Study of Some Intensive Properties of Some Binary Polar Solvents in Different Temperature

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Abstract

The density (ρ) , Viscosity (η) and refractive index(n_D)have been measured for binary polar systems of (protic – protic) solvents mixtures (ethanol-water) and (Aprotic – protic) solvents mixture(dimethyl sulfoxide) and (N – N - (dimethyl formamide) over the complete composition rang at 293 K , 298 K and 303 K at atmospheric pressure .

The experimental data were used to study the nature of intermolecular interaction between the mixing components.

The dependence ρ , η and n_D on composition rangewas checked by using an empirical relation .

1 . Introduction :-

Densities , viscosities and refractive indexes over the miscible composition rang of binary mixtures of (ethanol + water) , (dimethyl sulfoxide + water) and (N , N – dimethyl formamide + water) at 293 K , 298 K and 303 K at atmospheric pressure have been measured.[1 , 2 , 3 , 4 , 5 , 6 , 7 , 8]

The nature of the molecular interaction between the component of liquid mixtures have been investigated by these intensive properties.

These interaction help in better understanding the nature of the (Solvent – Solvent) interaction of binary mixtures with water and ethanol , dimethyl sulfoxide and N –N – dimethyl formamide .[6 . 9]

A polar solvent can be define as a liquid with a relative electro static forces between charged particles .Water is the best known polar solvent with structure which is determined to a great extent by the hydrogen bonding between molecules .[2]

N , N Dimethyl formamide is a versatile solvents used in the separation of saturated and unsaturated hydrocarbons and serves as a solvent for many polymers .[9]

DMSO : Organo sulfur compound with this colorless liquid is an important polar a portic solvent that dissolves both polar and non polar compounds and is miscible in a wide range of organic solvents as well as water .

2 . Experimental

2 . 1 Materials and Measurements :-

All chemicals were of highest purity and used as supplied from BDH.

The used solvents : absolute ethanol (ETOH 99.5% , Dimethyl sulfoxide (DMSO)99.8% and N–N– Dimethyl formamide(DMF 99%).

ten binary mixtures of the solvents from (1 – 10 volume) were prepared in aclean test tubes closed carefully and kept in thermostated water–bath (Optima) of 15 min at the meaning temperature.[10]

2 . 2 Density

Densities of the liquid mixtures were measured by using density bottle or (Pycnometer was calibrated) . The estimated uncertain are less than (± 0.0001) g . cm^{-3} for density .[11 , 12]

2 . 3 Viscosity

The viscosities were measured at the desired temperature using ostwaled viscometer . The viscometer was calibrated using water .[3 , 12]

2 . 4 Refractive index

The experimental values of refractive indexes of mixtures were measured by using an Abb refractometer .[13]

The theoretical values (n_D) were calculated by using the equation.[5,14]

$n = Q_1 n_{D1} + Q_2 n_{D2}$ …….. (1)

Where Q_1 , Q_2 volume fraction and n_{D1}, n_{D2} refractive indexces for pure compenents in the mixtures .

3 . Result and Discussion :-

3 . 1 The experimental values of measured densities and viscosities of the studied solvent – mixtures at 293K , 298K and 303K are given in Table (3 – 1 - a) ,Table (3 – 1 - b) and Table (3 – 1 – c) .

From table (3 – 1 – a) , (3 – 1 – b) and (3 – 1 – c) was observed that the densities and viscosities of the binary polar mixtures decreased with increased of temperature [1,5,9].Fig (1-a-b) to (3-a-b)

