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EXCESS ACOUSTICAL STUDIES IN LIQUID MIXTURES OF ANILINE WITH O-XYLENE AT DIFFERENT TEMPERATURES T= (303.15KK, 308.15K, 313.15K and 318.15) K

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ABSTRACT
Excess acoustical parameters such as excess intermolecular free length (L_f^E), excess adiabatic compressibility (β^E), excess acoustic impedance (Z^E) and excess ultrasonic velocity (U^E) have been computed from experimentally determined values of densities(ρ), ultrasonic velocities(u) and viscosities(η) in binary liquid mixtures containing aniline with o-xylene at temperatures T=(303.15,308.15,313.15 and 318.15)K. These results are fitted to the Redlich-Kister polynomial equation. These results have been explained on the basis of intermolecular interactions in liquid mixtures.
Keywords: Ultrasonic Velocity, Excess Intermolecular Free length, Excess Adiabatic Compressibility, Excess acoustic Impedance, Aniline.

INTRODUCTION

In understanding the strength of the molecular interactions in binary liquid mixtures[1-12] Excess acoustical parameters study is a useful tool. The structural arrangement and shape of the molecules will be influenced by these intermolecular interactions. Ultrasonic velocity and their calculated excess parameters study and their investigations in liquid mixtures find renowned applications in explaining physicochemical behavior and non-ideal behavior[13,14]. In the present performed research work[15,16] the author made a report on the variations of excess acoustical parameters such as excess intermolecular free length (L_f^E), excess adiabatic compressibility (β^E), excess acoustic impedance(Z^E) and excess ultrasonic velocity (U^E) in binary liquid mixtures of aniline with o-xylene at temperatures T=(303.15,308.15,313.15 and 318.15)K over the entire mole fraction range of aniline. The deviations produced through the study of these excess parameters indicate the presence of interactions between the component molecules of the liquid mixtures.

EXPERIMENTAL

Absolute AR grade chemicals are used and they are purified in the present investigation by standard procedure. By varying mole fractions with respect to Job's method of continuous variation, different concentrations of the liquid mixture are prepared. Ideal prepared mixtures are preserved in stoppard conical flasks and are left undisturbed to attain thermal equilibrium. Ultrasonic velocities values are measured using Ultrasonic pulse echo interferometer (Mittal enterprises, India) at a fixed frequency of 3MHz. The temperature controlled water bath is utilized for the measurement of the temperature of the pure liquids or liquid mixtures by using by circulating water around the liquid cell which is present in the interferometer .Specific gravity bottle is used for the measurement of densities of pure liquids and liquid mixtures. The measurements of the mass of pure liquids or liquid mixtures are examined using an electronic weighing balance (Shimadzu AUY220, Japan), with a precision of + or - 0.1 mg. Average of 4 to 5 measurements are taken for each sample. Ostwald's viscometer is used for the measurement of

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viscosity of pure liquids or liquid mixtures. The time of flow of liquid in the viscometer is estimated with an electronic stopwatch with a precision of 0.01s.
By using the following equations[1-12], excess acoustical parameters are evaluated.

$\beta^E=\beta_{exp} - (x_1\beta_1+ x_2\beta_2)$ m^2N^{-1} (1)
$L_f^E = L_{f\,(exp)} - (x_1L_{f1}+ x_2L_{f2})$ Å (2)
$Z^E = Z_{exp} - (x_1Z_1 + x_2Z_2)$ $Kgm^{-2}s^{-1}$ (3)
$U^E = U_{exp} - (x_1U_1 + x_2U_2)$ ms^{-1} (4)

Where, β^E, L_f^E, Z^E and U^E indicate the excess values of adiabatic compressibility, intermolecular free length, acoustic impedance and ultrasonic velocity respectively. Here x indicates the mole fraction and 1, 2 represent 1st and 2nd components respectively. These excess parameters are fitted to the Redlich-Kister equation as in the following given by Kumar *et al* [17].

$$A^E = x_1(1-x_1)-\sum_{i=1}^{N} A_i(2x_2-1)^i \quad (5)$$

RESULTS AND DISCUSSION

The experimentally determined values of ultrasonic velocities (**u**), densities (ρ) and viscosities (η) over an entire mole fraction range of aniline at temperatures T=(303.15,308.15,313.15 and 318.15)K are given in the Table-1.

