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Characterization of useful Functionality by the Study of Excess Thermo Acoustical Parameters in Binary mixture of Multi useful Heterocyclic Aromatic compound with 2-methylphenol at different Temperatures T(=303.15K,308.15K,313.15K and 318.15K.)

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Abstract

Densities, visocities and ultrasonic velocities have been measured in the binary mixture containing heterocyclic aromatic compound and 2-methylphenol over the entire range of composition at different temperatures T=303.15K, 308.15K, 313.15K and 318.15K. Using these measured values, various excess thermodynamic parameters like excess adiabatic compressibility (β^E), excess intermolecular free length (L_f^E), excess acoustic impedance (Z^E) and excess ultrasonic velocicities (U^E) have been calculated for the mixture. The observed variations can be helpful for the study the molecular interactions and functionality.

Keywords: Excess adiabatic compressibility, excess intermolecular free length, excess acoustic Impedance, excess ultrasonic velocity, heterocyclic aromatic compound.

Introduction

Excess properties of liquid mixtures are useful in the study of molecular interactions and arrangements. Thermoacoustical parameters are used to understand different kinds of associations like molecular packing, molecular motion, physico-chemical behaviour and various types of intermolecular interactions and their strengths, which are influenced by the sizes in pure components and in the mixtures. Molecular interaction in liquid mixtures has been extensively studied using ultrasonic technique by many workers[1], because mixed solvents find practical applications in many chemical, biological and industrial processes. In the present study we have taken the study with heterocyclic aromatic compound namely quinoline and 2-methylphenol namely o-cresol. Quinoline is a heterocyclic aromatic organic compound with the chemical formula C_9H_7N. It is a colorless hygroscopic liquid with a strong odor and it is widely used in manufacturing of dyes, pesticides, solar cells and terpenes. O-cresols are organic compounds which is 2-methylphenol with molecular formula C_7H_8O and is widely used for phonograph records, wood preservatives and selective weed killing .As a part of today's progressive and ongoing research[2] on thermoacoustic properties of binary liquid mixtures, we report here the results of study on binary liquid mixture of heterocyclic aromatic compound (quinoline) with 2-methylphenol (o-cresol) over the entire range of composition at T= 303.15K, 308.15K, 313.15K and 318.15K. By using the experimentally measured values of ultrasonic velocity (u), density (ρ) and viscosity (η), various excess thermo acoustical parameters like excess adiabatic compressibility, excess intermolecular free length, excess acoustic impedance, and excess ultrasonic velocity have been calculated the mixture. The calculated deviations and excess functions have been explained on the basis of the intermolecular interactions present in these mixtures. The binary liquid system studied here is

Heterocyclic aromatic compound (quinoline) + 2-methylphenol (o-cresol)

Material and Methods

The chemicals used were of Anala R grade and obtained from SDFCL chemicals (quinoline) and Merck (o-cresol).The chemicals were purified by standard procedure[3]. 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 prepared mixtures were preserved in well-Stoppard conical flasks. After mixing the liquids thoroughly, the flasks were left undisturbed to allow them to attain thermal equilibrium. The ultrasonic velocities were measured by using single crystal ultrasonic pulse echo interferometer of Mittal enterprises**,** India with model number F-80X**.** It consists of a high frequency generator and a measuring cell. The measurements of ultrasonic velocities were made at a fixed frequency of 3MHz. The densities of pure liquids and liquid mixture were measured by using a specific gravity bottle with an accuracy of ± 0.5%. Weights were measured with an electronic balance namely Shimadzu AUY220 made in Japan which is capable of measuring up to 0.1mg. An average of 4 to 5 measurements was taken for each sample. Viscosities were measured at the desired temperature using Ostwald's viscometer calibrated using water and benzene. For all pure compounds and mixture we have performed 4 to 5 measurements and average of these values were used in all the calculations.

Theory: The excess properties such as β^E, Lf ^{E}, Z^E, and u^E have been calculated using the relation

YE = Ymix – [x1Y1 + x2Y2]

where Y^E is β^E, Lf ^{E}, Z^E, or u^E and x represents mole fraction of the component and subscript 1 and 2 for the components 1 and 2, respectively.

Results and Discussion

The values of ultrasonic velocities and densities for all the three pure liquids are experimentally measured and are compared with the literature values and they are good agreement with each other as given in the below table1.

