

## TO STUDY THE EFFECT OF ADDITION OF BUTANOL TO BINARY LIQUID SYSTEM OF NON POLAR SOLVENTS

M.R.Aware\*

P. G. Department of Chemistry, Shri Shivaji Science College, Amravati (M.S)

\*E-mail: mahyu.007@gmail.com

---

### ABSTRACT

The excess molar volume ( $V^E$ ), viscosity deviation ( $\Delta\eta$ ) and enthalpy data were calculated from the experimental measurement of viscosity, density for binary liquid mixture of nonpolar solvents with polar protic solvents. The non polar solvents toluene and 1,4-dioxane were used to prepare binary liquid system. The butanol is used as a polar protic solvent. The study was carried out at different temperature 303, 309, 313 and 318 K. Results were used to explain solubility and molecular interaction for binary liquid mixture and polar protic solvent.

**Keywords:** Viscosity, Excess molar volume ( $V^E$ ), Enthalpy, Solubility, Molecular interaction.

©2013 RASAYAN. All rights reserved

---

### INTRODUCTION

Accurate knowledge of thermodynamic mixing property of binary mixture has great relevance in theoretical and applied field of research. In the last few year we have been developed a research program that consist of experimental determination of densities, viscosities, surface tension, interfacial tension of binary and ternary mixtures. All fluid exhibits a characteristic property of flowing under an applied force, which could be even the force of their own weight. Viscometric property has been a sensitive tool for understanding interactions in solution. Viscosity measurement, like other transport properties of liquids provide useful information about solute-solute and solvent-solvent interactions in nonaqueous and aqueous solvent. Many workers studied molecular interaction and thermodynamic study of binary and ternary liquid mixture at different temperature. Pandey and Yasmin<sup>1</sup> have experimentally measured viscosities and densities of aqueous binary electrolyte solutions of different molarities at 298.15 K and reported relative viscosities, apparent molar volumes and free energy of activation. Raju chanda, Ashis Banerajee and Mahendra Nath Roy<sup>2</sup> studied viscous antagonism, excess molar volume, viscosity deviation of ternary mixtures. Rose Venis and Rosario Rajkumar<sup>3</sup> studied densities, viscosities and ultrasonic velocities in ternary liquid mixture to explain molecular interaction between unlike molecule at different temperature. H. lioukhani<sup>4</sup> and et.al, studied volumetric and viscometric studies of molecular interactions of ternary system toluene + cyclohexane + n-hexane at 298.15 K. Palani<sup>5</sup> et.al studied thermodynamic and volumetric studies of molecular interaction in ternary liquid mixture at 303, 308 and 313 K. Mirjana, Lj<sup>7</sup> and et.al, studied densities, viscosities and surface and interfacial tension of the ternary mixture water + ethyl butyrate + methanol at 303.15 K. S.S Ubarhande<sup>9</sup> et.al, studied thermodynamic study of 1,3-diaryl carbamides in binary solvent mixtures at different temperatures.

In present work an attempt has been made to study the effect of addition of tert-butanol and iso-butanol in the binary mixture of non polar solvents toluene and 1, 4-dioxane at 303, 309, 313 and 318 K. From experimental measurements, Viscosity, Excess molar volume ( $V^E$ ), Viscosity deviation ( $\Delta\eta$ ), Enthalpy were calculated to interpret the molecular interaction and solubility.

### EXPERIMENTAL

1,4-dioxane, toluene, tert-butanol and iso-butanol of AR grade (purity 99.9%) solvents were used to prepare mixture. All weighing were made on electronic balance ( $\pm 0.001$ g). The accuracy of density

measurements was within  $\pm 0.1$  %  $\text{kg/m}^3$ . The viscosity measurements were carried out using cleaned, dried Ostwald's Viscometer. Temperature variation study was carried out by use of suitable water bath and temperature variation was maintained within  $\pm 0.01^\circ\text{C}$ . The accuracy of viscosity measurement was within  $\pm 0.11$  %  $\text{kg}^{-1}\text{s}^{-1}$ . From the observation viscosity, excess molar volume ( $V^E$ ), Viscosity deviation ( $\Delta\eta$ ), Enthalpy, Molecular interaction and thermodynamics properties were calculated.

$$\text{Log } \eta_{T1} - \text{Log } \eta_{T2} = \Delta H / 2.303 (1/T_1 - 1/T_2)$$

$$\Delta\phi = 1/\Delta\eta$$

## RESULTS AND DISCUSSION

Different mixture of Toluene, 1,4-dioxane, tert-butanol and iso-butanol were prepared. Densities were measured with pycnometer calibrated with doubly distilled water. The viscosities were measured by clean dried Ostwald Viscometer. The viscosities were determined for ternary mixture of different composition at different temperatures. The data was further used to evaluate enthalpy and excess parameters.

