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DEVIATIONS IN VISCOSITY OF THE BINARY MIXTURE OF 1-HEXANOL AND BENZENE AT 303.15 K TEMPERATURE

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ABSTRACT: The densities, ρ and viscosities, η of pure 1-Hexanol, Benzene and their binary mixture covering the whole composition range have been measured at 303.15K temperature. Deviations in viscosity, Δη and excess free energies of activation, $\Delta G^{\#E}$ have been calculated from the ρ and η data.To obtain correlation coefficients and standard deviations Δη and $\Delta G^{\#E}$ were fitted to Redlich–Kister type function in terms of mole fraction. In the whole range of composition the values of Δη and $\Delta G^{\#E}$ were found to be negative. The negative values of Δη and $\Delta G^{\#E}$ were shown dispersion due to break up of weak forces.

Keywords: Benzene, Density, 1-Hexanol,Viscosity.

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1.INTRODUCTION

Densities and viscosities of multi-component solvent mixtures are required for the process design involving heat transfer, mass transfer, fluidity and so forth as well as for the development of our understanding of molecular interactions in such systems[1-2]. Properties at several temperatures both for pure chemicals and their binary liquid mixtures over the whole composition range are useful for understanding of the thermodynamic and transport properties associated with heat and fluid flow [3-7]. The study of excess properties of liquid mixture is a subject of great theoretical interest because it gives information about molecular interaction and phenomenon or structural contribution[8-9].The practical importance of liquid mixtures rather than single component liquid systems has gained much importance during the last two decades in assessing the nature of

molecular interac-tions and investigating the physico-chemical behavior of such systems[10-14].In general, thermodynamic and transport properties are adequately employed in understanding the nature of molecular systems and physico-chemical behavior of liquid-liquid mixtures. In recent years several studies for alcohol + hydrocarbon[15-18] have been made on these properties of binary liquid mixtures in addition to their volumetric properties. Due to the presence of both hydrophilic and hydrophobic groups, alcohols are interesting polar solvents, self-associated through hydrogen bonding creating multimers of different degrees. The dipolar association of alcohols decreases when they are mixed with aromatic hydrocarbons, duetosomesort of specific inter molecular interactions between alcohols and aromatic hydrocarbons[19-21]. 1-Hexanol is a linear primary alcohol. It is formed as an intermediate during the catalytic transformation of cellulose. 1-Hexanol is produce from coconut oil and palm oils. It is used in the production of antiseptics, fragrances and perfumes. 1- Hexanol is also used as a solvent in the production of plasticizers. 1- Hexanol has been used as an odorant to study olfactory responses and to thin the dielectric layer of poly(PVP). 1-Hexanol is believed to be a component of the odour of freshly mown grass. It is used in the perfume industry and as a flavouring agent. 1-Hexanol is found in many plants, some of which are lemon, tea, yellow bell pepper, and hyssop. 1-Hexanol is a common constituent of essential oils (e.g. orange-peel oil)[22]. Benzene is a chemical that is a colorless, light yellow liquid at room temperature. It has a sweet odor and is highly flammable liquid with a sweet smell and is partially responsible for the aroma of gasoline. Benzene evaporates into the air very quickly. Its vapor is heavier than air and may sink into low-lying areas. Benzene dissolves only slightly in water and will float on top of water. Benzene are used to make some types rubbers lubricants, dyes, detergents, drug, explosive, pesticides, spot removers and other products[23]. Literature survey further revealed that although many attempts have already been made to study the binary mixtures of alcohols and aromatic hydrocarbons, systematic studies focusing their dependence on composition and number position as well as length of substituent on aromatic hydrocarbons are still scarce. In this paper I have reported on densities, viscosities, standard deviations $\Delta\eta$ and $\Delta G^{\#E}$ of the binary mixture of 1-Hexanol + Benzene.

2. MATERIALS AND METHODS

1-Hexanol: Aldrich, mole fraction purity>0.99%, Benzene: Merck, mole fraction purity > 0.993 were kept over molecular sieves for 2-3 weeks and binary mixture of various compositions were prepared by mass mixing pure components at different proportions with the help of an electronic balance(B204-S,METTLERTOLEDO) accurate up to ± 0.0004g. Densities, ρ were measured by using a10 cm^3 bi-capillary pycnometer and viscosity, η by an Ostwald viscometer (Technico, PSL BS/U, A-type) both being calibrated previously with twice distilled water. The flow time of liquids was recorded by an electronic stop watch reading up to ±0.02 s. For all measurements a thermostatic waterbath(ThermoHaake) controlled up to ± 0.02K was used. The mole fraction was estimated

accurate up to 10^{-4}, while the uncertainty in measured ρ and η were ± 1.2×10^{-4} g.cm^{-3} and ± 1.6×10^{-4} m Pa.s respectively. The purities were further checked by comparing measured ρ andη of pure liquids with the literature data as tabulated in Table1.

Table1. Comparison of experimental densities (ρ/g.cm^{-3}) and viscosities (η/mPa.s) of pure liquids with literature values at 303.15 K.