Table-1: The Values of Ultrasonic Velocities (u), Densities (ρ) and Viscosities (η) over an entire Mole Fraction Range of Aniline at Temperatures T=(303.15,308.15,313.15 and 318.15)K .

Molefraction of aniline (X_1)	Ultrasonic velocity(u)/($m.s^{-1}$)			
	T=303.15K	T=308.15K	T=313.15K	T=318.15K
0.0000	1339.93	1314.52	1298.45	1278.98
0.0146	1370.23	1346.48	1332.17	1317.86
0.0323	1398.86	1376.09	1361.78	1347.47
0.0541	1428.17	1405.70	1391.39	1377.08
0.0816	1458.64	1435.61	1421.30	1406.99
0.1176	1489.77	1466.82	1452.51	1438.20
0.1667	1519.88	1498.47	1484.16	1469.85
0.2373	1544.51	1522.90	1508.59	1494.28
0.3478	1574.14	1551.01	1536.70	1522.39
0.5455	1600.77	1577.97	1563.66	1549.35
1.0000	1614.15	1591.45	1569.65	1551.23
	Density(ρ)/($Kg.m^{-3}$)			
0.0000	870.72	869.40	867.70	865.90
0.0146	882.49	876.07	869.65	863.23
0.0323	897.72	891.30	884.88	878.46
0.0541	913.69	907.27	900.85	894.43
0.0816	930.69	924.27	917.85	911.43
0.1176	944.89	938.47	932.05	925.63
0.1667	957.89	951.47	945.05	938.63
0.2373	974.69	968.27	961.85	955.43
0.3478	989.40	982.98	976.56	970.14
0.5455	1005.39	998.97	992.55	986.13
1.0000	1020.14	1008.14	996.26	982.23
	viscosity (η)/($Ns.m^{-2}$)			

0.0000	0.7015	0.6650	0.6210	0.5690
0.0146	0.8789	0.7686	0.7032	0.5876
0.0323	1.1203	0.8703	0.8143	0.6875
0.0541	1.2620	1.0120	0.8254	0.7546
0.0816	1.3991	1.1491	0.9354	0.8477
0.1176	1.5150	1.2650	1.0150	0.9346
0.1667	1.6876	1.4376	1.1876	1.0692
0.2373	1.8602	1.6102	1.3602	1.2321
0.3478	2.0813	1.8313	1.5813	1.4321
0.5455	2.2876	2.0376	1.7876	1.6243
1.0000	2.5416	2.1652	1.8665	1.6122

Standard uncertainities (U_c) are given below :

$$U_c(u) = + \text{ or } - 0.1 m.s^{-1};\ U_c(\rho) = + \text{ or } - 0.01 Kg.m^{-3};\ U_c(\eta) = + \text{ or } - 0.001 Ns.m^{-2}$$

The excess acoustical parameters study is an important tool in understanding the nature of molecular interactions in liquid mixtures[18]. The variations of the above excess acoustical parameters such as excess intermolecular free length (L_f^E), excess adiabatic compressibility (β^E), excess acoustic impedance (Z^E) and excess ultrasonic velocity (U^E) with the mole fraction of aniline at temperatures T=(303.15,308.15,313.15 and 318.15)K are represented in the figures from Fig.-1 to Fig.-4 respectively.

In the present binary liquid mixtures, the variations of excess intermolecular free length (L_f^E) with the mole fraction of aniline ranging from 0 to 1 at different temperatures are as shown in Fig.-1. It is observed from Fig-1 that, the excess intermolecular free length values are negative for an entire mole fraction range of aniline. The negative values of excess intermolecular free length imply that there exist strong interactions between the components of the liquid mixture and positive values indicate weak interactions between the components of liquid mixture[19].These kinds of variations are also supported by Kerr effect. Fig.-2 represents the variations of excess adiabatic compressibility (β^E) with a mole fraction of aniline.

