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Thermoacoustic Characterization of Gasoline and Its Binary Mixtures with Ethanol

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ABSTRACT

The temperature dependent parameters such as ultrasonic velocity, density, viscosity and surface tension and have been measured at five temperatures from 298.15 to 318.15K having difference of 5K of the binary mixtures of gasoline with ethanol, at different volume concentration. From these values the parameters like Rao's Constant (R), Wada Constant (W), van der Wall's Constant (b) and Free Energy of Activation (ΔE) like solvation number 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.

I. INTRODUCTION

Among the entire petroleum product Gasoline is one of the important product. In the recent years we all face the main problem of decreasing natural occurring crude oil from which we obtained gasoline, to overcome this problem groups of scientist tried to search an alternative or additive fuel addictive of gasoline which is giving no effect on working of gasoline. They found that Ethanol is one of the best additives of Gasoline, and hence it is necessary to study interaction of Gasoline with Ethanol at microscopic level.

The ultrasonic measurement technique has been widely used for characterizing binary mixtures solution. It is due to it's non-destructively analysis of the mixtures that are optically opaque and unlike X-ray or gamma ray hence it have many application[1]. Along with the ultrasonic velocity, data on other properties associated with liquids and liquid mixtures like density, viscosity and surface tension are important. All those properties are helpful to study different elastic properties of the molecule from which the type of molecular interaction in system can be very well understood.[2-6] Ultrasonic velocity has proved to be useful in understanding the physico-chemical behavior of the understudy system.[7-12]

II. EXPERIMENTAL

Ultrasonic interferometer model F-81 of fixed frequency 2 MHz having accuracy $\pm$ .03% and hydrostatic plunger method having accuracy $\pm$ .05% were used for measurement of ultrasonic velocity and density, similarly Ostwald viscometer having accuracy $\pm$ .01% and stalognometer method having accuracy $\pm$ .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.

III. RESULTS AND DISCUSSION

The values of Rao's Constant (R), Wada Constant (W), van der Wall's Constant (b) and Free Energy Of Activation (Δ E) have been calculated using following formulae

$$R = u^{1/3} \times V \quad \text{----------1}$$

$$W = \left(\frac{M}{\rho}\right) \times \beta_{ad}^{-1/7} \quad \text{--}$$

$$b = \frac{M}{\rho}\left[1 - \frac{RT}{Mu^2}\left(\sqrt{1 + \frac{Mu^2}{3RT}} - 1\right)\right] \quad \text{----------3}$$

Where, R is gas constant.

$$\Delta E = \text{Slope} \times R \times 2.45 \quad \text{----------4}$$

Table 1. Rao Constant (R)

x %	298.15K	303.15K	308.15K	313.15K	318.15K
5	7045.644	7044.519	7043.130	7035.990	7037.182
10	6536.640	6534.951	6534.175	6528.327	6530.084
15	6096.644	6094.477	6094.261	6089.547	6091.789
20	5708.615	5709.937	5710.232	5706.520	5709.182
25	5369.857	5371.311	5372.075	5369.253	5372.283
30	5068.580	5070.840	5072.032	5070.008	5073.361
35	4802.027	4802.419	4804.004	4802.698	4806.338
40	4557.558	4561.179	4563.126	4562.468	4566.364
45	4340.150	4343.190	4345.470	4345.401	4349.528
50	4142.725	4145.246	4147.834	4148.302	4152.635
55	3961.077	3964.702	3967.575	3968.534	3973.056
60	3794.230	3799.361	3802.499	3803.909	3808.601
65	3643.264	3647.380	3650.764	3652.590	3657.437
70	3503.557	3507.202	3510.815	3513.026	3518.016
75	3372.972	3377.504	3381.332	3383.898	3389.018
80	3251.382	3257.153	3261.181	3264.077	3269.318
85	3140.282	3145.173	3149.388	3152.592	3157.944
90	3036.253	3040.720	3045.112	3048.603	3054.057
95	2935.979	2943.060	2947.617	2951.376	2956.925