The calculated values of excess parameters like excess adiabatic compressibility (β^E), excess intermolecular free length (L_f^E), excess acoustic impedance (Z^E) and excess ultrasonic velocicities (U^E) for the binary liquid system at different temperatures are given in the tables from table-2. The variations of the excess parameters with the mole fraction of quinoline in the binary liquid system at different temperatures are represented in the figures from figure-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
Heterocyclic aromatic comound (Quinoline)	1085	1085.82[4]	1554	1547[4]
2-methylphenol (o-Cresol)	1036	1036.9[5]	1485	1487[5]

[4]Jagan Nath, [5] Bhatia et al.

Table-2
Excess thermoacoustical parameters in system of heterocyclic aromatic compound (Quinoline) and 2-methyl phenol (o-cresol)

Molefraction of heterocyclic aromatic comound (Quinoline)	β^E				L_f^E			
	303.15K	308.15K	313.15K	318.15K	303.15K	308.15K	313.15K	318.15K
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0888	-0.8558	-1.5704	-2.1660	-2.7863	-1.2733	-2.3399	-3.2264	-4.1458
0.1798	-1.1485	-2.0032	-2.7226	-3.1583	-1.7109	-2.9957	-4.0775	-4.7163
0.2732	-1.2812	-2.0346	-2.5113	-3.0370	-1.9121	-3.0459	-3.7555	-4.5381
0.3690	-1.5303	-1.9737	-2.1706	-2.6163	-2.3035	-2.9599	-3.2357	-3.8982
0.4672	-1.4854	-1.7165	-1.9092	-2.2295	-2.2438	-2.5714	-2.8440	-3.3150
0.5681	-1.1960	-1.4451	-1.3950	-1.6789	-1.8026	-2.1641	-2.0575	-2.4772
0.6717	-0.8762	-1.1341	-0.8856	-1.2540	-1.3152	-1.6979	-1.2805	-1.8413
0.7782	-0.6160	-0.9585	-0.4599	-0.5410	-0.9248	-1.4519	-0.6392	-0.7508
0.8876	-0.4327	-0.4923	-0.2147	-0.2176	-0.6603	-0.7456	-0.2907	-0.2856
1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Molefraction of heterocyclic aromatic comound (Quinoline)	**Z^E**				**U^E**			
	303.15K	**308.15K**	**313.15K**	**318.15K**	**303.15K**	**308.15K**	**313.15K**	**318.15K**
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.0888	2.0365	3.2900	4.3714	5.3700	8.6600	19.4000	26.8000	34.7600
0.1798	2.7165	4.3200	5.6213	6.3500	11.9100	24.2400	33.9200	37.9200
0.2732	3.2095	4.5900	5.3321	6.3300	11.8400	22.8900	29.4600	34.5300
0.3690	3.9220	4.6000	4.8727	5.5800	14.7600	21.1700	22.2200	27.7300
0.4672	3.8657	4.1900	4.5374	5.0200	14.3500	16.4100	17.0100	20.6700
0.5681	3.2387	3.4900	3.4663	3.8700	10.0800	14.1000	9.5600	13.3300
0.6717	2.4061	2.7400	2.2601	2.9200	6.6700	11.0500	3.6900	9.0800
0.7782	1.5824	2.2800	1.2864	1.1300	5.7000	10.9100	-0.9700	2.1200
0.8876	1.1419	1.2400	0.5742	0.5200	4.5400	4.9500	-0.7600	-0.9400
1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

