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MEASUREMENT AND CORRELATION OF DENSITY AND VISCOSITY IN DIOXANE AND ETHANOL SOLVENT AT 293 K

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ABSTRACT

Correlation and measurement of density and viscosities of dioxane and ethyl alcohol have been measured in different temperatures at 293 K. The experimental value of density (ds) and viscosity (v) of dioxane and ethyl alcohol have been calculated in the pure state as well as in mixture over whole composition range at 293 K. These properties also provide important information about molecular packing, molecular motion and various types of intermolecular interactions and their strengths, influenced by the size, shape and chemical nature of component molecules.

Key words: Density, Viscosity, Dioxane, Ethanol.

INTRODUCTION

Density and viscosity; both the parameters are very important. Viscosity is mainly a term to define liquids, and solids in their liquid state. Density can refer to a liquid or gas. The density of a substance tends to stay similar, regardless of it's state. Temperature and composition dependence of the density and viscosity of binary mixtures of water + ionic liquid was reported[1]. Separate determination of liquid density and viscosity was also done with sagittally corrugated love-mode sensors[2]. The ultrasonic studies find extensive applications, as sound speed in liquids and liquid mixtures. It is intrinsically related with many parameters, which characterize the physicochemical behaviour of the liquids and liquid systems. Intermolecular interactions in various binary liquid mixtures at different temperatures have been studied by several authors[3-16].

Physicochemical properties like density and viscosity have got considerable importance in forming theoretical models as well as their applications in a number of branches of science. Volumetric and viscometric studies on N,N-dimethylacetamide and methanol binary mixtures at different temperatures was studied by Peshwe et al.[17] Viscosity and density measurements and the properties derived from these are excellent assets to detect solute-solute and solute-solvent interactions. It is used in many fields of scientific researches in physics, chemistry, biology, medicines and industry. The present paper deals with the measurement of density and viscosity and their excess values of binary liquid mixture dioxane and ethyl alcohol at 293 K. Density and viscosity properties are related indirectly. They reflect their own property with water molecule and organic solvent molecules.

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EXPERIMENTAL

Materials and methods

The organic liquid dioxane and ethyl alcohol were obtained from E-Merck. Density and viscosity measurements were carried out using Mechaniki Zakatasy Precyzynej Gdansk balance made in polond (± 0.001 g). The accuracy of density measurement was within ± 1% Kgm^{-3}. The densities of pure components and binary mixtures were measured using precalibrated pyknometer with an accuracy of ± 0.053% at 293 K. Viscosities of the pure liquids and their mixtures were measured using Ostwald viscometer. The flow of time of pure liquids and liquid mixtures were measured using an accurate stop watch with a precision of ± 0.1s. The purity of chemicals was checked by comparing their densities with literature values[18,19]. Viscosity and density are two different physical phenomena depending on totally different aspects.

It can be obtained from the simple equation,

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \qquad \ldots(1)$$

Its unit is Kgm^{-3}.

The relationship between dynamic viscosity and density is called the Kinematic viscosity. The viscosity of solution may be calculated from

$$\eta_s = \eta_w \frac{t_s P_s}{t_w P_w}$$

Where η = Dynamic viscosity (Pas), P = Density (Kg m^{-3}) and t = Time (s); Subscripts s and w represents solution and water respectively.

RESULTS AND DISCUSSION

The values of density and viscosity in different percentage of dioxane-water and ethanol-water mixtures are presented in Table 1-16 and graphs of these parameters against percentage dioxane-water and ethanol-water are shown in Fig. 1-4.

Density and viscosity at different percentage of dioxane-water mixture.