The ability to dissolve one component into another is known as solubility. The dissolved component may interact with each other and interaction may be studied from the determination of number of physical and thermodynamic parameters. In the present study, an attempt has been made to study the effect of addition of tert-butanol and iso-butanol in the binary mixture of nonpolar solvents toluene and 1,4-dioxane at different temperatures. The computed values of viscosities at different temperatures are presented in Table-1.

Table-1: Computed values of viscosities at different temperatures

Temp: 300 K

S. No.	X <sub>1</sub>	X <sub>2</sub> 1,4-dioxane	X <sub>3</sub> Toluene	Tert-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3 \text{ Kg/ ms}$	Iso-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3 \text{ Kg/ ms}$
1	0.64	0.20	0.16	10.131	9.986
2	0.48	0.20	0.32	11.120	11.121
3	0.32	0.20	0.48	13.613	14.099
4	0.16	0.20	0.64	17.207	18.171

Temp: 309 K

S. No.	X <sub>1</sub>	X <sub>2</sub> 1,4-dioxane	X <sub>3</sub> Toluene	Tert-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3 \text{ Kg/ ms}$	Iso-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3 \text{ Kg/ ms}$
1	0.64	0.20	0.16	6.946	6.931
2	0.48	0.20	0.32	8.583	8.093
3	0.32	0.20	0.48	9.174	9.776
4	0.16	0.20	0.64	12.384	11.736

Temp: 313 K

S. No.	X <sub>1</sub>	X <sub>2</sub> 1,4-dioxane	X <sub>3</sub> Toluene	Tert-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3 \text{ Kg/ ms}$	Iso-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3 \text{ Kg/ ms}$
1	0.64	0.20	0.16	6.445	6.455
2	0.48	0.20	0.32	8.147	7.058
3	0.32	0.20	0.48	8.714	8.663
4	0.16	0.20	0.64	11.170	11.124

Temp: 318 K

S. No.	X <sub>1</sub>	X <sub>2</sub> 1,4-dioxane	X <sub>3</sub> Toluene	Tert-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3 \text{ Kg/ ms}$	Iso-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3 \text{ Kg/ ms}$
1	0.64	0.20	0.16	5.868	6.124
2	0.48	0.20	0.32	6.273	6.464
3	0.32	0.20	0.48	6.766	7.958
4	0.16	0.20	0.64	7.625	9.939

Temp: 300 K

S. No.	X <sub>1</sub>	X <sub>2</sub> Toluene	X <sub>3</sub> 1,4-dioxane	Tert-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3$ Kg/ ms	Iso-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3$ Kg/ ms
1	0.64	0.20	0.16	13.055	12.830
2	0.48	0.20	0.32	13.145	13.012
3	0.32	0.20	0.48	14.344	13.908
4	0.16	0.20	0.64	17.957	16.888

Temp: 309 K

S. No.	X <sub>1</sub>	X <sub>2</sub> Toluene	X <sub>3</sub> 1,4-dioxane	Tert-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3$ Kg/ ms	Iso-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3$ Kg/ ms
1	0.64	0.20	0.16	8.775	9.173
2	0.48	0.20	0.32	8.834	9.050
3	0.32	0.20	0.48	9.285	9.287
4	0.16	0.20	0.64	10.719	11.398

Temp: 313 K

S. No.	X <sub>1</sub>	X <sub>2</sub> Toluene	X <sub>3</sub> 1,4-dioxane	Tert-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3$ Kg/ ms	Iso-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3$ Kg/ ms
1	0.64	0.20	0.16	7.998	8.090
2	0.48	0.20	0.32	8.104	8.080
3	0.32	0.20	0.48	8.252	8.586
4	0.16	0.20	0.64	9.111	9.891

Temp: 318 K

S. No.	X <sub>1</sub>	X <sub>2</sub> Toluene	X <sub>3</sub> 1,4-dioxane	Tert-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3$ Kg/ ms	Iso-butanol + X <sub>2</sub> + X <sub>3</sub> $\eta \times 10^3$ Kg/ ms
1	0.64	0.20	0.16	7.213	7.413
2	0.48	0.20	0.32	7.346	7.477
3	0.32	0.20	0.48	7.390	7.821
4	0.16	0.20	0.64	8.188	8.917

Table-2: Determination of Enthalpy and excess parameter

Tert-butanol + 1,4-dioxane + Toluene

% concentration of tert-butanol	$\Delta H$ J/K mole	$\Delta \phi$ Kg <sup>-1</sup> ms	V <sup>E</sup>
16	3413.6250	0.10557	-93.6590
32	3578.6875	0.09538	-91.7265
48	4370.2500	0.07676	-89.7758
64	5087.7500	0.06006	-87.4502