Table 2. Wada Constant (W)

x %	298.15K	303.15K	308.15K	313.15K	318.15K
5	3866.742	3866.213	3865.546	3862.178	3862.740
10	3589.437	3588.641	3588.253	3585.487	3586.316
15	3349.721	3348.700	3348.570	3346.334	3347.391
20	3138.599	3139.222	3139.330	3137.563	3138.819
25	2954.064	2954.749	2955.078	2953.729	2955.159
30	2789.991	2791.057	2791.588	2790.615	2792.198
35	2644.635	2644.820	2645.538	2644.903	2646.623
40	2511.677	2513.387	2514.277	2513.950	2515.791
45	2393.180	2394.617	2395.667	2395.619	2397.570

50	2285.572	2286.764	2287.963	2288.169	2290.219
55	2186.672	2188.387	2189.724	2190.165	2192.305
60	2095.862	2098.291	2099.757	2100.413	2102.634
65	2013.522	2015.471	2017.057	2017.912	2020.208
70	1937.353	1939.080	1940.778	1941.816	1944.181
75	1866.247	1868.397	1870.199	1871.409	1873.836
80	1800.065	1802.804	1804.705	1806.073	1808.559
85	1739.448	1741.770	1743.764	1745.280	1747.820
90	1682.715	1684.837	1686.918	1688.572	1691.162
95	1628.237	1631.603	1633.766	1635.550	1638.186

Table 3. van der Wall's Constant (b) L mol^{-1}

x %	**298.15K**	**303.15K**	**308.15K**	**313.15K**	**318.15K**
5	1.461E-01	1.469E-01	1.477E-01	1.486E-01	1.495E-01
10	1.355E-01	1.362E-01	1.370E-01	1.378E-01	1.386E-01
15	1.264E-01	1.270E-01	1.277E-01	1.284E-01	1.292E-01
20	1.183E-01	1.189E-01	1.196E-01	1.203E-01	1.210E-01
25	1.112E-01	1.118E-01	1.124E-01	1.131E-01	1.137E-01
30	1.050E-01	1.055E-01	1.061E-01	1.067E-01	1.073E-01
35	9.941E-02	9.988E-02	1.004E-01	1.010E-01	1.016E-01
40	9.432E-02	9.482E-02	9.536E-02	9.589E-02	9.646E-02
45	8.980E-02	9.025E-02	9.076E-02	9.126E-02	9.181E-02
50	8.569E-02	8.610E-02	8.659E-02	8.706E-02	8.759E-02
55	8.191E-02	8.232E-02	8.278E-02	8.324E-02	8.373E-02
60	7.843E-02	7.885E-02	7.929E-02	7.973E-02	8.021E-02
65	7.529E-02	7.567E-02	7.609E-02	7.651E-02	7.696E-02
70	7.238E-02	7.273E-02	7.313E-02	7.353E-02	7.397E-02
75	6.966E-02	7.001E-02	7.040E-02	7.078E-02	7.121E-02
80	6.713E-02	6.748E-02	6.786E-02	6.823E-02	6.864E-02
85	6.482E-02	6.514E-02	6.550E-02	6.586E-02	6.625E-02
90	6.265E-02	6.295E-02	6.330E-02	6.364E-02	6.402E-02
95	6.057E-02	6.090E-02	6.124E-02	6.157E-02	6.194E-02

Table 4. Free Energy of Activation (ΔE) J mol^{-1}

x %	**ΔE**
5	7928.89
10	8501.02
15	8969.87
20	9442.40
25	9824.95
30	10180.52

35	10543.43
40	10844.25
45	11122.95
50	11401.56
55	11645.83
60	11884.87
65	12108.53
70	12304.60
75	12498.79
80	12684.79
85	12875.68
90	13025.26
95	13170.94

