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Research Article

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A comparative study of excess Gibb's free energy function values in three binary liquid mixtures containing quinoline and o, m, p-xylenes at different temperatures T(=303.15, 308.15, 313.15 and 318.15)K

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ABSTRACT

Viscosity, density and ultrasonic velocity values have been measured experimentally in three binary liquid mixtures containing (quinoline+o-xylene),(quinoline+m-xylene) & (quinoline+p-xylene) at different temperatures at different mole fractions. These experimentally measured values have been used to obtain the excess Gibb's free energy function (G^{*E}) in all the three binary liquid mixtures at different temperatures. The obtained results have been used to explain the molecular interactions.

Keywords: Density, ultrasonic velocity, quinolone and excess Gibb's free energy function.

INTRODUCTION

An ultrasonic velocity study provides a lot of information on molecular interactions. Ultrasonic wave propagation affects the physical properties of the medium and hence can furnish information on the liquid and liquid mixtures. Studies on ultrasonic velocity, density, viscosity, acoustic, thermodynamic, excess thermodynamic parameters and their deviations in binary systems have been the subject of many investigations in the recent years[1-7]. These investigations on different systems reveal specific interactions between the molecules of the component liquids. The study of the propagation behavior of ultrasonic waves in liquids & liquid mixtures is now rather well established as an effective means for examining certain physical properties of materials or medium, molecular interactions etc.[8-11].As a part of ongoing research [12-15] on thermodynamic and excess properties of binary liquid mixtures, we report here the results of study on three binary liquid mixtures containing heterocyclic aromatic compound such as quinoline with o, m, p-xylenes over the entire range of composition at different temperatures T(=303.15, 308.15, 313.15 and 318.15)K. Quinoline is a colourless liquid with strong odor and widely used in manufacturing of dyes, pesticides and solvent for resins and terpenes. Xylenes are very much useful in many agricultural applications. Here excess thermodynamic function like excess Gibb's free energy function (G^{*E}) in all three binary liquid mixtures have been calculated for the study of molecular interactions between components of liquid mixtures.

EXPERIMENTAL SECTION

The chemicals used were obtained from SDFCL chemicals (quinoline) and Merck (o, m, p-xylenes). The chemicals were purified by standard procedure [16].The purity of samples was checked by comparing experimental values of density and ultrasonic velocity with the available literature. Job's method of continuous variation was used to prepare the mixtures of required proportions. The ultrasonic velocities were measured by using single crystal ultrasonic pulse echo interferometer of Mittal enterprises**,** India with model number F-80X **.**The densities of pure liquids and liquid mixture were measured by using a specific gravity bottle with an accuracy of ± 0.5%.Viscosities were measured at the desired temperature using Ostwald's viscometer calibrated using water and benzene. The flow

time has been measured after the attainment of bath temperature by each mixture. For all pure compounds and mixtures, 4 to 5 measurements were performed and the average of these values was used in all the calculations.

THEORY:

Excess free energy function is calculated by the following equation

$$G^{*E} = RT\left[\ln\left(\frac{\eta V_m}{\eta_2 V_{m2}}\right) - x_1 \ln\left(\frac{\eta_1 V_{m1}}{\eta_2 V_{m2}}\right)\right] \quad \textbf{(1)}$$

and

It is fitted to Redlich-Kister polynomial equation

$$Y^E = X_1.X_2 \sum_{i=0}^{n} A_i \left(X_1 - X_2\right)^i \quad \textbf{(2)}$$

RESULTS AND DISCUSSION

Ultrasonic velocities and densities of pure liquids are experimentally measured and are compared with the literature values and they are good agreement with each other as given in **Table-1.**

Table-1: Comparison of experimental densities ρ and ultrasonic velocities U of pure liquids with literature values

Liquids	Density 'ρ' (kg . m^{-3})		Ultrasonic Velocity 'U' (m . s^{-1})	
	Expt	Lit	Expt	Lit
Quinoline	1085.45	1085.79[17]	1553.68	1547[17]
o-xylene	870.70	870.73[18]	1338.75	1328.30[18]
m-xylene	855.70	855.47[18]	1304.21	1300.34[18]
p-xylene	852.80	852.26[18]	1288.43	1289.68[18]