Table 1& 2: 4-Nitrophenylidene-4'-aniline [L1], 4-Nitrophenylidene-4'-nitroaniline [L2], Temp. = 20 ± 0.1°C, Concentration: 0.01 M

% Dioxane	ds x 10^3 ($Kg.m^3$)	V ($m.\ sec^{-1}$)	% Dioxane	ds x 10^3 ($Kg.m^3$)	V ($m.\ sec^{-1}$)
70	1.0488	1.46072	70	1.0507	1.43824
75	1.0478	1.52188	75	1.0501	1.4376
80	1.0469	1.4400	80	1.0498	1.3595
85	1.0457	1.42728	85	1.0478	1.2003
90	1.0451	1.2395	90	1.0469	1.3038

Table 3 & 4: 4-Chlorophenylidene-4'-aniline[L3],4-Cholorophenylidene-4'-nitroaniline[L4], Temp.= 20 ± 0.1°C, Concentration: 0.01 M

% Dioxane	ds x 10^3 ($Kg.m^3$)	V ($m. sec^{-1}$)	% Dioxane	ds x 10^3 ($kg.m^3$)	V ($m. sec^{-1}$)
70	1.0545	1.4072	70	1.05084	1.6008
75	1.05094	1.3576	75	1.05064	1.4675
80	1.05064	1.4084	80	1.05034	1.50967
85	1.05034	1.40888	85	1.0486	1.4392
90	1.04894	1.42728	90	1.04824	1.4353

Table 5 & 6: 4-Methoxyphenylidene-4'-aniline[L5],4-Methoxyphenylidene-4'-nitroaniline[L6], Temp.= 20 ± 0.1°C, Concentration: 0.01M

% Dioxane	ds x 10^3 ($Kg.m^3$)	V ($m. sec^{-1}$)	% Dioxane	ds x 10^3 ($Kg.m^3$)	V ($m. sec^{-1}$)
70	1.05223	1.5196	70	1.05263	1.52280
75	1.05154	1.46112	75	1.05233	1.4836
80	1.05104	1.49319	80	1.0516	1.4936
85	1.04974	1.4400	85	1.0514	1.4192
90	1.04924	1.4006	90	1.05104	1.4036

Table 7 & 8: 2,4-Dimethylphenylidene-4'-aniline[L7], 2,4-Dimethylphenylidene-4'-nitroaniline[L8], Temp. = 20 ± 0.1°C, Concentration: 0.01M

% Dioxane	ds x 10^3 ($Kg.m^3$)	V ($m. sec^{-1}$)	% Dioxane	ds x 10^3 ($kg.m^3$)	V ($m. sec^{-1}$)
70	1.05362	1.53281	70	1.0616	1.6280
75	1.05924	1.5262	75	1.0599	1.6496
80	1.05965	1.5566	80	1.0614	1.6885
85	1.0614	1.4961	85	0.618	1.7126
90	1.0812	1.5661	90	1.0699	1.7585

Density and viscosity at different percentage of ethanol-water mixture**.**

Table 9 & 10: 4-Nitrophenylidene-4'-aniline [L1], 4-Nitrophenylidene-4'-nitroaniline[L2], Temp.= 20 ± 0.1°C, Concentration: 0.01 M

% Ethanol	ds x 10^3 ($kg.m^3$)	V ($m. sec^{-1}$)	% Ethanol	ds x 10^3 ($kg.m^3$)	V ($m. sec^{-1}$)
70	0.88623	1.4064	70	0.8864	1.4078
75	0.87874	1.4323	75	0.8747	1.3568
80	0.86736	1.3596	80	0.8609	1.3612
85	0.85299	1.3472	85	0.8519	1.3416
90	0.84350	1.2500	90	0.8330	1.3133

Table 11 & 12: 4-Chlorophenylidene-4'-aniline[L3],4-Cholorophenylidene-4'-nitroaniline[L4], Temp.= 20 ± 0.1°C, Concentration: 0.01M

% Ethanol	ds x 10^3 ($kg.m^3$)	V ($m. sec^{-1}$)	% Ethanol	ds x 10^3 ($Kg.m^3$)	V ($m. sec^{-1}$)
70	0.88493	1.44	70	0.88493	1.4405
75	0.87694	1.4067	75	0.87495	1.5188
80	0.85798	1.3592	80	0.86197	1.4817
85	0.84859	1.2387	85	0.84181	1.4388
90	0.83702	1.2808	90	0.83262	1.3216