Iso-butanol + 1,4-Dioxane + Toluene

% concentration of iso-butanol	$\Delta H$ J/K mole	$\Delta \phi$ Kg <sup>-1</sup> ms	V <sup>E</sup>
16	3056.6875	0.10733	-93.2738
32	3447.7500	0.09455	-90.9722
48	3575.1250	0.07446	-88.6659
64	3771.7500	0.0569	-86.3975

Tert-butanol + Toluene + 1,4-dioxane

% concentration of tert-butanol	$\Delta H$ J/K mole	$\Delta\phi$ $\text{Kg}^{-1} \text{ms}$	$V^E$
16	3708.6875	0.08274	-85.0464
32	3637.4375	0.08116	-86.6693
48	4145.8125	0.07316	-87.3703
64	4909.1250	0.05703	-88.5307

Iso-butanol + Toluene + 1,4-dioxane

% concentration of iso-butanol	$\Delta H$ J/K mole	$\Delta\phi$ $\text{Kg}^{-1} \text{ms}$	$V^E$
16	3429.0000	0.08438	-84.6953
32	3463.4375	0.08217	-85.5139
48	3598.4375	0.07575	-86.3393
64	3992.2500	0.06128	-87.1321

The present investigation reflects that the viscosity increases on addition of butanol to binary mixture of toluene - 1,4-dioxane. The increase in viscosity on addition of tert-butanol is more than on addition of iso-butanol, also with the increase in temperature viscosity decreases. The solubility concept can be explained on the basis of Hansen Solubility parameter value with the concept of 'like dissolves like'. The non polar solvent toluene and 1,4-dioxane have lower values of  $\partial P$  and  $\partial H$ . The mixture of toluene-1,4-dioxane can form completely soluble binary solvent system. On addition of polar protic solvent like butanol having higher values of  $\partial P$  and  $\partial H$  to the binary system of toluene and 1,4-dioxane, variation in intermolecular interaction may be observed.

Dissolution may involve thermodynamic changes. Breaking of solute-solute attractions maybe endothermic, breaking of solvent-solvent interactions maybe endothermic where as solvent-solute interactions may involves exothermic. The concept of mixing is supported from the thermodynamic parameter. The enthalpy value for the system represented in Table-II is positive ie endothermic indicating decrease in interaction between mixing components. The excess volume values are negative predicting nonspecific interaction between unlike molecules, which is supported by the values of deviation in fluidity ( $\Delta\phi$ ) calculated from excess viscosity.

### REFERENCES

1. J.D. Pandey and A. Yasmin, *Proc. Indian Acad.Sci.*, **9**, 289(1997).
2. R Chanda., A. Benerajee and M. N. Roy, *J. Berg. Chem. Soc.*, **75(12)**, 1721(2010).
3. R. Venis and R. Rajkumar, *J. Chem. Pharm. Res.*, **3(2)**, 878 (2011).
4. H Iiouxhani., M. Rezaei-Sameti, H. A. Zarei, *Thermodynamyc Acta*, **438**,9(2005)
5. A.N Kannapam, S. Thirumaran, and R. Palani, *Journal of Physical Science*, **20(2)**,97(2009).
6. Mirjana, Lj. Kijevcanin, Ines S. A. Ribeiro, Abel G. M. Ferreira, and Isabel M. A. Fonseca, *J. Chem. Eng. Data*, **48**, 1266 (2003).
7. Rui M. Pires, Henrique F. Costa, Abel G. M. Ferreira and Isabel M. A. Fonesca, *J. Chem. Eng. Data*, **52**, 1240 (2007)
8. A.S. Burghate, R.M. Kedar, P.B. Agrawal, and M.L. Nalwade, *Oriental J. Chem.*, **16(3)**, 503(2000).
9. S.S. Ubarhande, A.G. Gotmare, A.S. Burghate, and B.N. Berad, *RASAYAN J. Chem.*, **5**,(3), 360(2012).
10. R.J. Rao, Rao, C.V., Ternary Liquid Equillibria; Methanol-Water-Ester. *J. Appl. Chem.*, **7**, 435 (1957).
11. B.M. Santos, S., Ferreira, A. G. M., Fonesca, I. M. A. *Fluid Phase Equilib.*, **208**, 1(2003.)
12. K.J. Patil, S.M. Manwatkar and S.S. Donge, *Indian J. Chem.*, **33**, 4(1994).
13. R.K. Wadi and V. Kakkar, *Indian J. Chem.*, **39**, 598(2000).

[RJC-1030/2013]