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Thermoacoustic Study of Binary Liquid Mixtures of Hydrocarbon and Fuel Oil

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Abstract: ***Thermodynamic studies like ultrasonic velocity, density, viscosity and surface tension in the binary mixture of gasoline+2T fuel oil have been measured in the volume concentration at temperatures 298.15K to 318.15K. Thermodynamic parameters apparent Molar Compressibility (Φk), Relative Association (R_A), Solvation Number (S_n), Rao Constant (R), Wada Constant (W) and van der Wall's Constant (b) have been computed from experimental findings.. These acoustic and thermodynamic parameters found to be sensitive to the nature and the results are interpreted in terms of the interactions taking place in these binary mixtures.***

Keyword: Ultrasonic velocity, Acoustic parameter and Molecular association interaction.

1. Introduction

Gasoline is produced in oil refineries. Material that is separated from crude oil via distillation, called virgin or straight-run gasoline, does not meet the required specifications for modern engines (in particular octane rating; see below), but will form part of the blend. The bulk of a typical gasoline consists of hydrocarbons with between 5 and 12 carbon atoms per molecule. In air-cooled applications, two-stroke cycle engines require an oil to provide reliable lubrication during high engine temperatures and under the most severe operating conditions. 2T Oils are formulated with 100 percent synthetic fluids. Today's lubricants must meet the performance demands of high-powered professional and recreational outdoor equipment including string trimmers, leaf blowers, snow blowers, snowmobiles, mopeds, motorcycles, outboard marine engines and all-terrain vehicles. We offer premium additive systems designed to enhance the lubrication performance of quality base stocks in the extreme environment of the two-stroke cycle, air-cooled engine

Industry demands reliable and accessible reference data on the physical and chemical properties of a wide variety of liquid mixtures. These data are required in the development of models for process design, energy efficiency and in the evaluation of possible environmental impacts. Ultrasonic methods have the added advantage of being less costly with efficiency comparable to other methods hence it plays an important role to understanding the physicochemical behavior of binary liquid mixtures [1-12].

2. Experiment

The sample of gasoline used was obtain from the Bharat petrol pump which is run by company itself, the samples of 2T-fual oils used is meets the specification of API TC (formerly API TSC-3) and standard of JASO FC Specification, which was obtain from their related companies dealer so we obtain pure sample up to high level. The samples of different concentrations were prepared by mixing the components in volume proportions of liquids 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. Densities of the experimental liquids can also be measured by the hydrostatic plunger method. A cell is designed and fabricated specially for this purpose. It consists of double walled, cylindrical glass vessel of length 12 cm, inner diameter 1.7 cm and an outer diameter 3 cm with inlet and outlet. A small glass tube of length 3.2 cm and diameter 0.7 cm sealed with a glass hook at the upper end filled with mercury is used as a plunger.

3. Result and Discussion

The experimentally measured values of density and ultrasonic velocity for the mixtures at 298.15, 303.15, 308.15, 313.15 and 318.15 K. This parameter used to compute the thermo-acoustic parameter given in bellow using equations [13-21]. The values of apparent Molar Compressibility (Φk), relative Association (R_A), solvation Number (S_n), Rao Constant (R), wada Constant (W) and van der Wall's Constant (b) are depicted in table-1.

$$\Phi_K = \left(\rho_0\beta_{ad} - \rho\beta^0_{ad}\right)\times\frac{1000}{\rho_0 C} + \frac{\beta^0_{ad}M_2}{\rho_0} \quad .....(1)$$

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

$$S_n = \frac{n_1}{n_2}\left(1-\frac{\beta_{ad}}{\beta^0_{ad}}\right) \quad .....(3)$$

$$R = u \times \rho \quad ....(4)$$

$$W = \left(\frac{M}{\rho}\right) \times \beta_{ad}^{-1/7} \quad ....(5)$$

$$b = \frac{M}{\rho}\left[1-\frac{RT}{Mu^2}\left(\sqrt{1+\frac{Mu^2}{3RT}}-1\right)\right] \quad .....(6)$$

Table 1: Apparent Molar Compressibility (Φk), Relative Association (R_A), Solvation Number (S_n), Rao Constant (R), Wada Constant (W) and van der Wall᾽s Constant (b).

