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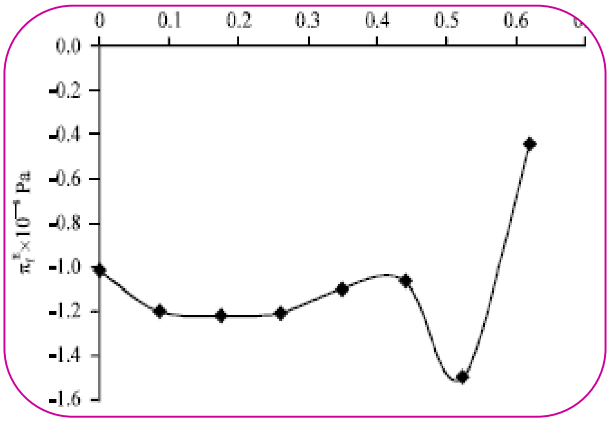
STUDY OF THERMO EXCESS ACOUSTICAL PARAMETERS IN BINARY LIQUID MIXTURES OF ANILINE WITH TOLUENE AT FOUR DIFFERENT TEMPERATURES



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ABSTRACT

Thermo excess acoustical parameters such as excess internal Pressure(π^E), excess enthalpy (H^E) and excess free volume (V_f^E) have been measured from experimentally measured values of densities(ρ),ultrasonic velocities(u) and viscosities(η) in binary liquid mixtures containing aniline with toluene 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: *Density,ultrasonic velocity, excess internal pressure,excess free volume compressibility, aniline.*

INTRODUCTION

Study of thermo excess acoustical parameters is very much important in explaining the nature of molecular interactions in binary liquid mixtures[1-10]. These interactions influence the structural arrangement and shape of the molecules. Study ultrasonic velocity and their derived excess parameters investigations in liquid mixtures finds eminent applications in explaining physico-chemical behavior and non-ideal behavior[11-13]. In the present research work[14] the authors reported the variations of excess acoustical parameters such as excess internal Pressure(π^E),excess enthalpy (H^E) and excess free volume (V_f^E) in binary liquid mixtures of aniline with toluene at temperatures T=(303.15,308.15,313.15 and 318.15)K over the entire molefraction range of aniline. The deviations of these excess acoustical parameters indicate the presence of interactions between the component molecules of the liquid mixtures.

EXPERIMENTAL

In the present investigation the chemicals used are of AR grade and they are purified by standard procedure. The different concentrations of the liquid mixture are prepared by varying mole fractions with respect to Job's method of continuous variation. Stoppard conical flasks are used for preserving the prepared mixtures and the flasks are left undisturbed to attain thermal equilibrium. Ultrasonic pulse echo interferometer (Mittal enterprises, India) is used for ultrasonic velocities measurements and all these measurements are done at a fixed frequency of 3MHz.The temperature of the pure liquids or liquid mixtures is done by using temperature controlled water bath by circulating water around the liquid cell which is present in interferometer .Specific gravity bottle is used for the measurement of densities of pure liquids and liquid mixtures. An electronic weighing balance (Shimadzu AUY220, Japan), with a precision of + or - 0.1 mg is used for the measurements of mass of pure liquids or liquid mixtures. Average of 4 to 5 measurements is taken for each sample. Ostwald's viscometer is used for the measurement of viscosity of pure liquids or 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 acoustical parameters are evaluated by using the following equations[1-10],

$$\pi^E = \pi_{exp} - (x_1\pi_1 + x_2\pi_2) \qquad m^2N^{-1} \qquad \text{------(1)}$$

$$H^E = H_{(exp)} - (x_1H_1 + x_2H_2) \qquad \text{Å} \qquad \text{------(2)}$$

$$V_f^E = V_{fexp} - (x_1V_{f1} + x_2V_{f2}) \qquad m^3 \qquad \text{------(3)}$$

Here x is the molefraction and 1, 2 represent 1st and 2nd component respectively.These excess parameters are fitted to the following Redlich-Kister equation as given by Kumar *et al* [15].

$$A^E = x_1(1-x_1) - \sum_{i=1}^{N} A_i(2x_2-1)^i \qquad \text{------(4)}$$

RESULTS AND DISCUSSION

The experimentally measured values of ultrasonic velocities(**u**), densitites(ρ) and viscosities (η) over entire molefraction 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**), densitites(ρ) and viscosities (η) over entire molefraction 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	1273.52	1254.23	1238.39	1226.19
0.1145	1303.82	1286.19	1271.04	1251.84
0.2254	1332.45	1315.80	1301.00	1280.49
0.3328	1361.76	1345.41	1331.65	1313.14
0.4369	1392.23	1375.32	1362.16	1343.79