Table-2: Calculated Values of Excess Gibb's free energy function (G^{*E})

(Quinoline + o-xylene)			
at (T=303.15K)	at (T=308.15K)	at (T=313.15K)	at (T=318.15K)
0.00	0.00	0.00	0.00
155.34	178.56	204.19	225.56
173.89	191.23	213.79	238.56
185.67	202.89	223.95	248.91
195.77	212.23	234.50	259.23
193.61	211.48	239.83	267.34
146.58	160.66	183.39	217.23
87.34	106.29	119.72	145.45
42.23	54.12	69.18	84.12
19.45	29.60	34.12	39.14
0.00	0.00	0.00	0.00
(Quinoline + m-xylene)			
0.00	0.00	0.00	0.00
173.45	191.86	211.25	230.34
187.78	202.42	220.08	242.34
193.60	209.82	226.15	246.66
199.42	215.05	229.79	251.89
174.40	186.99	198.92	214.56
130.40	142.07	152.68	167.74
90.37	97.35	101.58	117.56
49.72	53.71	57.42	65.67
11.69	13.86	9.98	19.78
0.00	0.00	0.00	0.00
(Quinoline + p-xylene)			
0.00	0.00	0.00	0.00
206.45	227.60	248.02	254.67
216.34	232.88	252.34	265.34
218.56	236.67	257.33	268.32
223.45	240.44	264.34	276.98
177.26	187.33	201.40	223.43
124.88	132.50	143.86	160.39
90.51	92.04	99.80	112.30
39.62	41.58	45.83	51.34
8.13	10.92	9.82	14.49
0.00	0.00	0.00	0.00

The values of excess Gibb's free energy function (G^{*E}) in all the three binary liquid mixtures at four different temperatures are given in **Table-2** and their corresponding variations with respect to mole fractions at four different temperatures are given in figures from**Figure-1 to Figure-3.** It is observed from the figures that G^{*E} values are positive in all the three binary liquid mixtures. According to Oswal *et al.*[19] and Reed *et al.*[20] the positive G^{*E} may be attributed to specific interactions and also by the conclusions of Rathnam *et al.[*21], the positive values of G^{*E} show strong interactions.

Figure-1: Variations of excess Gibb's free energy function (G^{*E}) in (quinoline + o-xylene) mixture

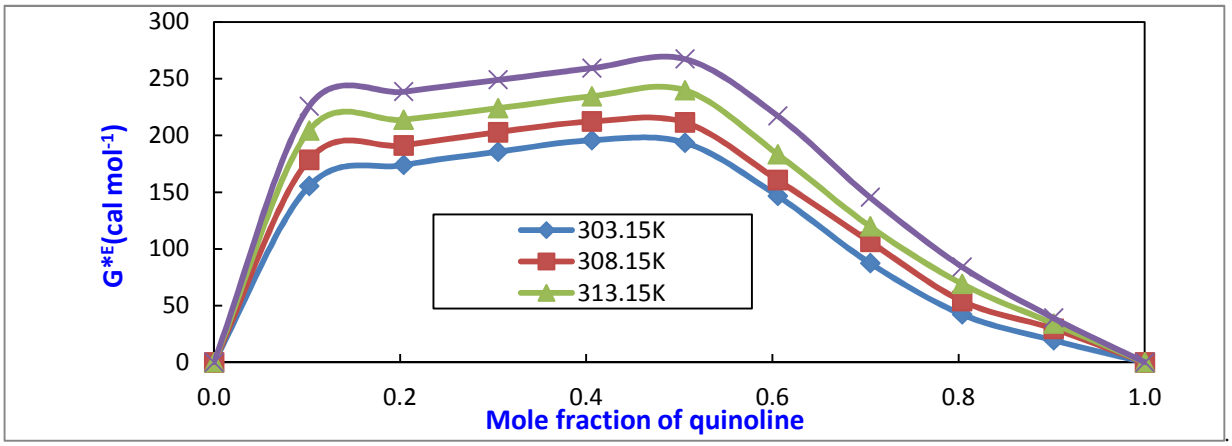


Figure-2: Variations of excess Gibb's free energy function (G^{*E}) in (quinoline + m-xylene) mixture

