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Study and analysis of thermoacoustic parameters of petrochemical product and its mixtures at different temperatures from 298.15K to 318.15K

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ABSTRACT

The density, viscosity, surface tension and ultrasonic velocity have been measured in the binary mixture of gasoline with ethanol at five temperatures from 298.15 to 318.15K having difference of 5K. From these values the parameters like salvation number (Sn), relative association (R_A), ultrasonic relaxation time (τ_u), dielectric relaxation time (τ_{Di}), excess adiabatic compressibility (β_{ad}^E), and excess volume (V^E) have been calculated. These acoustic and thermodynamic parameters have been used to discuss the presence of significant interactions between the component molecules in the binary mixtures

Keyword: Ultrasonic velocity, Binary mixtures and Intermolecular interaction.

INTRODUCTION

The lifeline of a country depends on its communicational/ transportation infrastructure facilities. The support system of this communication/ transportation is basically divided into three parts, namely Land, Air and Marine. The heart of all transportation modes in all the three areas is the most important petrochemical product i.e. gasoline fuel. But in the recent year we all face the main problem of decreasing of natural occurring crude oil from which we obtained gasoline and increase in earth pollution due to combustion engine gasoline. To overcome this problem many scientist work on alternative or additive fuel which solve both problem, the product of research come forward that ethanol is one of the best additive in gasoline. As ultrasonic technique have been found to be more powerful and comprehensive tool in understanding the solute-solvent interaction,[1-3] derived parameters from ultrasonic velocity measurement and the corresponding excess functions of gasoline, ethanol and its mixtures have been provide qualitative information regarding the nature of association, the molecular pacing, molecular motion, and various types of intermolecular interactions.[4-9] Therefore, this work was undertaken in order to understand possible association and intermolecular interaction in gasoline-ethanol.

MATERIALS AND METHODS

Experimental

Ultrasonic interferometer model F-81 of fixed frequency 2 MHz having accuracy ±.03% and hydrostatic plunger method having accuracy ±.05% were used for measurement of ultrasonic velocity and density, similarly Ostwald viscometer having accuracy ±.01% and stalognometer method having accuracy ±.02% were used for measurement of viscosity and surface tension of different percentage of volume concentration of ethanol from 5%, 10%,-----,95% in gasoline at different temperatures. The calibration of the apparatus was done with air and deionizer double-distilled water.

RESULTS AND DISCUSSION

The values of salvation number (S_n), relative association (R_A), ultrasonic relaxation time (τ_u), dielectric relaxation time (τ_{Di}), excess adiabatic compressibility (β_{ad}^E), and excess volume (V^E) have been calculated using following formulae

$$S_n = \frac{n_1}{n_2}\left(1 - \frac{\beta_{ad}}{\beta_{ad}^0}\right) \qquad \text{----------------1}$$

$$R_A = \left(\frac{\rho}{\rho_0}\right)\left(\frac{u_0}{u}\right)^{1/3} \qquad \text{---------2}$$

$$\tau_u = \frac{4\eta}{3\rho u^2} \qquad \text{----------3}$$

$$\tau_{Di} = \frac{3b\eta}{4NKT} \qquad \text{-------------4}$$

$$\beta_{ad}{}^{E} = \beta_{ad\ (Expt)} - \beta_{ad\ (Idea)} \qquad \text{------5}$$

$$V^E = V_{(Expt).} - V_{(Ideal)} \qquad \text{---------6}$$

Table: 1 Solvation Number (S_n), Relative Association (R_A), Ultrasonic Relaxation Time (τ_u), Dielectric Relaxation Time (τ_{Di}), Excess Adiabatic Compressibility (β_{ad}^E) cm^2 $dyne^{-1}$ and Excess Volm. (V^E) cm^3 mol^{-1}