Conc. x %	Φk	R_A	S_n	R	W	b L Mol^{-1}
298.15K						
1	3.828E-08	1.002488	0.334896	7863.091	4314.528	1.630E-01
2	3.812E-08	1.003649	0.298314	8087.707	4438.510	1.675E-01
3	3.796E-08	1.004810	0.283456	8304.246	4558.099	1.718E-01
4	3.780E-08	1.005971	0.274055	8513.099	4673.506	1.760E-01
5	3.764E-08	1.007131	0.266861	8714.629	4784.929	1.800E-01
6	3.748E-08	1.008290	0.260786	8909.179	4892.555	1.838E-01
7	3.733E-08	1.009449	0.255368	9097.070	4996.557	1.875E-01
8	3.718E-08	1.010607	0.250372	9278.605	5097.100	1.911E-01
9	3.703E-08	1.011765	0.245670	9454.069	5194.339	1.946E-01
303.15K						
10	3.688E-08	1.012923	0.241183	9623.728	5288.418	1.979E-01
1	4.005E-08	1.002343	0.334331	7864.763	4315.314	1.639E-01
2	3.988E-08	1.003492	0.299256	8089.523	4439.365	1.684E-01
3	3.971E-08	1.004641	0.284866	8306.211	4559.023	1.728E-01
4	3.954E-08	1.005789	0.275677	8515.213	4674.501	1.770E-01
5	3.938E-08	1.006937	0.268590	8716.896	4785.996	1.810E-01
6	3.921E-08	1.008084	0.262572	8911.601	4893.695	1.849E-01
7	3.905E-08	1.009231	0.257181	9099.650	4997.771	1.886E-01
8	3.889E-08	1.010378	0.252195	9281.344	5098.390	1.922E-01
9	3.873E-08	1.011524	0.247491	9456.969	5195.705	1.957E-01
10	3.858E-08	1.012670	0.242994	9626.791	5289.861	1.990E-01
308.15K						
1	4.211E-08	1.002609	0.348606	7858.602	4312.416	1.648E-01
2	4.192E-08	1.003737	0.308440	8083.361	4436.466	1.694E-01
3	4.174E-08	1.004864	0.292296	8300.061	4556.130	1.738E-01
4	4.156E-08	1.005991	0.282187	8509.090	4671.620	1.780E-01
5	4.139E-08	1.007118	0.274515	8710.813	4783.133	1.820E-01
6	4.121E-08	1.008244	0.268081	8905.570	4890.856	1.859E-01
7	4.104E-08	1.009370	0.262370	9093.682	4994.962	1.897E-01
8	4.087E-08	1.010496	0.257125	9275.451	5095.615	1.933E-01
9	4.070E-08	1.011621	0.252203	9451.160	5192.969	1.968E-01
10	4.054E-08	1.012746	0.247518	9621.077	5287.170	2.002E-01
313.15K						
1	4.423E-08	1.002315	0.343639	7855.754	4311.077	1.658E-01
2	4.404E-08	1.003423	0.307930	8080.582	4435.159	1.704E-01
3	4.384E-08	1.004532	0.293218	8297.362	4554.860	1.748E-01
4	4.365E-08	1.005640	0.283787	8506.480	4670.392	1.790E-01
5	4.347E-08	1.006748	0.276491	8708.300	4781.951	1.831E-01
6	4.328E-08	1.007855	0.270283	8903.164	4889.723	1.870E-01
7	4.310E-08	1.008963	0.264714	9091.390	4993.883	1.908E-01
8	4.292E-08	1.010070	0.259557	9273.281	5094.593	1.945E-01
9	4.274E-08	1.011176	0.254688	9449.118	5192.007	1.980E-01
10	4.256E-08	1.012282	0.250032	9619.170	5286.271	2.013E-01
318.15K						
1	4.648E-08	1.002581	0.359397	7850.550	4308.629	1.668E-01
2	4.627E-08	1.003673	0.317591	8075.372	4432.707	1.714E-01
3	4.607E-08	1.004764	0.300796	8292.157	4552.411	1.758E-01
4	4.587E-08	1.005855	0.290285	8501.292	4667.950	1.801E-01
5	4.567E-08	1.006945	0.282312	8703.140	4779.522	1.842E-01
6	4.547E-08	1.008036	0.275629	8898.041	4887.312	1.881E-01
7	4.528E-08	1.009126	0.269700	9086.315	4991.493	1.919E-01
8	4.509E-08	1.010216	0.264256	9268.261	5092.229	1.956E-01
9	4.490E-08	1.011305	0.259150	9444.164	5189.674	1.991E-01
10	4.471E-08	1.012395	0.254291	9614.288	5283.971	2.025E-01

