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EXCESS VISCOSITY AND EXCESS MOLAR VOLUME STUDIES IN BINARY LIQUID MIXTURES CONTAINING METHANOL WITH HETERO CYCLIC COMPOUND DIFFERENT TEMPERATURES

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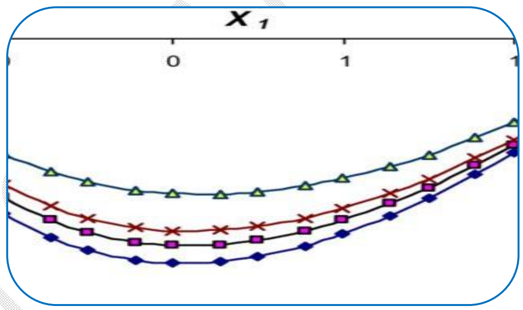
ABSTRACT :

Excess viscosity (η^E) and excess molar volume (V_m^E) have been calculated at four temperatures T=(303.15,308.15,313.15 and 318.15)K in binary liquid mixtures of methanol with hetero cyclic compound quinoline by using the experimentally measured data of ultrasonic sound velocities, viscosities and densities. These results have been explained on the basis of molecular interactions present in the liquid mixtures.



KEYWORDS : *Excess viscosity; excess molar volume; methanol.*

INTRODUCTION

Study of Excess parameters has been much efficient technique [1-8] in for chemical separations and heat transfer. Quinoline is a hetero cyclic aromatic organic compound with the chemical formula C_9H_7N. Methanol, also known as methyl alcohol with chemical formula CH_3OH. In the present work, study of excess viscosity and excess molar volume have been reported at four temperatures T=(303.15,308.15,313.15 and 318.15)K over the entire mole fraction range of quinoline.

EXPERIMENTAL

The chemicals used for the present work are of AR grade (Quinoline from SDFCL and Methanol from MERCK) and they are purified with standard procedure [9]. The liquid mixtures of different concentrations are made by changing mole fractions with respect to Job's method.For preserving these liquid mixtures Stoppard conical flasks are used and they are left undisturbed to get thermal equilibrium. Ultrasonic interferometer (Mittal enterprises, India) is used for the measurement of velocities at a fixed frequency of 3MHz. Temperature controlled water bath is used for changing the temperature of the pure liquids and liquid mixtures by circulating water around the liquid cell. Densities of pure liquids and liquid mixtures are measured by specific gravity bottle. Shimadzu AUY220 electronic weighing balance is used for the measurements of mass of pure liquids and liquid mixtures with precision of + or - 0.1 mg. Ostwald's viscometer is used for the measurement of viscosity of pure liquids and liquid mixtures. The time of flow of liquid in the viscometer is measured with an electronic stopwatch with a precision of 0.01s.

THEORY

Excess viscosity and excexx molar volume are evaluated from the experimentally measured values of ultrasonic velocity (u), viscosity (η) and density (ρ) by using the following equations [10-13].

$\eta^E = \eta_{exp} - (X_1\eta_1 + X_2\eta_2)$ $\quad$ N.s.m^{-2} $\quad$ ------(1)
$V_m^E = V_{m(exp)} - (X_1V_{m1} + X_2V_{m2})$ $\quad$ m^3.mol $\quad$ ------(2)

Here η^E and V_m^E represent excess values of thermo-acoustical parameters such as viscosity, molar volume, And also these excess parameters are fitted to the following Redlich-Kister equations [10-13]

$$A^E = x_1(1-x_1) - \sum_{i=1}^{N} A_i(2x_2-1)^i \qquad \text{------(3)}$$

The standard deviation values are summarized by the following relation [10-13]

$$\sigma = \left[\sum (x_{exp} - x_{cal})^2 \big/ (n-p)\right]^{1/2} \qquad \text{------(6)}$$

Here n represent the number of experimental points, p is the number of parameters, X_{exp} and X_{cal} are experimental and calculated parameters.

RESULTS AND DISCUSSION

Experimentally measured values of ultrasonic velocities, densities and viscosities of pure liquids together with the literature values are given in **Table-1**.

Table-1: The values of ultrasonic velocities (U), densities (ρ) and viscosities (η) of pure liquids along with the literature values at temperature T=303.15K.

Liquid	Ultrasonic velocity U(m.s^{-1})		Density ρ(Kg.m^{-3})		Viscosity η (N.s.m^{-2})	
	Exp	Lit	Exp	Lit	Exp	Lit
quinoline	1553.68	1547.00[14]	1085.45	1085.79[14]	2.9320	2.9280[14]
methanol	1084.14	1084[15]	795.18	795.1[15]	0.5068	0.5070[15]

Generally the difference between the experimental value and ideal mixture value is known as excess parameter. The variations of excess parameters such as η^E and V_m^E for the present binary liquid mixture containing methanol with quinoline at four different temperatures T=(303.15,308.15,313.15 and 318.15)K are represented in **Fig-1** and **Fig-2** respectively.The Redlich–Kister coefficients (A_0, A_1, A_2,A_3, A_4) and their standard deviations(σ) of evaluated excess parameters at four different temperatures T=(303.15,308.15,313.15 and 318.15)K are represented in **Table-2.**

Table-2: Values of Redlich –Kister coefficients (A_0, A_1, A_2, A_3, A_4) and their standard deviations(σ) of the evaluated excess parameters in liquid mixture of (quinoline + methanol) at temperatures 303.15,308.15,313.15 and 318.15K .