Table 13 & 14: 4-Methoxyphenylidene-4'-aniline[L5],4-Methoxyphenylidene-4'-nitroaniline[L6], Temp. = 20 +- 0.1°C, Concentration: 0.01M

% Ethanol	ds x 10^3 ($kg.m^3$)	V ($m. sec^{-1}$)	% Ethanol	ds x 10^3 ($kg.m^3$)	V ($m. sec^{-1}$)
70	0.8793	1.4172	70	0.8824	1.5172
75	0.86556	1.5176	75	0.8649	1.5224
80	0.85548	1.4932	80	0.8539	1.4399
85	0.83901	1.4392	85	0.84290	1.2783
90	0.8270	1.3572	90	0.8328	1.3575

Table 15 & 16: 2,4-Dimethylphenylidene-4'-aniline[L7], 2,4-Dimethylphenylidene-4'-nitroaniline[L8], Temp. = 20 ± 0.1°C, Concentration: 0.01M

% Ethanol	ds x 10^3 ($kg.m^3$)	V ($m. sec^{-1}$)	% Ethanol	ds x 10^3 ($kg.m^3$)	V ($m. sec^{-1}$)
70	0.84290	1.5315	70	0.8826	1.5271
75	0.8530	1.4391	75	0.8654	1.5223
80	0.8635	1.5426	80	0.8523	1.3576
85	0.8739	1.3579	85	0.8624	1.6217
90	0.8859	1.5466	90	0.8666	1.5315

From tables, it can be noted that the 'd' values in dioxane medium are considerably higher than in alcohol medium. This may be due to nature of solvents. Density of ethanol is less as compared to density of dioxane. It may be due to denser or bulky solvent dioxane than ethanol.

L - Dioxane > L - Ethanol

L_1 has lower density as compared to L_2, L_3, L_4, L_5, L_6, L_7 and L_8 in dioxane, whereas in case of ethanol, the value of density is near about same or it increases. Also V values in dioxane medium are considerably higher than in alcohol medium. This may be due to nature of solvents.

L - Dioxane > L - Ethanol

Nature of substituent is responsible for smaller or higher value of ultrasonic velocity.