0.5379	1423.36	1406.53	1391.27	1370.44
0.6358	1453.47	1438.18	1419.38	1402.09
0.7309	1488.10	1473.61	1452.03	1432.74
0.8232	1527.73	1510.72	1484.68	1466.39
0.9129	1567.36	1549.68	1522.33	1501.04
1.0000	1614.15	1591.45	1569.65	1551.23
	Density(ρ)/(Kg.m^{-3})			
0.0000	867.11	856.12	845.19	832.17
0.1145	880.49	866.65	855.17	842.63
0.2254	895.72	881.99	869.15	855.09
0.3328	915.69	901.96	888.13	875.55
0.4369	935.69	922.96	907.11	894.01
0.5379	954.89	942.16	926.09	912.47
0.6358	974.89	959.16	945.07	930.93
0.7309	991.69	974.96	962.05	949.39
0.8232	1005.16	990.43	976.03	964.23
0.9129	1014.39	1001.66	989.01	976.43
1.0000	1020.14	1008.14	996.26	982.23
	viscosity (η)/(Ns.m^{-2})			
0.0000	0.5955	0.4396	0.3029	0.1992
0.1145	0.7749	0.6039	0.4516	0.3293
0.2254	0.9543	0.7682	0.6003	0.4694
0.3328	1.1337	0.9325	0.749	0.6095
0.4369	1.3131	1.0968	0.8977	0.7496
0.5379	1.4925	1.2611	1.0464	0.8897
0.6358	1.6719	1.4254	1.1951	1.0298
0.7309	1.8513	1.5897	1.3438	1.1699
0.8232	2.0307	1.754	1.4925	1.3100
0.9129	2.250899	1.9183	1.6412	1.4501
1.0000	2.5416	2.1652	1.8665	1.6122

Standard uncertainities (U_c) are given below :

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

The thermo excess acoustical parameters play an important role in studying the nature of molecular interactions in liquid mixtures16. The variations of the above excess acoustical parameters such as excess internal Pressure(π^E),excess enthalpy (H^E) and excess free volume (V_f^E) with the molefraction 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-3** respectively

Fig-1: The variations of excess internal pressure (π^E) in binary liquid mixtures of (aniline + toluene) with the molefraction of aniline at temperatures T=(303.15,308.15,313.15 and 318.15)K .

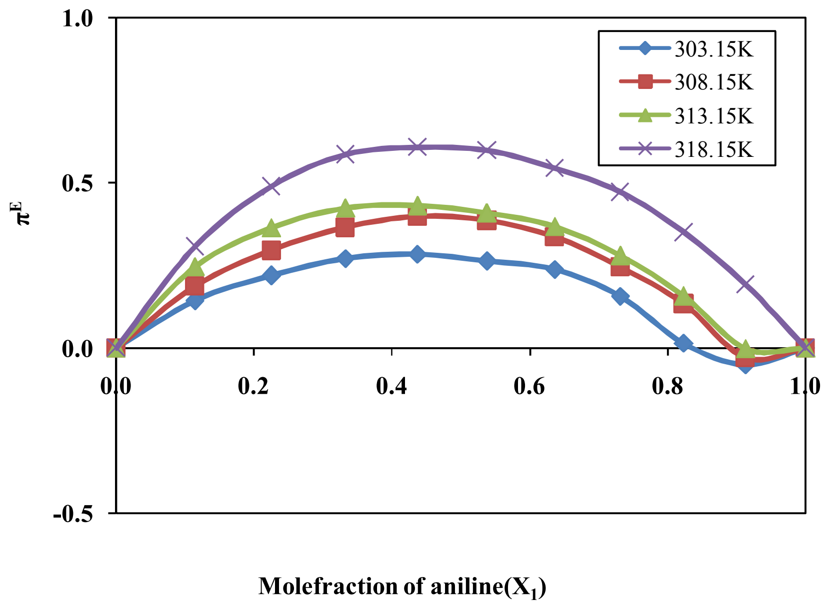


Fig-2: The variations of excess enthalpy (H^E) in binary liquid mixture of (aniline + toluene) with the molefraction of aniline at temperatures T=(303.15,308.15,313.15 and 318.15)K .