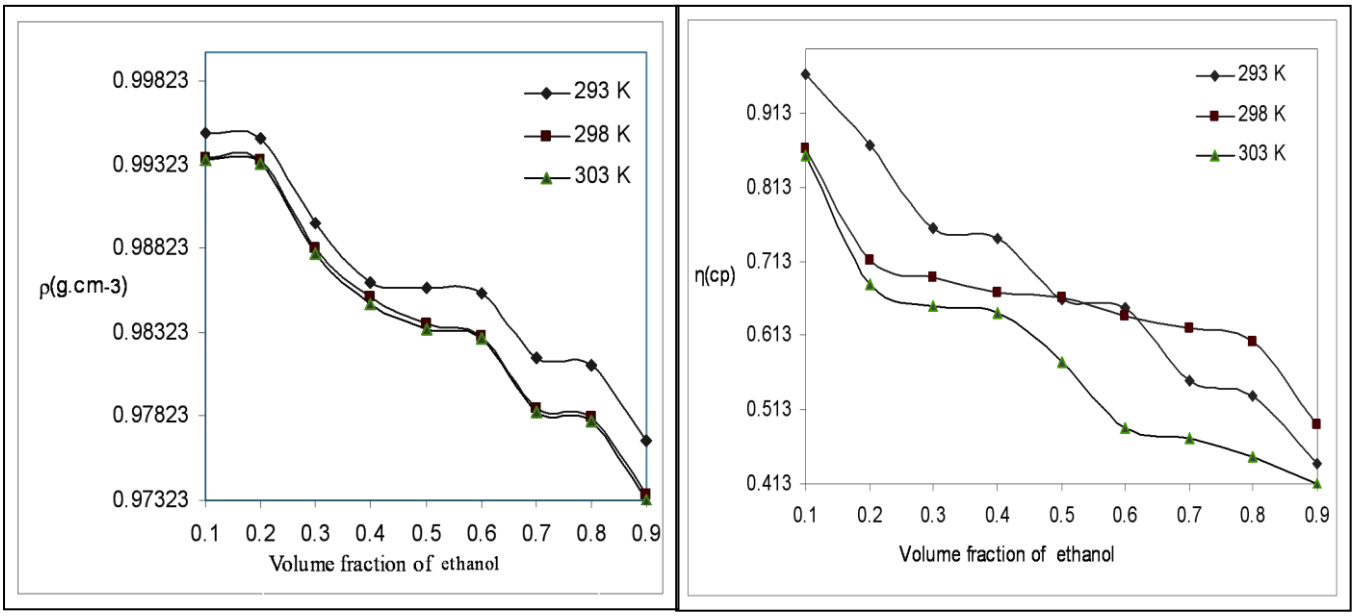
The trend in density and viscosity indicates the intermolecular interaction.

In ethanal-water the intermolecular hydrogen bonding in present between ethanal and water.

In dimethylsulfoxide-water and N,N-dimethylformamide-water mixtures the dipole-dipole interaction in present between dimethylsulfoxide and water and between N,N-dimethylformamide-water[3,6,7].

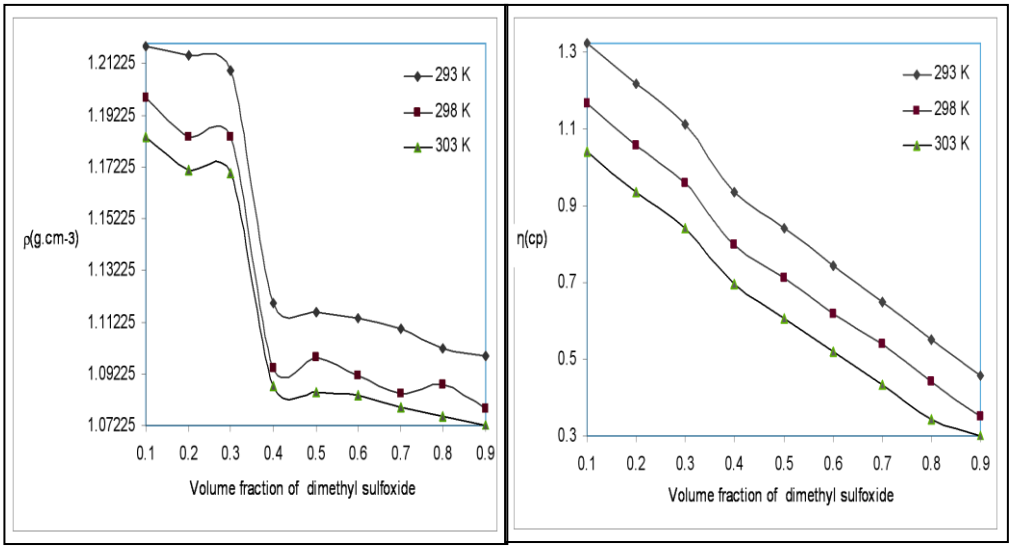
Table 1 : Experimental values of densities and viscosities of (Ethanol + water) at 293K , 298K , and 303K

Volume fraction Solvent ethanol -water	P (g . cm^{-3})			η (cp)		
	293K	298K	303K	293K	298K	303K
0.1	0.99519	0.99369	0.99354	0.965	0.865	0.857
0.2	0.99479	0.99359	0.99338	0.870	0.714	0.683
0.3	0.98979	0.98829	0.98798	0.759	0.691	0.652
0.4	0.98629	0.98539	0.98499	0.745	0.671	0.644
0.5	0.98589	0.98379	0.98344	0.662	0.664	0.578
0.6	0.98559	0.98299	0.98288	0.651	0.639	0.488
0.7	0.98169	0.97869	0.97851	0.553	0.624	0.475
0.8	0.98129	0.97819	0.97794	0.532	0.605	0.450
0.9	0.97679	0.97359	0.97327	0.441	0.493	0.414



Fig(1-a-b):- variation of density and viscosity of sinary mixtures ethanol –water with volume of ethanol at 293 K,298 K and 303 K.