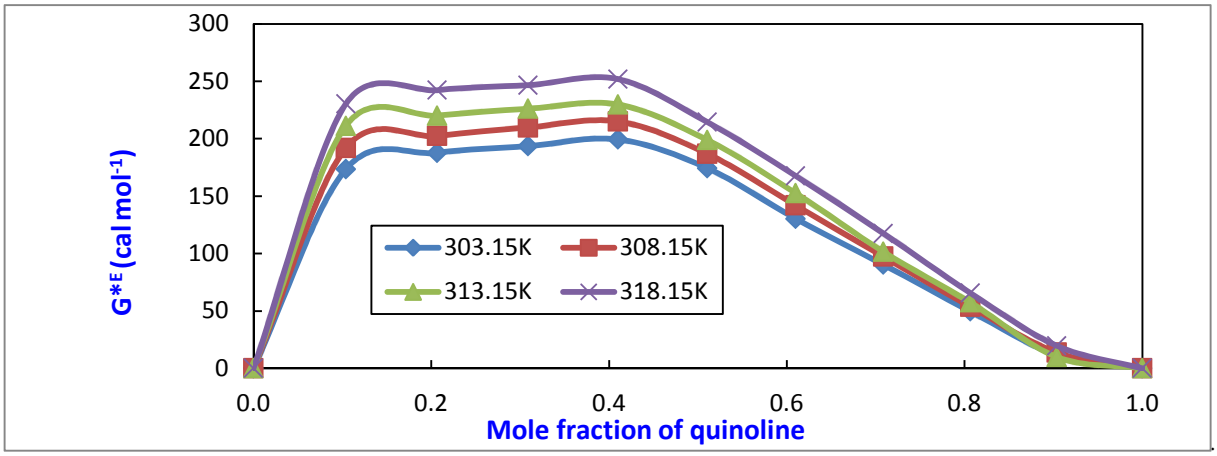
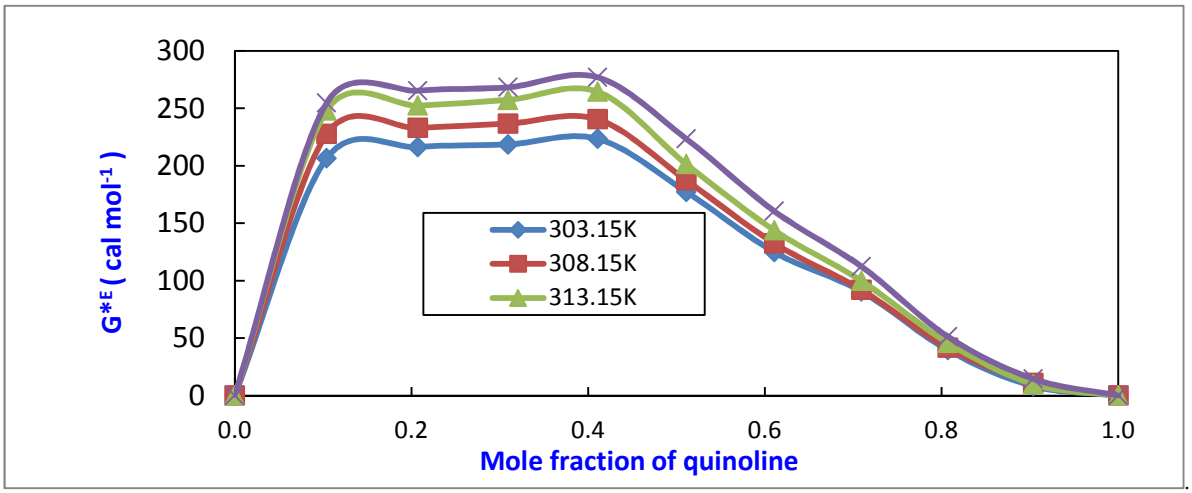


Figure-3: Variations of excess Gibb's free energy function (G^{*E}) in (quinoline + p-xylene) mixture



CONCLUSION

The variations of excess Gibb's free energy function with the mole fraction of quinoline in all the three binary liquid mixtures at different temperatures are suggested that there exists a strong molecular interaction between the components of the three binary liquid mixtures.

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