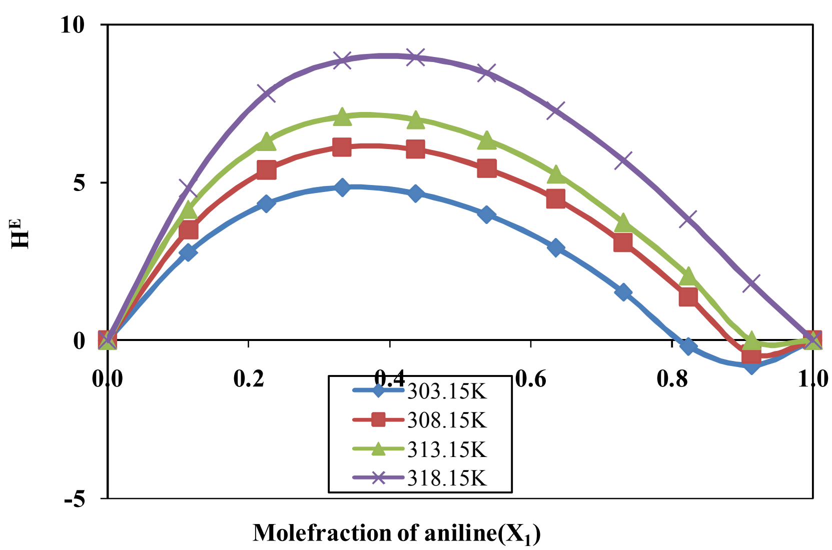
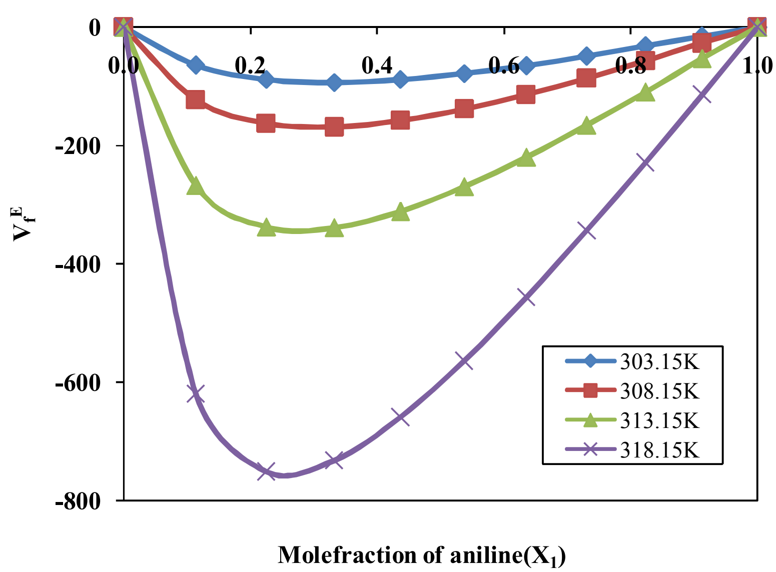


Fig-3: The variations of excess free volume (V_f^E) in binary liquid mixture of (aniline + toluene) with the molefraction of aniline at temperatures T=(303.15,308.15,313.15 and 318.15)K .



The variations of excess internal pressure (π^E) with the molefraction of aniline ranging from 0 to 1 at different temperatures in the present binary liquid mixtures are as shown in **Fig-1**.It is observed from **Fig-1** is that, the excess internal pressure values are positive for entire molefraction range of aniline. The positive values of excess internal pressure suggest that there exist strong interactions between the components of liquid mixture[17].These types of variations are also supported by Kerr effect. **Fig-2** represents the variations of excess enthalpy (H^E). From **Fig-2**, it is observed that the variations of excess enthalpy values are positive in present the binary liquid mixtures. The positive variation indicates strong interaction[18].**Fig-3** represents the variations of excess free volume (V_f^E) with the molefractions of aniline. It is observed from **Fig-3** is that, V_fE values are negative over the entire molefraction 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 interactions19 between component molecules such as hydrogen bonding, dipole-dipole interactions and other specific interactions between unlike molecules are operative in the system.

CONCLUSIONS

Ultrasonic velocity, density and viscosity values are measured in the binary liquid mixtures containing aniline with toluene at temperatures T=(303.15,308.15,313.15 and 318.15)K. By using these values, excess acoustical parameters such as excess intermolecular freelength (L_f^E), excess adiabatic compressibility (β^E), excess acoustic impedance (Z^E) and excess ultrasonic velocity (U^E) are obtained over the entire molefraction range of aniline. An analysis of these results suggests the presence of strong intermolecular interactions20,21 in the present binary liquid mixtures. Also the strength of intermolecular interactions is observed to be decreased in the present binary system with temperature.

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