Conc. x %	S_n	R_A	τ_u	τ_{Di}	(β_{ad}^E) cm^2 $dyne^{-1}$	(V^E) cm^3 mol^{-1}
298.15K						
10	0.039903	1.00786	8.73E-11	2.46E-05	-3.715E-14	-7.193E-02
20	0.036205	1.01656	9.59E-11	2.38E-05	-1.293E-13	-1.373E-01
30	0.031458	1.02498	1.04E-10	2.33E-05	-1.655E-13	-1.799E-01
40	0.026815	1.03352	1.12E-10	2.28E-05	-1.909E-13	-2.059E-01
50	0.022002	1.04150	1.2E-10	2.24E-05	-1.359E-13	-2.084E-01
60	0.017581	1.05044	1.28E-10	2.21E-05	-1.537E-13	-2.033E-01
70	0.012986	1.05827	1.35E-10	2.19E-05	-4.004E-14	-1.713E-01
80	0.008628	1.06719	1.43E-10	2.17E-05	-9.997E-15	-1.321E-01
90	0.004255	1.07500	1.5E-10	2.15E-05	-1.461E-13	-6.881E-02
303.15K						
10	0.058590	1.00819	8.73E-11	2.34E-05	-2.144E-13	-8.268E-02
20	0.048456	1.01640	9.53E-11	2.26E-05	-3.332E-13	-1.446E-01
30	0.041056	1.02459	1.03E-10	2.20E-05	-4.195E-13	-1.876E-01
40	0.034438	1.03277	1.11E-10	2.15E-05	-4.742E-13	-2.123E-01
50	0.028206	1.04094	1.18E-10	2.11E-05	-4.982E-13	-2.190E-01
60	0.022228	1.04910	1.25E-10	2.08E-05	-4.923E-13	-2.084E-01
70	0.016444	1.05724	1.32E-10	2.05E-05	-4.573E-13	-1.808E-01
80	0.010822	1.06537	1.39E-10	2.03E-05	-3.941E-13	-1.367E-01
90	0.005345	1.07349	1.45E-10	2.01E-05	-3.033E-13	-7.638E-02
308.15K						
10	0.058590	1.00774	8.62E-11	2.39E-05	-4.191E-13	-8.332E-02
20	0.048456	1.01575	9.35E-11	2.45E-05	-5.433E-13	-1.459E-01
30	0.041056	1.02374	1.01E-10	2.47E-05	-6.278E-13	-1.894E-01
40	0.034438	1.03171	1.07E-10	2.46E-05	-6.736E-13	-2.143E-01
50	0.028206	1.03967	1.14E-10	2.42E-05	-6.820E-13	-2.212E-01
60	0.022228	1.04762	1.2E-10	2.36E-05	-6.539E-13	-2.105E-01
70	0.016444	1.05555	1.27E-10	2.26E-05	-5.903E-13	-1.826E-01
80	0.010822	1.06346	1.33E-10	2.14E-05	-4.924E-13	-1.380E-01
90	0.005345	1.07137	1.38E-10	1.99E-05	-3.609E-13	-7.713E-02
313.15K						
10	0.055039	1.00796	8.54E-11	2.24E-05	-1.681E-13	-8.441E-02
20	0.049313	1.01570	9.19E-11	2.28E-05	-3.693E-13	-1.474E-01
30	0.042921	1.02343	9.82E-11	2.29E-05	-5.207E-13	-1.912E-01
40	0.036479	1.03114	1.04E-10	2.27E-05	-6.240E-13	-2.163E-01
50	0.030107	1.03883	1.1E-10	2.23E-05	-6.805E-13	-2.232E-01
60	0.023840	1.04650	1.16E-10	2.16E-05	-6.917E-13	-2.124E-01
70	0.017694	1.05416	1.21E-10	2.07E-05	-6.589E-13	-1.843E-01
80	0.011671	1.06180	1.26E-10	1.95E-05	-5.834E-13	-1.393E-01
90	0.005773	1.06943	1.31E-10	1.81E-05	-4.665E-13	-7.793E-02
318.15K						
10	0.067781	1.00729	8.415E-11	2.10E-05	-5.002E-13	-8.463E-02
20	0.056523	1.01483	8.983E-11	2.12E-05	-6.696E-13	-1.480E-01
30	0.047990	1.02235	9.529E-11	2.12E-05	-7.808E-13	-1.921E-01
40	0.040267	1.02985	1.005E-10	2.09E-05	-8.358E-13	-2.174E-01
50	0.032969	1.03734	1.056E-10	2.04E-05	-8.363E-13	-2.244E-01
60	0.025963	1.04480	1.104E-10	1.97E-05	-7.840E-13	-2.135E-01
70	0.019190	1.05225	1.151E-10	1.88E-05	-6.806E-13	-1.853E-01
80	0.012617	1.05968	1.195E-10	1.77E-05	-5.275E-13	-1.401E-01
90	0.006225	1.06709	1.238E-10	1.64E-05	-3.264E-13	-7.842E-02