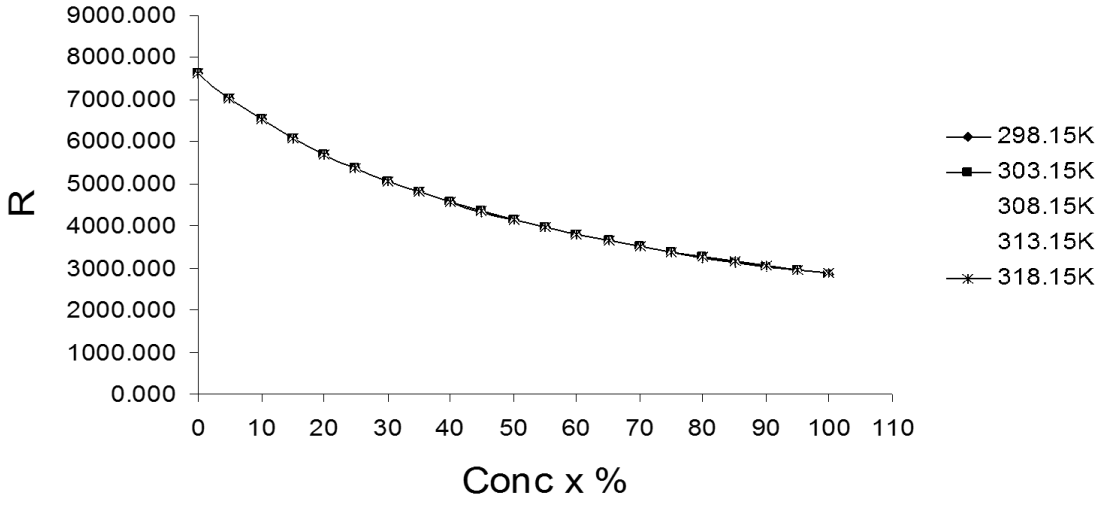

Figure 1. Volume conc. x % versus Rao constant (R)

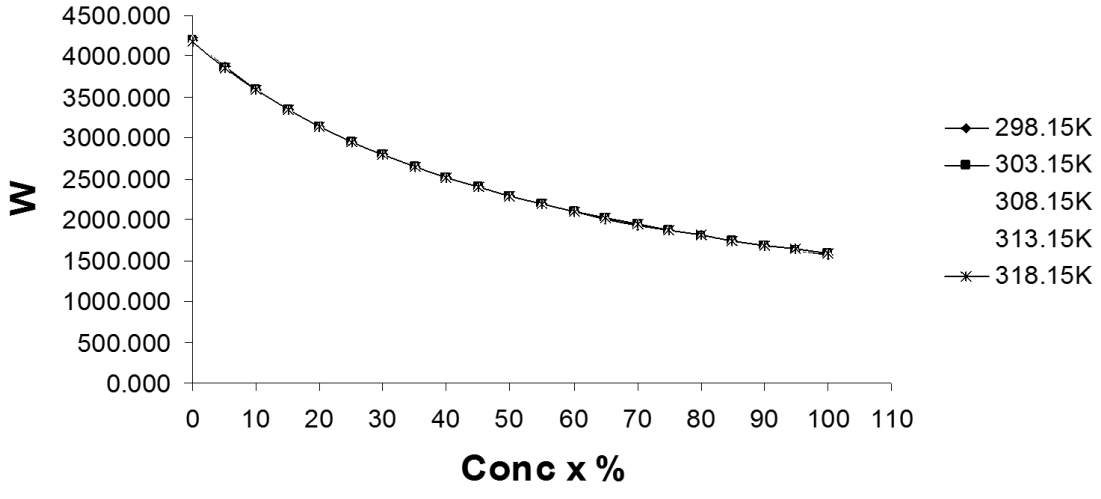

Figure 2. Volume conc. x % versus Wada constant (W)