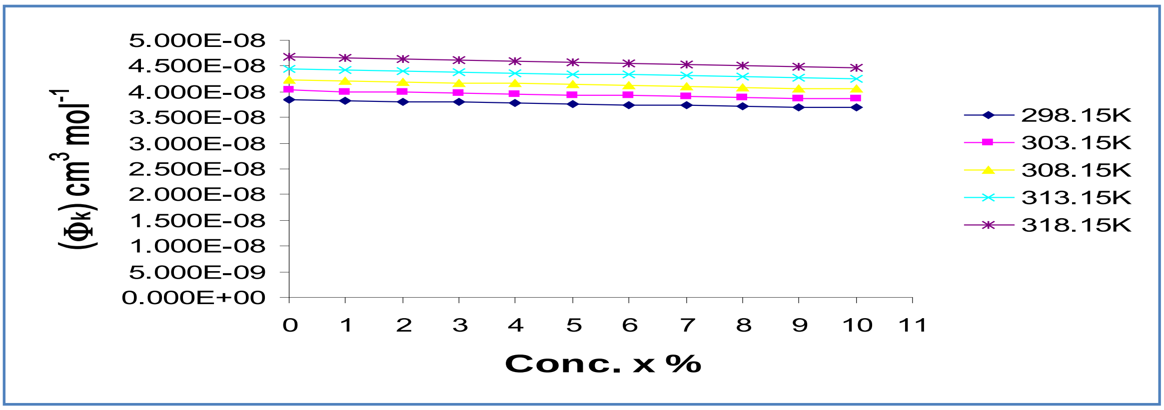

Figure 1: Volume conc. x % versus Apparent Molar Compressibility (Φ_K)

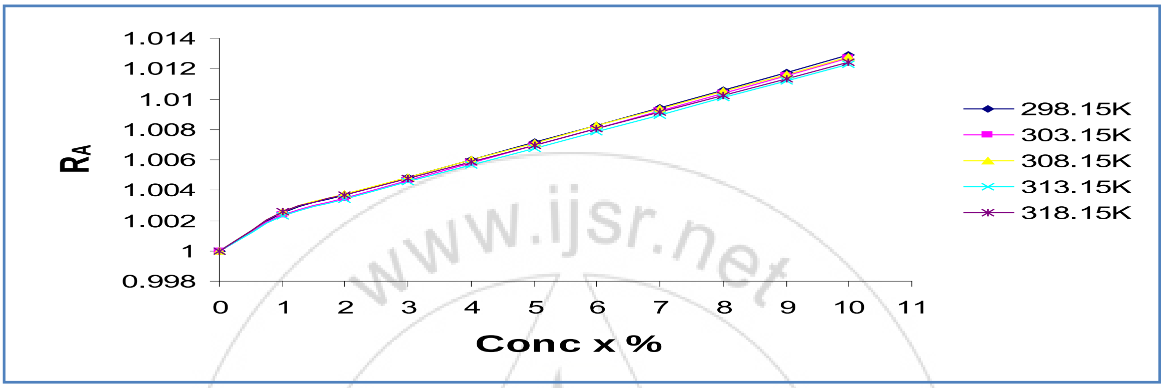

Figure 1.2: Volume conc. x % versus Relative Association (R_A)

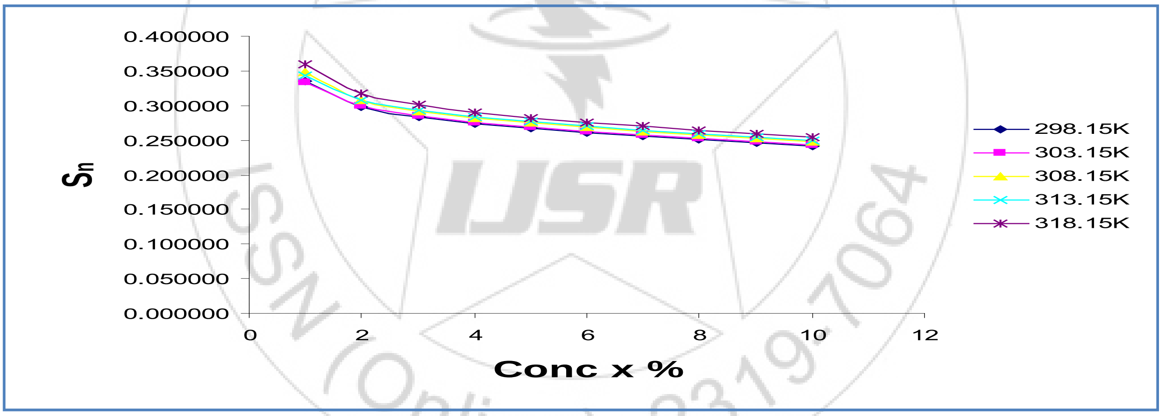

Figure 5.4.7: Volume conc. x % versus Solvation Number (S_n)