Excess Parameter	Co-efficients	Temperatures			
		303.15K	308.15K	313.15K	318.15K
η^E	A_0	1.8928	1.9829	2.2799	2.2337
	A_1	o.1149	0.0169	-0.2730	-0.6044
	A_2	2.0057	-1.8894	-1.5409	-0.6407
	A_3	-1.2246	-1.3541	-1.6677	-0.5838
	A_4	3.5932	3.6599	3.8547	1.900
	σ	0.0010	0.0011	0.0012	0.0013
$V_m^E x10^2$	A_0	-0.0349	-0.0261	-0.0173	-0.0102
	A_1	-0.0604	-0.0708	-0.082	-0.0914
	A_2	0.0036	0.0074	0.0018	0.0028
	A_3	0.0843	0.0733	0.0614	0.0517
	A_4	-0.0811	-0.0762	-0.0712	-0.0673
	σ	0.0079	0.0081	0.0082	0.0084

Fig-1: Variations of excess viscosity (η^E) in binary liquid mixture of (quinoline + methanol) with the mole fraction of quinoline at temperatures T=(303.15,308.15,313.15 and 318.15)K.

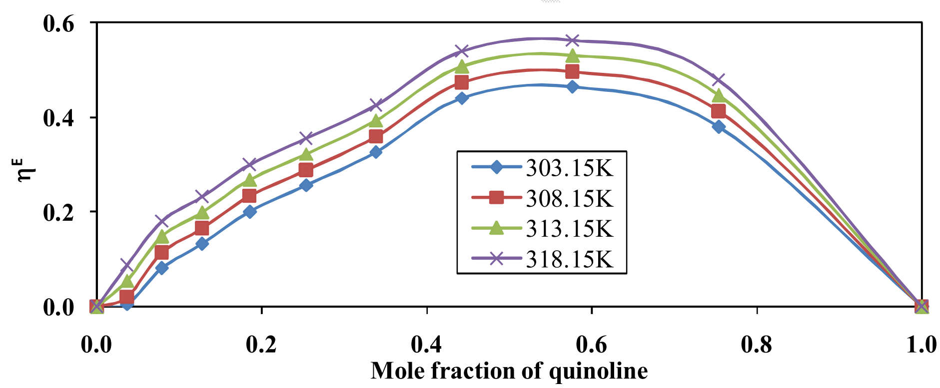
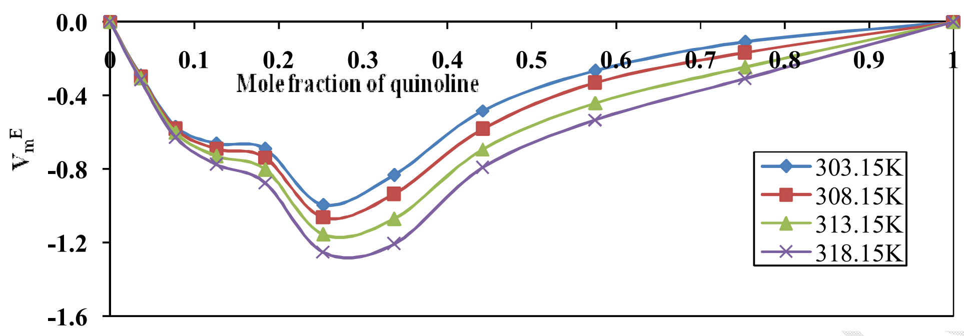


Fig-2: Variations of excess molar volume (V_m^E) in binary liquid mixture of (quinoline + methanol) with the mole fraction of quinoline at temperatures T=(303.15,308.15,313.15 and 318.15)K.



The excess viscosity variation gives a qualitative estimation of the strength of intermolecular interactions. Variation of excess viscosity (η^E) with the mole fraction of quinoline at four different temperatures T=(303.15,308.15,313.15 and 318.15)K in the binary liquid mixtures are as shown in **Fig-1**. From **Fig-1** it is observed that,η^E values are positive. According to Yang *et al* [16] and Tianyu *et al*[17], excess viscosityη^E tends to become more positive as the strength of interactions increases.

Generally, excess molar volumes on mixing of two liquids can arise from one of the factors like (a) Difference in size and shape of the component molecules (b) Structural changes such as changes in the correlation of molecular orientations (c)Difference in the intermolecular interaction energy between like and unlike molecules (d)Formation of new chemical species. **Fig-2** represents the variations of excess molar volume (V_m^E) in the above binary liquid mixtures at four different temperatures T=(303.15,308.15,313.15 and 318.15)K. From **Fig-2** it is observed that, the variations in excess molar volume V_m^E with mole fraction of quinoline for the binary liquid mixtures of methanol with quinoline are negative at four different temperatures studied. This suggests that mixture prefers to have compact structure in the mixture. This confirms strong interactions [18] are present in the binary liquid mixture.

CONCLUSIONS

Excess parameters such as excess viscosity (η^E) and excess molar volume (V_m^E) have been calculated. An analysis of these results suggests the presence of strong intermolecular interactions in binary liquid mixtures. Also the strength of intermolecular interactions is observed to be decreased in the binary liquid mixtures with increase of temperature.

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