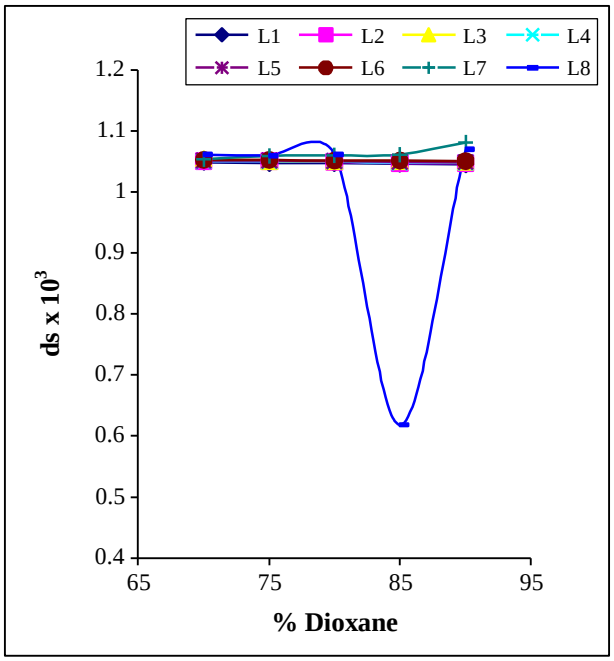

Fig. 1: Plot between % dioxane Vs ds
Temp. 20°C

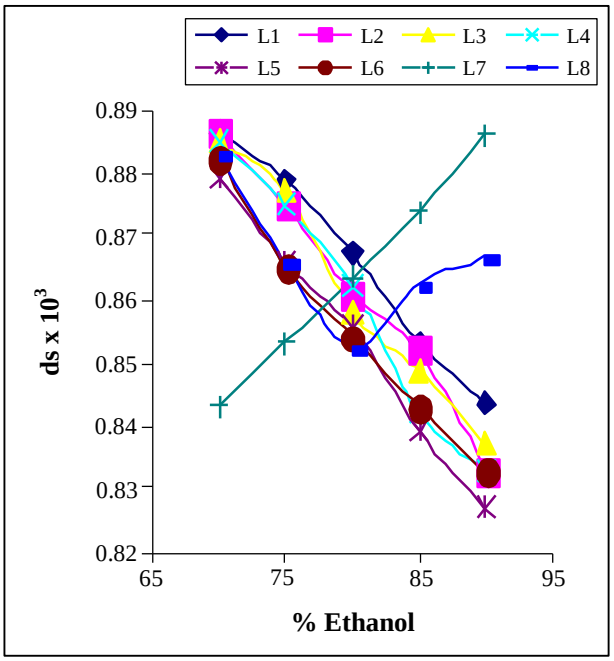

Fig. 2: Plot between % ethanol Vs ds
Temp. 20°C

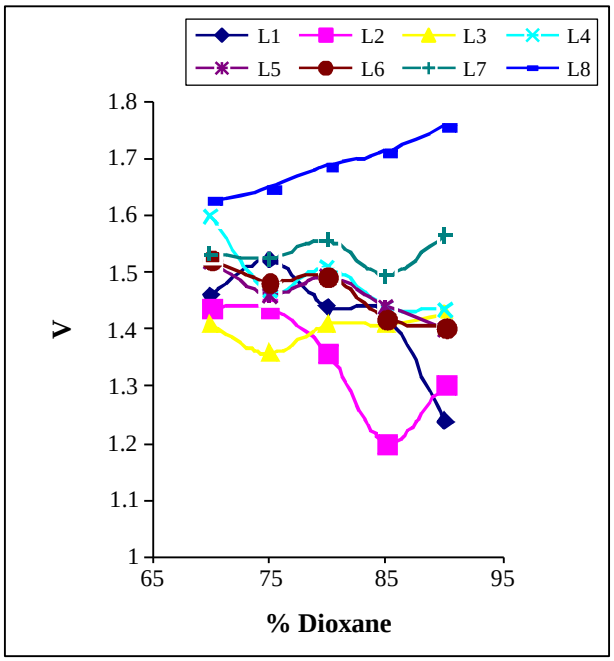

Fig. 3: Plot between % dioxane Vs V
Temp. 20°C

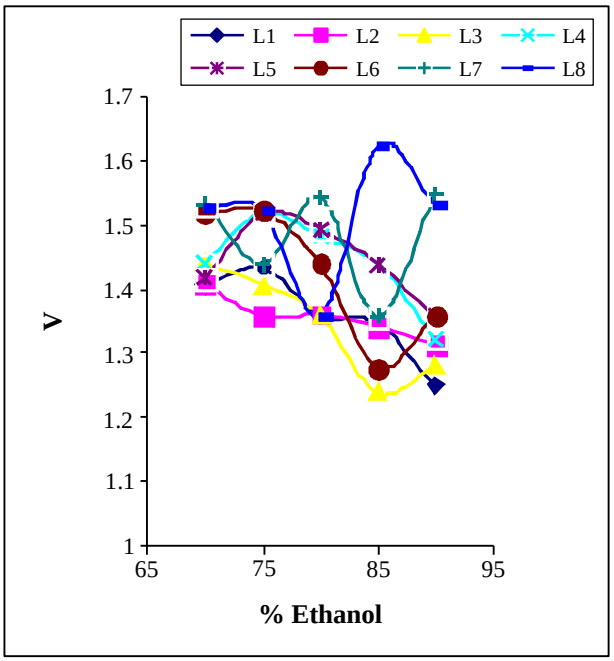

Fig. 4: Plot between % ethanol Vs V
Temp. 20°C

CONCLUSION

Hence, it can be concluded from these studies (density and viscosity measurements) that the values are smaller or higher in dioxane and ethyl aclohol medium at 293 K. This may be due to nature of solvent or substituents.

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