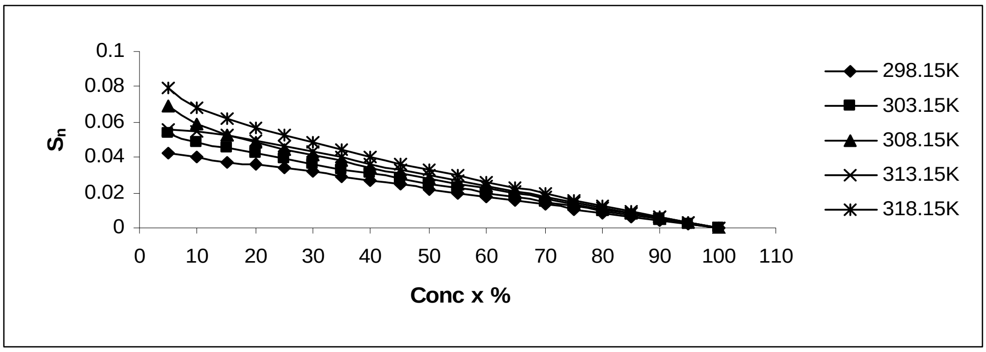

Fig. 1 Solvation Number (S_n) verses volume concentration x %

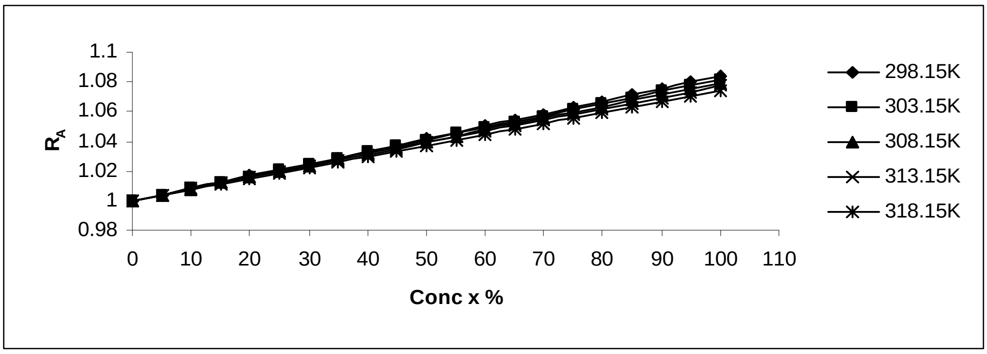

Fig. 2 Relative Association (R_A) verses volume concentration x %

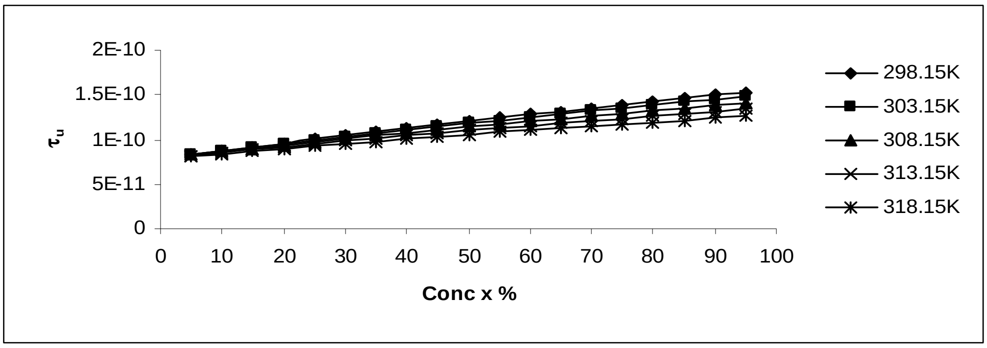

Fig. 3 Ultrasonic Relaxation Time (τ_u) verses volume concentration x %

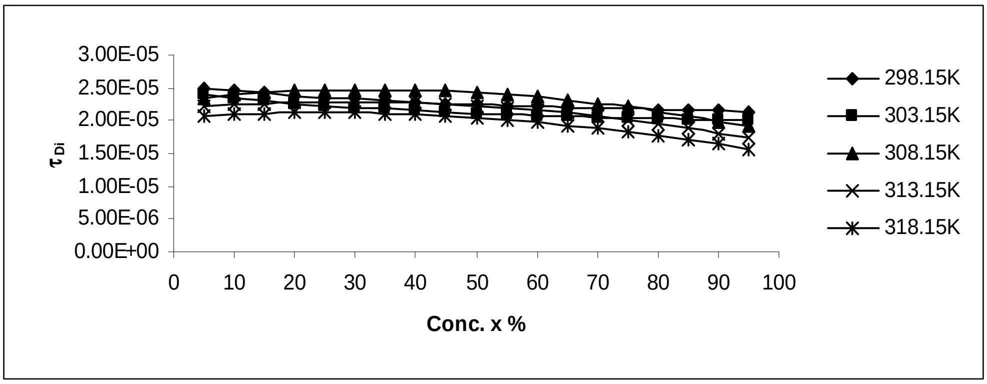

Fig. 4 Dielectric Relaxation Time (τ_{Di}) verses volume concentration x %

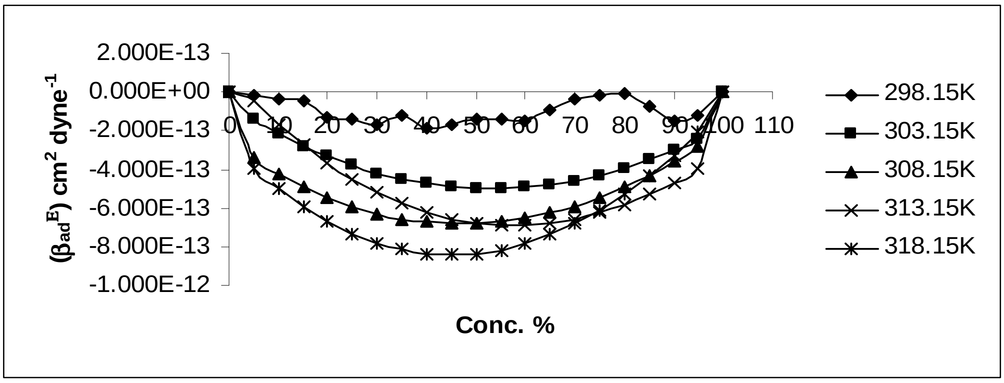

Fig. 5 Excess Adiabatic Compressibility (β_{ad}^{E}) verses volume concentration x %

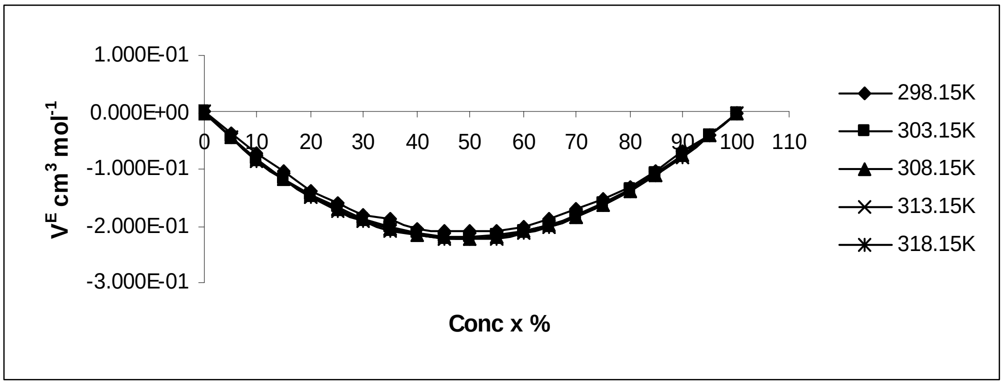

Fig. 6 Excess Volume (V^E) verses volume concentration x %

Fig. 1 has shown the variation of salvation number (S_n) with percentage volume of mixture at all five temperatures. The value S_n decrease with increase in percentage volume which suggest that ethanol are preferentially solvated by gasoline The positive salvation number of solution suggests that the compressibility of the solution will be less than that of solvent Fig. 2 exhibits the variation of relative association (R_A) with percentage volume of mixture at five different temperatures which increased linearly. The increase in R_A with concentration suggests that salvation of ions predominates over the breaking up of the solvent aggregates on addition substance. Fig. 3 and 4 showed variation of excess relaxation time (τ_u) and excess dielectric relaxation time (τ_{Di}). At all temperatures, the variation of τ_u positive and variation of τ_{Di} negative with percentage volume concentration of mixtures. Fig. 5 and 6 showed the variation of excess adiabatic compressibility and excess volume with percentage volume of mixture at five different temperatures. The fig.1.6 shows negative variation of $\beta_{ad}{}^{E}$ and V^E with increased of percentage volume of mixture at all temperatures indicate an attractive hetromolecular AB interaction leading to association of the molecules.

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