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Ultrasonic Study of Theoretical and Experimental Free Length of Binary Liquid Mixtures

Ajay R. Chaware
Department of Applied Physics, S.D. College of Engineering, Wardha, India

ABSTRACT

The density 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 study of free length between the molecules of mixture has been calculated using theoretical free length theory (FLT) and experimental method. These have been used to discuss the presence of significant interactions between the component molecules in the binary mixtures

Keyword : Ultrasonic velocity, Binary mixtures, FLT and Intermolecular interaction.

I. 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, in all the three areas, gasoline fuel is the heart of all transportation modes. 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 comparison of theoretical (FLT) and experimental free length of binary mixtures of gasoline, ethanol and its mixtures have been provide qualitative information regarding the various types of intermolecular interactions. Therefore, this work was undertaken in order to understand possible association and intermolecular interaction in gasoline-ethanol.

II. 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 of different percentage of volume concentration of ethanol from 10%, 20%,-----,100% in gasoline at different temperatures. The calibration of the apparatus was done with air and deionizer double-distilled water.

III. RESULTS AND DISCUSSION

Jacobson introduced the concept of intermolecular free length in order to explain ultrasonic velocity in pure liquids and liquid mixtures. By the knowledge of free length, certain properties of liquid which mainly depend upon the forces between the molecules such as surface tension, compressibility, viscosity, etc. can be obtained. This free length can be taken as the distance between the surfaces of two molecules

instead of the distance between the centers of attraction of molecules. Jacobson established a semi-empirical relation for the intermolecular free length.

$$L_f = \frac{2V_a}{Y} \quad \text{.....1.1}$$

$V_a = V_T - V_O$ 1.2

V_T being the molar volume at temperature T.

$Y = N \times (36\pi V_o^2)^{1/3}$ 1.3

and for non-spherical molecules,

$Y = f \times (36\pi V_o^2)^{1/3}$ 1.4

$$V_O = V_T \left(1 - \frac{T}{T_C}\right)^{1/3} \quad \text{.....1.5}$$

T_C is the critical temp of the liquid.

As we have,

$$\beta_a = \frac{1}{u^2 \rho} \quad \text{.....1.6}$$

$$\frac{1}{u^2 \rho} = A \times L^2 \quad \text{.....1.7}$$

from which we get

Table 1. Comparisons of Experimental And Theoretical (LFT) F_f

$$L = \frac{K}{u \times \rho^{1/2}} \quad \text{.....1.8}$$

where K is temp dependent constant.

For binary liquid mixtures,Jacobson extended the formula as

$$L_{Mix} = \frac{K}{u_{Mix} \times \rho_{Mix}^{1/2}} \quad \text{.....1.9}$$

$$L_{Mix} = \frac{V_m - (x_A V_O^A + x_B V_O^B}{x_A Y_A + x_B Y_B} \quad \text{.....1.10}$$

Table 1

Temp.	298.15K		303.15K		308.15K		313.15K		318.15K	
Conc x%	Lf(Expt)	Lf(Theo)	Lf(Expt)	Lf(Theo)	Lf(Expt)	Lf(Theo)	Lf(Expt)	Lf(Theo)	Lf(Expt)	Lf(Theo)
0	6.58E-09	6.60E-09	6.77E-09	6.78E-09	6.98E-09	6.97E-09	7.2E-09	7.17E-09	7.42E-09	7.38E-09
10	6.54E-09	6.43E-09	6.72E-09	6.58E-09	6.92E-09	6.78E-09	7.14E-09	6.97E-09	7.34E-09	7.18E-09
20	6.49E-09	6.25E-09	6.67E-09	6.41E-09	6.86E-09	6.60E-09	7.08E-09	6.79E-09	7.27E-09	6.99E-09
30	6.45E-09	6.09E-09	6.63E-09	6.24E-09	6.81E-09	6.43E-09	7.02E-09	6.61E-09	7.21E-09	6.81E-09
40	6.41E-09	5.94E-09	6.58E-09	6.09E-09	6.76E-09	6.27E-09	6.96E-09	6.45E-09	7.14E-09	6.64E-09
50	6.38E-09	5.80E-09	6.54E-09	5.94E-09	6.71E-09	6.12E-09	6.9E-09	6.30E-09	7.08E-09	6.49E-09
60	6.34E-09	5.66E-09	6.49E-09	5.81E-09	6.66E-09	5.98E-09	6.84E-09	6.16E-09	7.01E-09	6.34E-09
70	6.3E-09	5.55E-09	6.45E-09	5.68E-09	6.61E-09	5.85E-09	6.78E-09	6.02E-09	6.95E-09	6.20E-09
80	6.26E-09	5.42E-09	6.4E-09	5.56E-09	6.56E-09	5.73E-09	6.73E-09	5.90E-09	6.89E-09	6.08E-09
90	6.23E-09	5.32E-09	6.36E-09	5.44E-09	6.51E-09	5.61E-09	6.67E-09	5.78E-09	6.83E-09	5.95E-09
100	6.18E-09	5.19E-09	6.32E-09	5.34E-09	6.47E-09	5.50E-09	6.63E-09	5.67E-09	6.77E-09	5.84E-09