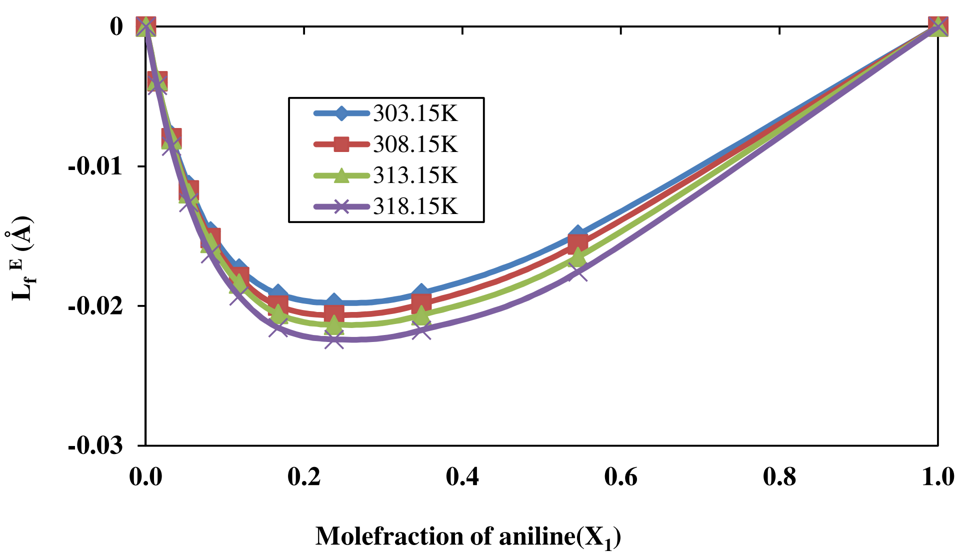

Fig.-1: The variations of excess intermolecular free length (L_f^E) in binary liquid mixtures of (aniline + o-xylene) with the mole fraction of aniline at temperatures T=(303.15,308.15,313.15 and 318.15)K .

The variations of excess adiabatic compressibility (β^E) values are negative observed from Fig.-2, in the present the binary combination of liquid mixtures. According to Fort and Moore[20], negative excess compressibility is an indication of strong hetero molecular interaction in the liquid mixtures while positive sign indicates weak interaction and is attributed to dispersion forces (London forces) which are likely to be operative in every case. In the present study, variations of excess compressibility are negative. This observation together with Fort and Moore's result suggests the existence of strong intermolecular interactions.

Fig-3 gives information about the variations of excess acoustic impedance (Z^E) with the mole fractions of aniline. It is observed from Fig.-3 is that, Z^E values are positive over the entire mole fraction range of aniline. This suggests that the component molecules are more close together in the liquid mixture than in pure liquids forming the mixture, indicating that strong attractive interactions[21] between component molecules such as hydrogen bonding, dipole-dipole interactions and other specific interactions between unlike molecules are operative in the system. The variations of excess ultrasonic velocity (U^E) in the present binary system are shown in Fig.-4. From Fig.-4 it is observed that, U^E values are positive in the present binary system over the entire mole fraction range of aniline. The positive values of U^E suggest strong interactions between the component molecules of liquid mixtures considered for the present study.

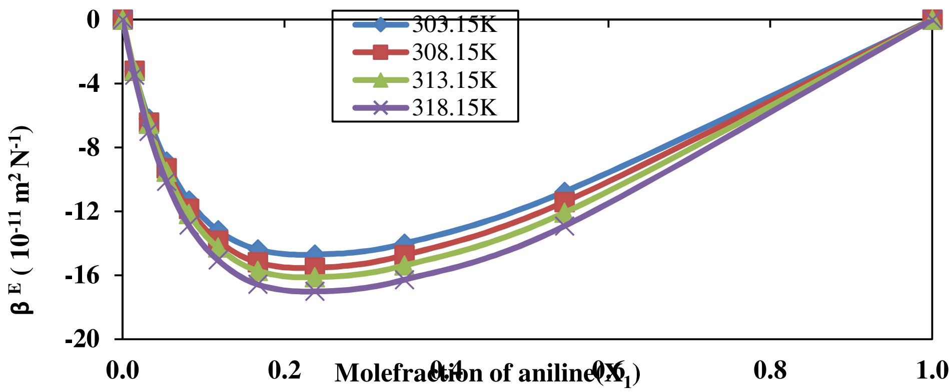

Fig.-2: The variations of excess adiabatic compressibility (β^E) in a binary liquid mixture of (aniline + o-xylene) with the mole fraction of aniline at temperatures T=(303.15,308.15,313.15and 318.15)K .