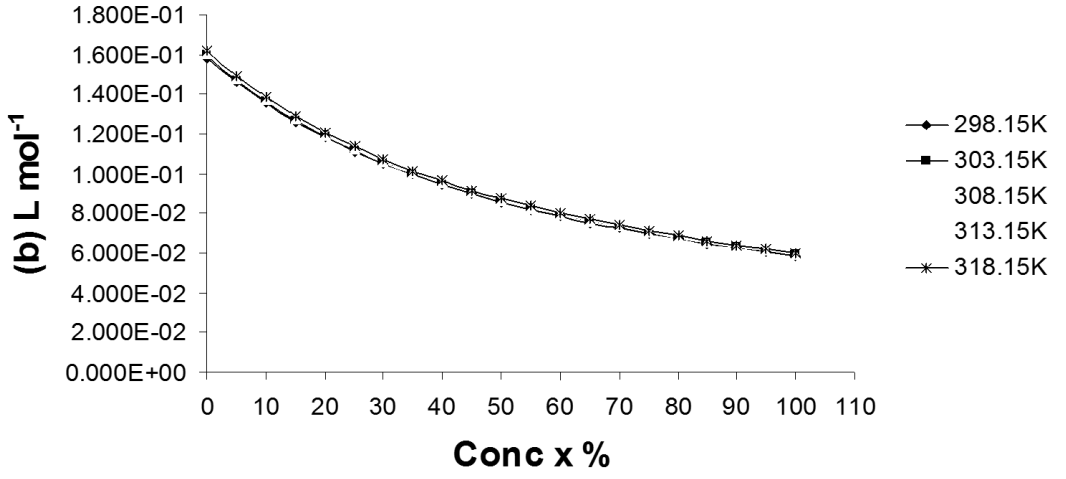

Figure 3. Volume conc. x % versus van dar Wall's constant (b)

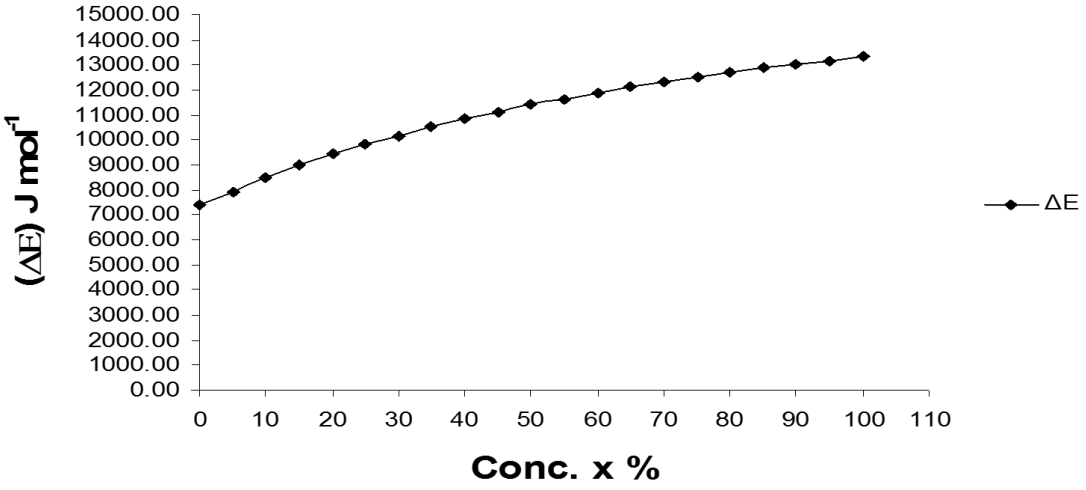

Figure 4. Volume conc. x % versus Free Energy of Activation (Δ E)

Figure 1, Figure 2 and Figure 3 showed the variation of Rao constant (R), Wada constant (W), and van dar Wall's constant (b), with percentage volume of mixtures at all temperatures. It has been found that R, W and b significantly decrease with increase of percentage concentration and it is independent of temperature.

The variation of free energy of activation (Δ E) with percentage volume of mixtures showed in Fig. 4. It has been found that Δ E increased as increase of percentage volume of mixture.

IV. CONCLUSION

It seemed that the dissociation effect is more pronounced in the solution having higher concentration of ethanol. The energy of activation also gives the similar kind of indication.

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