© 2017 IJSRST | Volume 3 | Issue 10 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
National Conference on Research and Developments in Synthetic Organic Chemistry

Density, Excess Molar Volumes of Water-Ethanol Binary Mixtures at Various Temperatures

Ramesh R. Pawar[1*], Sachin S. Kale[2], Atul S. Kale[3]

[1]Department of Chemistry, M.S.G. College, Malegaon camp, Nashik, Maharashtra, India
[2]Department of Chemistry, A.S.C. College, Navapur, Nandurbar, Maharashtra, India
[3]Department of Chemistry, S.P.H. Mahila College, Malegaon camp, Nashik, Maharashtra, India

ABSTRACT

In the present work Densities of pure ethanol, water and its binary mixtures were measured at temperatures ranges from 293.15 to 313.15 K, over the whole mole fraction range of ethanol. Excess molar volume obtained is negative. Density and excess molar volumes plotted against mole fraction X1 of ethanol.

Keywords : Ethanol, Water, Binary Mixtures, Density, Excess Molar Volume.

I. INTRODUCTION

Water is one of the most basic and important materials in living systems. Despite its apparent molecular simplicity, it has long been considered as complex nature [1]. Ethanol has been widely used in medicine and food. Especially, the interaction between ethanol and water molecules by hydrogen bonding is a central issue [2–4].

Ethanol has been used in the last few years as a distillation container or extractive solvent in the chemical industry, as a carrier or additive in food and pharmaceutical processes, and in antimicrobial applications for medical uses. This molecule contains a hydrophilic hydroxyl group which is available to hydrogen-bond of similar compounds, and a residual end conferring a degree of hydrophobicity on the molecule [5].

Mixtures of water with aliphatic alcohols are of considerable interest from the view point of the existence of some interaction, such as hydrogen bonding between water-which contains an –OH group and can act as a π-type donar – and alcohol molecules, which have one acidic H atom on the –OH group and can act as σ- acceptor [6]. The values of density of pure water is determined in previous work [7]

In this study, results obtained of density and excess molar volume of binary mixture formed by ethanol with water at temperature from 293.15 to 313.15 K are reported.

II. EXPERIMENTAL SECTION

Material:

Ethanol was supplied by Changzhou Yangquan chemical with purity (GC) 99.9%. In all experiment, triple distilled water was used.

Method:

Binary mixture was prepared by knowing masses of each liquid in airtight stoppered glass bottles. The densities of pure liquid and binary mixture of liquids were measured in 15 cm^3 double arm pycnometer [8-11]. This pycnometer was calibrated using conductivity water with 0.9970 cm^{-3} at 25^0C its density. The pycnometer filled with air bubble free experimental liquid was kept in a transparent walled water bath in which the temperature was maintained to attained thermal equilibrium. The position of the liquid level in the two arms was recorded with travelling microscope which read correctly to ± 0.01 mm. [12].

III. RESULT AND DISCUSSION

Density and excess molar volume of ethanol with water at temperatures from (293.15 to 313.15) K are shown in table 2 and in figures 1 and 2. Following equation is used to calculate excess molar volume V^E [13].

$$V^E = \frac{(X_1M_1 + X_2M_2)}{\rho_{12}} - \left(\frac{X_1M_1}{\rho_1}\right) - \left(\frac{X_2M_2}{\rho_2}\right)$$

Where, X_1, X_2 are mole fractions, M_1, M_2 are molecular weights and ρ_1, ρ_2 are density of components 1 & 2 respectively of binary mixtures. ρ_{12} is the mixtures density.

Densities of ethanol with water is determined at temperatures from 293.15 to 313.15 K. the densities of the pure ethanol are shown in table 1 along with the literature values. From table 1 it is seen that there is closeness between experimental values and literature values. The results obtained are satisfactory. The density and corresponding V^E data of the binary systems of ethanol with water is shown in table 2 at different temperatures. Figure1 shows the plots of densities as a function of mole fraction of ethanol in water. Continuous decrease in density at the same rate on addition of ethanol in water is observed. Excess molar volumes, V^E for ethanol in water have been plotted in figure 2 from this fig. V^E Found to be negative.

Table 1. Densities (ρ) of pure ethanol at various temperatures (T/K)

Temp. (T/K)	Density ($\rho \cdot 10^{-3}$(kg·m^{-3})	
	Expt.	Lit.
293.15	0.7892	-
295.15	0.7876	-
298.15	0.7851	0.7850[14]
300.15	0.7835	-
303.15	0.7809	-
305.15	0.7792	-
308.15	0.7768	0.7771[15]
310.15	0.7750	-
313.15	0.7731	0.7731[15]

Table 2. Density (ρ), Excess molar volume (V^E) for various mole fractions (X_1) of ethanol at (293.15 to 313.15) K