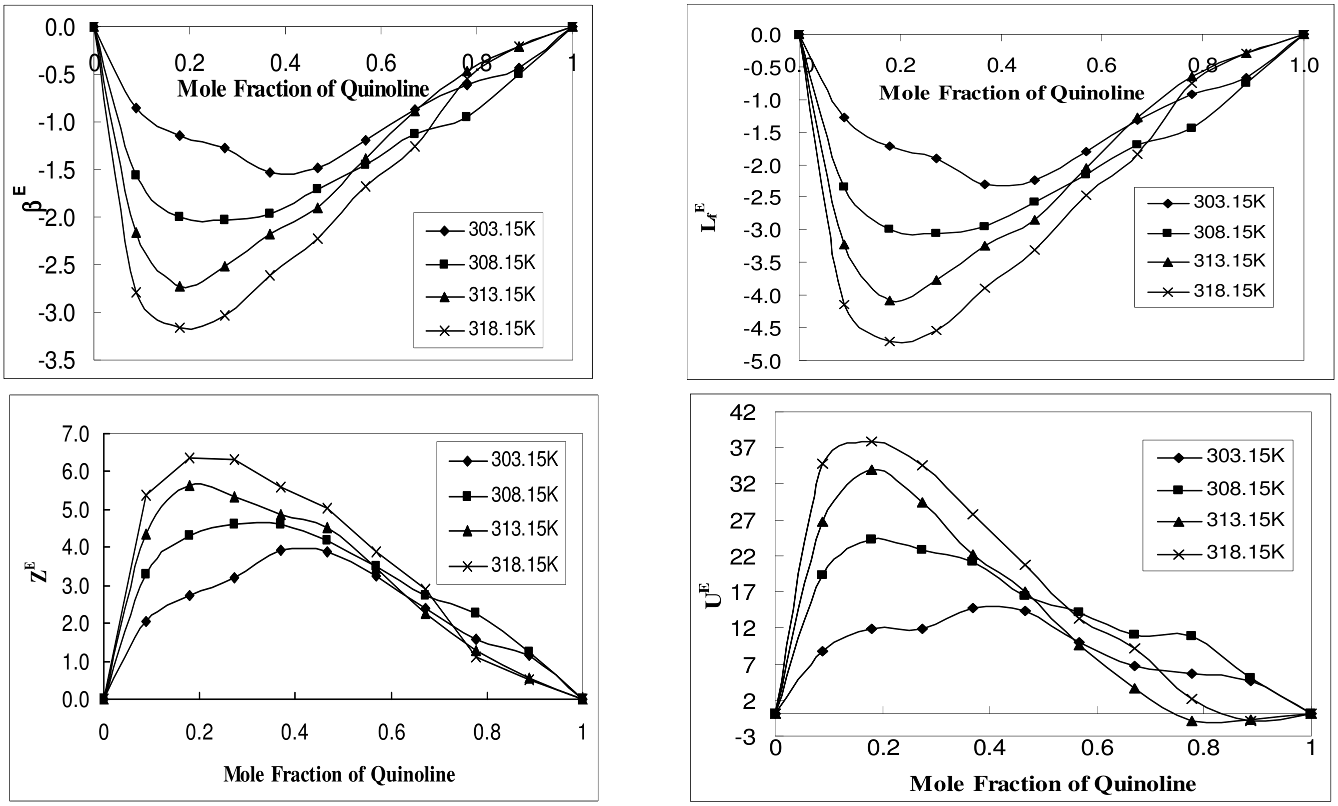

Figure-1

Variations of excess thermoacoustical parameters with the mole fractions in system of heterocyclic aromatic compound (Quinoline) and 2-methyl phenol (o-cresol)

The excess properties of the mixtures are influenced by three main types of contributions, namely, i. due to non specific Van der Waals type forces, ii. due to hydrogen bonding, dipole-dipole, and donor-acceptor interaction between unlike molecules, and iii. due to the fitting of smaller molecules into the voids created by the bigger molecules. The first effect leads to contraction in volume hence leads to negative contribution towards u^E and positive contribution towards β^E. However, the second effect leads to negative contribution towards β^E and positive contribution towards u^E. For the mixture, the results of the excess adiabatic compressibility β^E plotted in Figure-1 are negative at all the temperatures studied. The negative values of β^E suggest that the mixtures are less compressible than the corresponding ideal mixture. According to Fort and Moore[6], the liquids of different molecular size usually mix with decrease in volume yielding negative β^E values. The strength of the interactions between component molecules increases when excess values tend to become increasingly negative. As the temperature increases, the β^E values also increases in the present system, suggesting that the thermal energy activates the molecules towards complex formation between unlike molecules[7]. Also from Figure-1 it is observed that $L_f{}^E$ values are negative for the entire mole fraction range, for all the four temperatures in case of the present system. The $L_f{}^E$ values are increasingly negative as the strength of interaction between component molecules increases[8]. The excess values of Z^E which are plotted in figure-1 are all positive in the present system over the entire composition range and for all the four temperatures studied. The positive excess values of Z^E clearly suggest that there exist strong molecular interactions between the molecules of system of liquid mixture[9]. Further the results for the excess ultrasonic velocity u^E plotted in Figure-1are positive for the present system of liquid mixture at all the temperatures studied. The positive values of u^E increase with the increase in temperature which indicates the increase in strength of interaction with temperature in the present system of liquid mixture.

Conclusion

From the results of these excess parameters, it is observed that there exists a strong molecular interaction between the unlike molecules in the system of liquid mixture.

Applications: By the above conclusion it can be cleared that there are different kinds of useful applications with quinoline when mixed with other organic compound by the information of strong interactions**.**

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