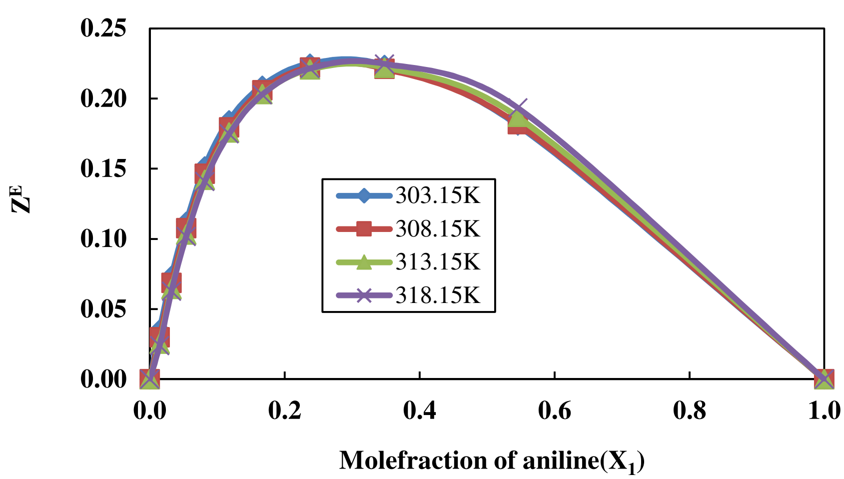

Fig.-3: The variations of excess acoustic impedance (Z^E) in a binary liquid mixture of (aniline + o-xylene) with the mole fraction of aniline at temperatures T=(303.15,308.15,313.15 and 318.15)K .

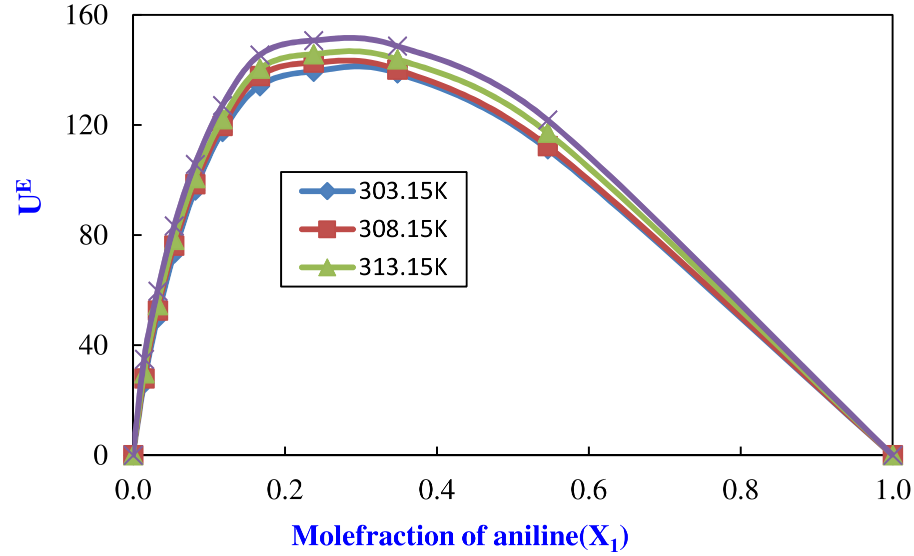

Fig.-4: The variations of excess ultrasonic velocity (U^E) in a binary liquid mixture of (aniline + o-xylene) with the mole fraction of aniline at temperatures T=(303.15,308.15,313.15 and 318.15)K

CONCLUSION

In the present binary liquid mixtures containing aniline with o-xylene, density, ultrasonic velocity and viscosity values are measured experimentally at temperatures T=(303.15,308.15,313.15 and 318.15)K. By using these values, other excess acoustical parameters such as excess intermolecular free length (L_f^E), excess adiabatic compressibility (β^E), excess acoustic impedance (Z^E) and excess ultrasonic velocity (U^E) are obtained over the entire mole fraction range of aniline. An analysis of these results suggests the strength of intermolecular interactions is observed to be decreased in the present binary system with temperature and also certifies the presence of strong intermolecular interactions in the present binary liquid mixtures.

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