298.15

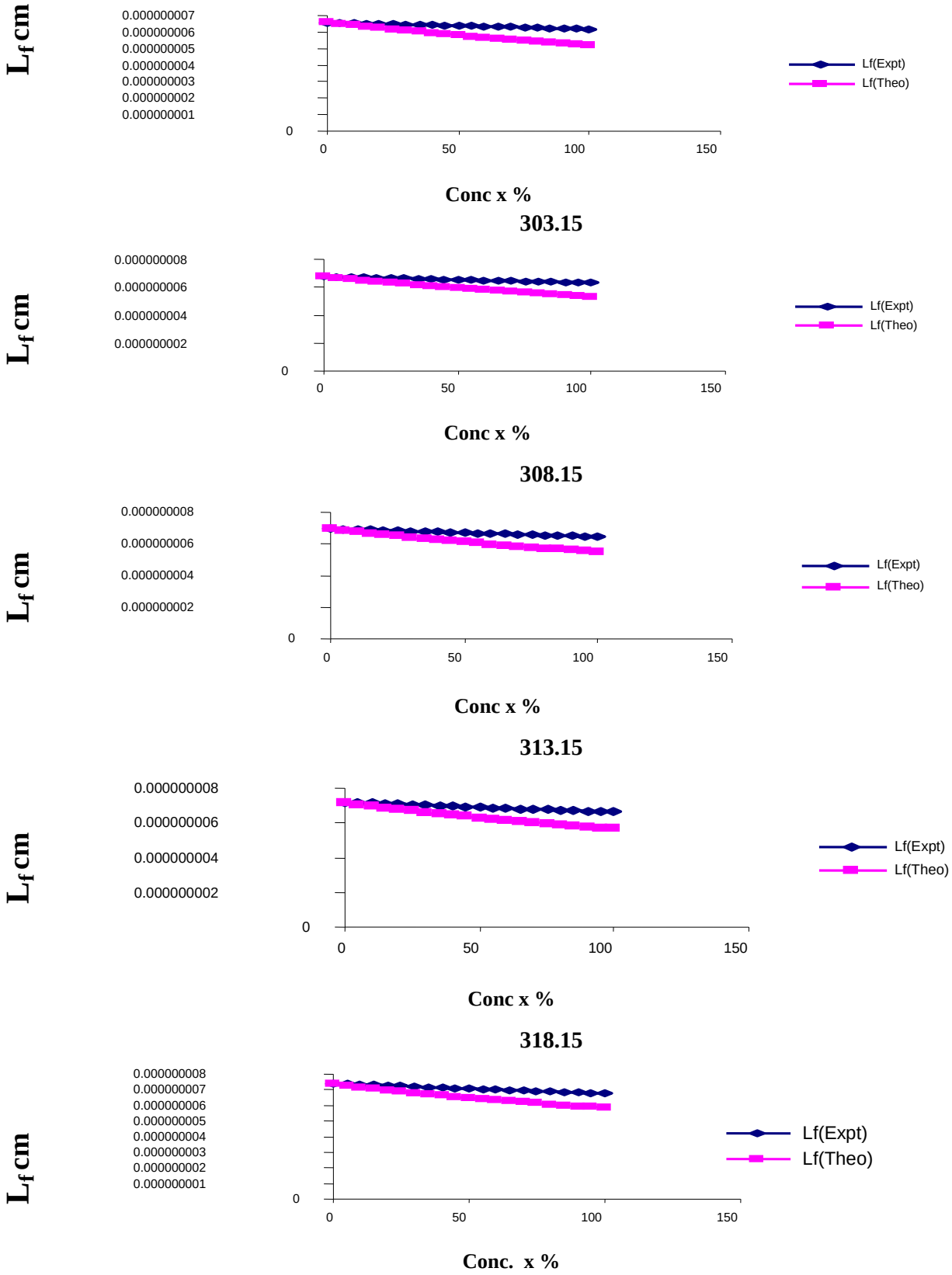

Figure 1. Volume conc. x % versus Comparisons of Experimental And Theoretical (LFT) L_f

Figure 1 has shown the variation of theoretical free length and experimental free length with percentage volume of mixture at all five temperatures. The small difference in theoretical and observed value of free length of mixture at five temperatures predicts that FLT well applicable to the above system which give leading to association of the molecules of the above binary mixtures.

IV. REFERENCES

[1]. Jacobson B, Acta Chem. Scand, 5(1951) 1214.

[2]. Jacobson B, Acta Chem. Scand, 6(1952) 1485.

[3]. D. Sarvana Kumar & D. Krishna Rao Indian J. of Pure & Appy. Phys. 45 (2007) 210.

[4]. S. Acharya, R. Paikray and G. C. Mohanty Ind. J. Pure & Appl. Phy., 41 (2003) 855-857.

[5]. Patki, Ind. J. Pure & Appl. Phy., 22 (1984) 447-452.

[6]. M Kalidas & SrinivasamoorthyR, Acoust Lett., 20 (1997) 213.

[7]. H. Iloukhani1 and Z. Rostami Journal of Solution Chemistry, 32 (2003) 451 – 462.

[8]. C. S. Adgaonkar & V. D. Gokhale, Ind. J. of Pure & Appl. Phy., 26 (1988) 577-578.

[9]. S. A. Ghosh and S. Agrawal, Ind. J. of Pure & Appl. Phy., 37 (1999) 583-586.