T/K	X_1 Ethanol	$\rho \cdot 10^{-3}$ (kg·m^{-3})	$V^E.10^6$ (m^3·mol^{-1})	T/K	$\rho \cdot 10^{-3}$ (kg·m^{-3})	$V^E.10^6$ (m^3·mol^{-1})
293.15	0.0000	0.9975	0.0000	305.15	0.9944	0.0000
	0.0416	0.9816	-0.1962		0.9778	-0.2057
	0.0891	0.9683	-0.4669		0.9628	-0.4624
	0.1436	0.9532	-0.7228		0.9458	-0.6964
	0.2068	0.9348	-0.9200		0.9261	-0.8798
	0.2812	0.9137	-1.0466		0.9044	-1.0026
	0.3698	0.8990	-1.3903		0.8810	-1.0550
	0.4772	0.8677	-1.1086		0.8576	-1.0674

	0.6100	0.8430	-0.9800		0.8327	-0.9428
	0.7788	0.8178	-0.7124		0.8076	-0.6902
	1.0000	0.7892	0.0000		0.7792	0.0000
295.15	0.0000	0.9970	0.0000	308.15	0.9934	0.0000
	0.0416	0.9810	-0.1975		0.9767	-0.2100
	0.0891	0.9675	-0.4666		0.9613	-0.4639
	0.1436	0.9520	-0.7172		0.9438	-0.6912
	0.2068	0.9334	-0.9114		0.9239	-0.8715
	0.2812	0.9122	-1.0379		0.9019	-0.9919
	0.3698	0.8892	-1.0902		0.8785	-1.0450
	0.4772	0.8660	-1.0982		0.8551	-1.0583
	0.6100	0.8412	-0.9708		0.8300	-0.9309
	0.7788	0.8161	-0.7070		0.8049	-0.6762
	1.0000	0.7876	0.0000		0.7768	0.0000
298.15	0.0000	0.9963	0.0000	310.15	0.9927	0.0000
	0.0416	0.9802	-0.2011		0.9760	-0.2114
	0.0891	0.9662	-0.4667		0.9603	-0.4622
	0.1436	0.9502	-0.7115		0.9424	-0.6842
	0.2068	0.9312	-0.9017		0.9224	-0.8649
	0.2812	0.9099	-1.0285		0.9004	-0.9874
	0.3698	0.8868	-1.0807		0.8768	-1.0381
	0.4772	0.8635	-1.0908		0.8533	-1.0507
	0.6100	0.8387	-0.9622		0.8283	-0.9277
	0.7788	0.8136	-0.7053		0.8032	-0.6778
	1.0000	0.7851	0.0000		0.7750	0.0000
300.15	0.0000	0.9958	0.0000	313.15	0.9916	0.0000
	0.0416	0.9796	-0.1817		0.9747	-0.2136
	0.0891	0.9653	-0.4451		0.9587	-0.4637
	0.1436	0.9489	-0.6870		0.9404	-0.6830
	0.2068	0.9299	-0.8789		0.9200	-0.8583
	0.2812	0.9084	-1.0052		0.8978	-0.9773
	0.3698	0.8851	-1.0564		0.8743	-1.0342
	0.4772	0.8619	-1.0699		0.8507	-1.0494
	0.6100	0.8370	-0.9480		0.8256	-0.9230
	0.7788	0.8119	-0.6919		0.8005	-0.6732
	1.0000	0.7835	0.0000		0.7723	0.0000

303.15	0.0000	0.9950	0.0000	
	0.0416	0.9786	-0.2059	
	0.0891	0.9639	-0.4660	
	0.1436	0.9471	-0.7024	
	0.2068	0.9275	-0.8855	
	0.2812	0.9058	-1.0084	
	0.3698	0.8826	-1.0635	
	0.4772	0.8593	-1.0745	
	0.6100	0.8344	-0.9485	
	0.7788	0.8093	-0.6954	
	1.0000	0.7809	0.0000	

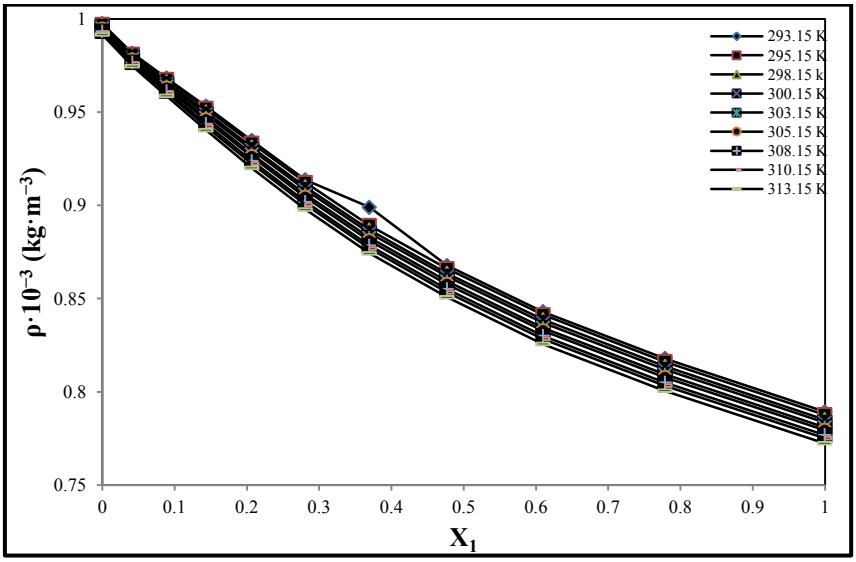

Figure 1. Plot of density (ρ) Vs mole fraction (X_1) of ethanol in water system at 293.15 to 313.15 K.