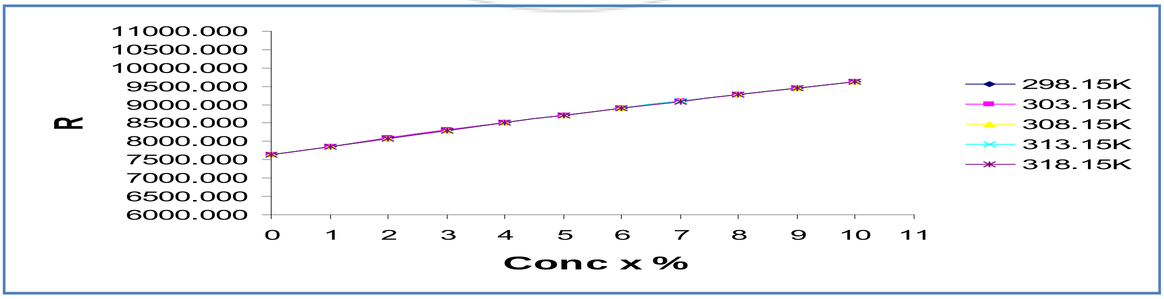

Figure 1.3: Volume conc. x % versus Rao constant (R)

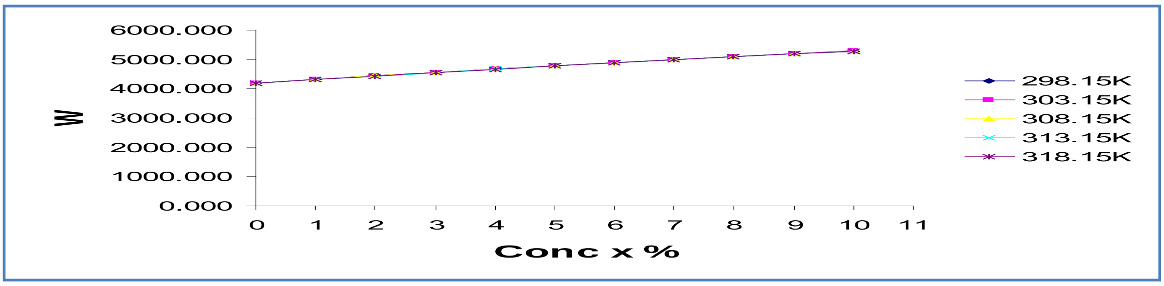

Figure 1.4: Volume conc. x % versus Wada constant (W)

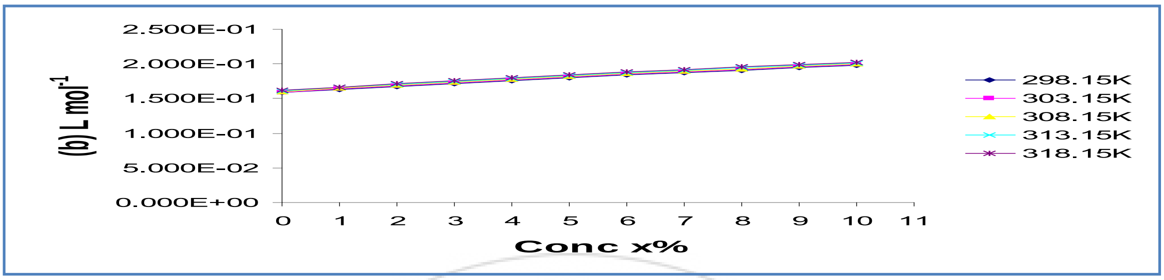

Figure 5.4.10: Volume conc. x % versus van dar Wall's constant (b)

The apparent molar compressibility (Φk) which decreased linearly with percentage volume concentration of mixtures at all five different temperatures have been shown in fig. 1.1.The positive value of Φ_K shows strong electrostatic force in the vicinity of ion, causing electrostatic solution in ions. Fig. 1.2 reveals 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. The variation of salvation number (S_n) with percentage volume concentration of mixture at five all five temperatures exhibit in fig. 1.3. The value S_n decrease with increase in percentage volume and temperatures. The positive salvation number of solution suggests that the compressibility of the solution will be less than that of solvent.

Fig. 1.4, 1.5 and 1.6 showed the variation of Rao constant (R), Wada constant (W), and van dar Wall's constant (b), with percentage volume of mixture at all five temperatures. It has been found that R, W and b significantly increase with increase of percentage volume concentration of mixtures and it is independent of temperature.

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