S.No	Liquids	Densities		Viscosities	
		Exp. Values	Lit. values	Exp. Values	Lit. values
1.	1-Hexanol	0.8113	0.8100	3.5128	3.5130
2.	Benzene	0.8674	0. 8680	0.574	0.571

3. RESULTS AND DISCUSSION

Viscosities and Deviations in Viscosity

Measured viscosities, η of 1-Hexanol and Benzene in the range$0\leq x_2 \leq 1$ composition at 303.15 K are as summarized in Table2. From experimental data, η deviations in viscosity, $\Delta\eta$ for the binary mixture were calculated as follows [24-25]

$\Delta\eta = \eta - \eta_1 x_1 - \eta_2 x_2$ ……..(1)

where, η is the viscosity of solution, η_1 and η_2 are viscosities of pure components1 and 2, respectively. The estimated $\Delta\eta$ were correlated well to equation (3) and the adjustable parameters and standard deviations are as given in Table3. In this system, $\Delta\eta$ are found to be negative in the whole range of composition. Negative values of $\Delta\eta$ indicated that all the species get favorable conditionst of low.This is because addition of 1-Hexanol to Benzene causes mainly dispersion due to breakup of weak forces. Also, aromatic hydrocarbons with longer chain lengths encounter less inconvenience to flow even through intermolecular H-bonded species may also be present in thesolutions.TheGrunberg - Nissan interaction parameter (ε) estimated by followingtheequation[26]

$\ln \eta = x_1 \ln \eta_1 + x_2 \ln \eta_2 + x_1 x_2 \varepsilon$ ……..(2)

ε are as listed in Table 2. In this system, $\varepsilon$are observed to be negative. According to Fort and Moore[27], εmay betermedasanapproximateindexforestimatingthestrengthofinteraction between dissimilar components of a mixture in flow: If $\Delta\eta < 0$and$\varepsilon < 0$and magnitudes of both are large, specific interaction would be absent and only dispersion force may be dominant there. The negative values of ε indicates that any interaction between the alcohol and aromatic hydrocarbons is of non – specific type.

Table 2. Viscosities, η(mPa.s) and interaction parameter (ε) of the systems of 1-Hexanol (x_1)+Benzene(x_2)fordifferentmolarratiosat303.15K.

Mole fraction(x_2)	Viscosities (η)	interaction parameter (ε)
0.0000	3.5130	-------
0.1021	3.2154	0.6520
0.2003	2.9458	0.6145
0.3110	2.6227	0.5447
0.4028	2.3022	0.5102
0.5100	2.0017	0.4645
0.6009	1.6450	0.4003
0.7087	1.2874	0.3685
0.8142	1.0163	0.3189
0.9006	0.7155	0.2458
1.0000	0.5710	--------

Excess Free Energy

The values of binary liquid mixture of 1-Hexanol and Benzene were fitted by the Redlich-Kister equation [28]:

$Y^E = [(1-x_1)x_2\sum_{i=0}^{n} Ai\ (1-2\cdot x_1)^i$ ……..(3)

The standard deviation, σ followed the equation:

$$\sigma = \left[\frac{\Sigma(Yexp-Ycal)^2}{n-p-2}\right]^{1/2} \quad \text{…….(4)}$$

Where, A_i is the i-th polynomial fitting coefficient, Y_{exp} and Y_{cal} are the experimental and calculated of properties, n the total number of compositions for a particular system and p is the number of coefficients. Excess free energies of activation $\Delta G^{\#E}$ for viscous flow have been calculated using the equation[29-30]:

$\Delta G^{\#E} = RT\ [\ln(\eta V_m\ )\ \ \Sigma x_i \ln(\eta V_i^*)]$ …….(5)

Table 3. Fitting coefficient sofpolynomial equation (3) and standard deviations, σ in equation(4)for the systemof1-Hexanol and Benzene for different molarratiosat 303.15K.

Property	A 0	A1	A 2	A 3	A 4	σ
$\Delta\eta$ (mPa.s)	-1.5482	-1.2128	-0.9584	-0.6258	-0.4215	0.0728
$\Delta G^{\#E}$/ kJ mol^{-1}	-2.3546	0.9878	-0.6587	-0.4587	-0.3587	0.0098

Where all the terms have their usual significance. The values of $\Delta G^{\#E}$ are all negative in the whole range of composition. This leads to suggest that irrespective of volume expansion and contraction,

all the flowing species surpass energy barriers smaller than expected from the additive rule.

4. CONCLUSION

Density and viscosity for the binary mixture of 1-Hexanol+ Benzene system at 303.15 K have measured and calculated $\Delta\eta$, $\Delta G^{\#E}$ and ε. The values of $\Delta\eta$, $\Delta G^{\#E}$ and ε were found to be negative in the whole range of composition. These negative values are observed in the alcohol-rich region which may be suggested as due to partial interstitial accommodation, irrespective of contraction and interaction between molecules non-specific type.

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

HUMAN AND ANIMAL RIGHTS

No Animals/Humans were used for studies that are base of this research.

CONSENT FOR PUBLICATION

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CONFLICT OF INTEREST

The authors have no conflict of interest.

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