	8.7371
1.0393	2.9599	1.5572	8.8074
1.0483	2.9024	1.5289	9.5290
1.0554	2.8376	1.4962	9.5301
1.0432	2.7269	1.4354	10.6707
1.0421	2.6401	1.3895	13.1891
1	2.4650	1.2897	18.0214

IV. CONCLUSION

The trends and behavior is evaluated values of mixtures of substituted nitrobenzenes with acetophenone. There are exist molecular interactions between the acetophenone and with substituted benzenes through dipole-dipole interactions. The strength of the molecular interactions gets weakened on further addition of substituted benzenes. Weak dipolar and cohesive forces are in the present systems of liquid mixtures. The present study also predicts the formation of donor-acceptor complexes in the component mixtures. The present study also predicts the formation of donor-acceptor complexes in the component mixtures. Our experiment results are good agreement of other binary combination of liquids for Rao's and Wada's constant. So we can say that our results can overcome to calculate other physics parameters.

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