

Thermo acoustical studies on some electrolytic solvent mixtures at 303 K

S. NITHIYANANTHAM^{*}, S. MULLAINATHAN² and R. JAYALAKSHMI¹

^{*}Department of Physics, (Ultrasonics Division), SRM University, Kattankulathur - 603 203 (India).

²Department of Physics, AVC Engineering College, Mayiladuthurai (India).

¹Department of Chemistry, SRM University, Kattankulathur - 603 203 (India).

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ABSTRACT

Ultrasonic velocity of Benzene with Toluene and O-Xylene with various concentration at 303 K. The internal pressure and some parameters are calculated from the measured sound velocity, density and viscosity. The results were discussed in terms of ion-solvent and solvent-solvent interactions.

Key words: Thermo acoustical studies, electrolytic solvent.

INTRODUCTION

In our earlier work¹ studies the ion-solvent interactions of benzene with toluene and O-Xylene at 303 K. The present investigation deals with the measurement of ultrasonic velocity, density and viscosity and the evaluation of internal pressure, Rao's, Wads's constant, relaxation time, Gibb's free energy, classical absorption coefficient are calculated. From the knowledge of these parameters the changes of ion – solvent and solvent – solvent interactions have been analyzed and discussed.

EXPERIMENTAL

The AnalaR grade mixture of varying composition of were prepared by mole fractions, The Ultrasonic velocities of mixture were measured using Mittals' M-82 interferometer at 2 MHz with an accuracy of ± 0.05 %. The viscosities of mixtures were measured using an Oswald's viscometer and

are accurate to ± 0.001 mNsm⁻². A specific gravity bottle was used to measure the density of the mixture and the accuracy in the measurements is ± 0.1 kg m⁻³.

RESULTS AND DISCUSSION

The internal pressure, Rao's Constant, Wada's constant, relaxation time, Excess Gibb's free energy, van der Waals constant and Classical absorbent co-efficient of binary mixture of Benzene with Toluene and O-Xylene at 303 K are given in Table 1, and computed from the following relations (1 -7)
2,3, 6,7.

$$\pi_i = bRT (K\eta/U)^{1/2} (\rho^{2\beta}/M^{1/6}) \quad \dots(1)$$

$$R = (M/\rho)U^{1/\beta} \quad \dots(2)$$

$$W = (M/\rho)\beta^{-1/7} \quad \dots(3)$$

$$\tau = 4\pi^2\eta^3\rho U^2 \quad \dots(4)$$

$$b_w = (M/\rho)[1 - (RT/MU^2)\{[(1+MU^2)/3RT]^3 - 1\}] \dots(5)$$

$$(a/f^2) = 4\pi^2\eta^3\rho U^2 \quad \dots(6)$$

$$\Delta G^E = -2.303 KT \log(h/KT\tau) \quad \dots(7)$$

where M is the effective molecular weight, U sound velocity, K a constant having a value of 4.28×10^9 independent of temperature and nature of liquids, η the viscosity, b space packing factor being equal to 2 in the present case, R the gas constant, T the absolute temperature, ρ the density, T absolute temperature and h plank's constant of the mixture.

The internal pressure (π_i) is the resultant force of attraction and force of repulsion per unit area between the components. The decreasing trend shows the lowering the on solvent interaction. Higher values are recorded in system I. The interaction may be solvent-solvent type².

The molar sound velocity (R) indicates the cube root of sound velocity through one molar volume of mixture, Called as Rao's constant, and does also a measure of interaction exist in the solution. Further, the trend of molar compressibility (W), called a Wada's constant, which depends on the adiabatic compressibility of one molar solution, may be taken as a confirmation for existing interactions. The observed values of molar sound velocity and molar compressibility in all the systems are of increasing trend with amylase, indicating that the magnitude of interaction are enhanced. The increasing trend of R and W indicates availability of more number of components in a given region, thus leads to a tight packing of the medium and thereby increase the interactions.

The Gibb's free energy of activation for viscous flow is almost positive for all the three systems studied. In DMF system, low positive values indicate the existence of specific interaction between the two components. The high positive values do not indicate the existence of any specific interaction between the two components^{5,9}.

The values of b_w increased linearly with mole fraction of benzene in all the two systems studied indicating solute-solvent interactions⁴.

Table 1: Computed values of internal pressure (π_i), Rao Constant (R), Wada's constant (W), relaxation time (τ), Excess Gibb's energy (ΔG^E), van der Walls constant (b_w) and classical absorbent coefficient (a/f^2) of the binary mixture of benzene with Toluene and O-xylene at 303 K

Mol. frac X_2	$\pi_i \times 10^{-9}$ Nm ⁻²	$R \times 10^3 \text{m}^{10/3} \text{s}^{-1}$ ^{1/3} mol ⁻¹	$W \times 10^3 \text{m}^3 \text{mol}^{-1}$ ¹ (N/m ²) ^{1/7}	$\tau \times 10^{-12}$ (s)	ΔG^E (J mol ⁻¹)	b_w	$(a/f^2) \times 10^{-14}$ (s ² /m)
Benzene + Toluene							
0.0936	1.5810	1.0033	1.8735	0.6455	2.515	-0.0154	0.99
0.1882	1.4354	1.0275	1.9168	0.6789	2.536	-0.0157	1.03
0.2887	1.3115	1.0443	1.9483	0.7423	2.573	-0.0160	1.14
0.3915	1.1267	1.0655	1.9871	0.6954	2.546	-0.0163	1.06
0.5015	0.9990	1.0791	2.0141	0.7219	2.562	-0.0166	1.12
Benzene + O – Xylene							
0.0957	1.5810	1.0017	1.8709	0.6546	2.521	-0.0154	1.01
0.1953	1.4317	1.0224	1.9088	0.6813	2.537	-0.0156	1.04
0.3023	1.2548	1.0433	1.9474	0.6751	2.533	-0.0160	1.03
0.4118	1.0992	1.0648	1.9869	0.6678	2.529	-0.0162	1.01
0.5376	0.9437	1.0921	2.0365	0.6507	2.518	-0.0166	0.97

The resistance offered by viscous force in the flow of sound waves appears as classical absorption associated with viscous relaxation time⁵. The classical absorption coefficient is increasing trend with increasing concentration of benzene in system I and reverse in system II, This confirms structural changes due to entropy fluctuation associated in solutions of dynamically formed physical entity^{2,4,8}.

CONCLUSION

Ion-Solvent and solvent-solvent interactions are observed. But solvent-solvent interactions are higher favored.

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