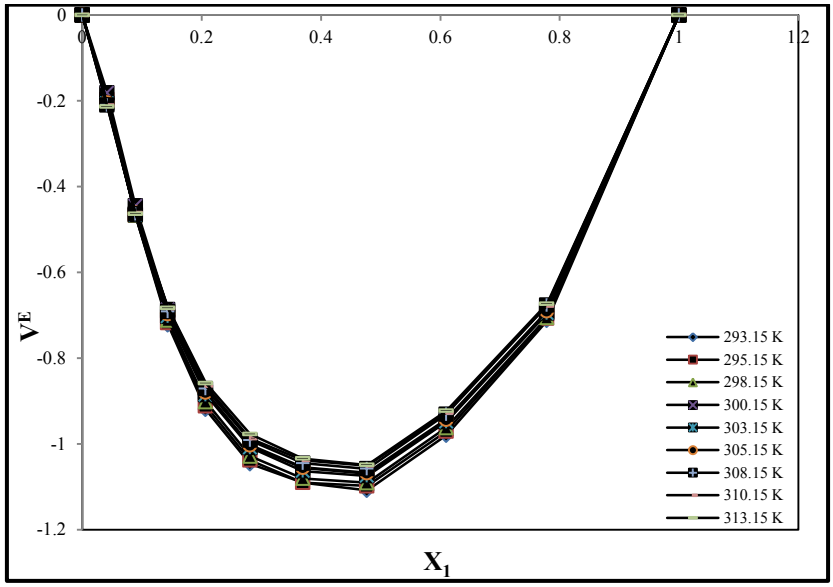

Figure 2. Plot of Excess molar volume (V^E) Vs X_1 for ethanol in water at 293.15 to 313.15 K.

IV. CONCLUSION

Densities, Excess molar volume of pure water, ethanol and in water-ethanol binary mixtures is measured at temperatures from 293.15 to 313.15 K. Continuous decrease in density at the same rate on addition of ethanol in water are observed and excess molar volume is found to be negative.

V. REFERENCES

[1]. C.Q. Sun, X. Zhang, J. Zhou, Y.L. Huang, Y.C. Zhou, W.T. Zheng, Density, elasticity, and stability anomalies of water molecules with fewer than four neighbors, J. Phys. Chem. Lett., 4 (2013) 2565–2570.

[2]. C.J. Benmore, Y.L. Loh, The structure of liquid ethanol: a neutron diffraction and molecular dynamics study, J. Chem. Phys., 112 (2000) 5877–5883.

[3]. C. Talon, M.A. Ramos, S. Vieira, Low-temperature specific heat of amorphous, orientational glass, and crystal phases of ethanol, Phys. Rev. B, 66 (2002) 012201.

[4]. A. Matic, C. Masciovecchio, D. Engberg, G. Monaco, L. Börjesson, S.C. Santucci, R. Verbeni, Crystal-like nature of acoustic excitations in glassy ethano, Phys. Rev. Lett., 93 (2004) 145502.

[5]. O. Redlich, A.T. Kister, Ind. Eng. Chem., 40 (1948) 341.

[6]. Hulya Y., excess properties of alcohol-water systems at 298.15 K, Turkey journal physics, 26, (2002), 243-246.

[7]. R.R. Pawar, S.S. Kale, A.S. Kale and S.B. Nahire, density and excess molar volumes of water-methanol binary mixtures at (293.15 to 313.15) K, International Journal of Current Advanced Research, Volume, 6, (2017), 6657-6659.

[8]. M.Hasan, , D.F.Shirude, , A. P.Hiray, U.B.,Kadam, A.B. Sawant, J Chem Eng Data, 51, (2006) 1922-192.

[9]. P.S.Nikam, A.B. Sawant, J. Chem Data, 42 (1997), 585.

[10]. P.S.Nikam, A.B. Sawant, J molecular liquid, 75, (1998), 119.

[11]. P.S. Nikam, A.B. Sawant, Bull Chem Soc. JPN, 71, (1998), 2061.

[12]. Kaminsky, J. phys Chem (NF), 5, (1995), 154.

[13]. M.A. Tejraj, Thermodynamic interactions in binary mixtures of ethenylbenzene with methanol, ethanol, butan-1-ol, pentan-1-ol, and hexan-1-ol in the temperature range 298.15–308.15 K. J. Chem. Eng. Data, 44, (1999), 1291–1297.

[14]. J.V. Herr´aez, R. Belda, Refractive Indices, Densities and Excess Molar Volumes of Monoalcohols + Water, J Solution Chem., 35, (2006), 1315–1328.

[15]. A.B. Dikko, A. Alkasim, Some Excess Properties of Ternary Liquid Mixture of Water, Methanol, Ethanol at Several Temperatures, IJRRPCS., 1, (2014), 8-12.