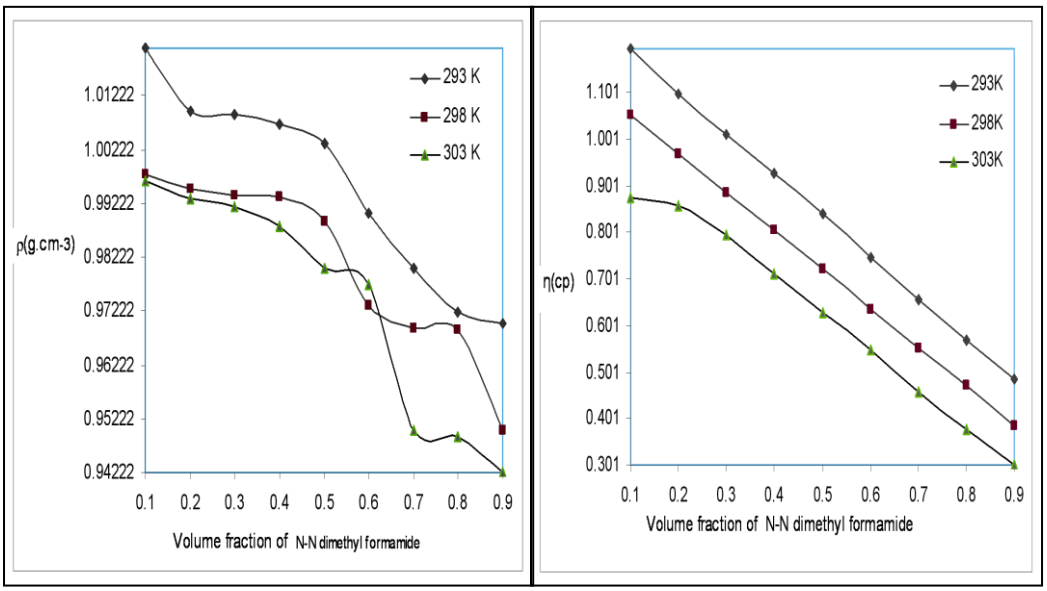
Volume fraction Solvent Dimethyl Sulfoxide -water	ρ (g . cm^{-3})			η (cp)		
	293K	298K	303K	293K	298K	303K
0.1	1.21905	1.19905	1.18405	1.325	1.168	1.043
0.2	1.21525	1.18405	1.17105	1.219	1.057	0.937
0.3	1.20975	1.18375	1.16955	1.113	0.961	0.843
0.4	1.11953	1.09453	1.08735	0.936	0.799	0.696
0.5	1.11633	1.09833	1.08515	0.840	0.713	0.608
0.6	1.11343	1.09143	1.08365	0.745	0.620	0.520
0.7	1.10973	1.08473	1.07915	0.649	0.541	0.432
0.8	1.10203	1.08803	1.07565	0.553	0.441	0.344
0.9	1.09923	1.07883	1.07225	0.459	0.350	0.300



Fig(2-a-b):- variation of density and viscosity of sinary mixtures dimethyl sulfoxide –water with volume of dimethyl – sulfoxide at

Table 3 : Experimental values of densities and viscosities of (N.N- Dimethyl – Formamide + water) at 293K , 298k and 303K

Volume fraction Solvent N.N-dimethyl formamide -water	ρ (g . cm^{-3})			η (cp)		
	293K	298K	303K	293K	298K	303K
0.1	1.02102	0.99769	0.99639	1.195	1.052	0.874
0.2	1.00934	0.99500	0.99300	1.097	0.969	0.856
0.3	1.00879	0.99369	0.99150	1.012	0.887	0.794
0.4	1.00703	0.99333	0.98800	0.926	0.806	0.712
0.5	1.00322	0.98871	0.98000	0.839	0.722	0.627
0.6	0.99021	0.97322	0.97700	0.745	0.634	0.547
0.7	0.98000	0.96900	0.95010	0.655	0.550	0.456
0.8	0.97211	0.96880	0.94882	0.569	0.471	0.379
0.9	0.97000	0.95011	0.94222	0.486	0.385	0.301



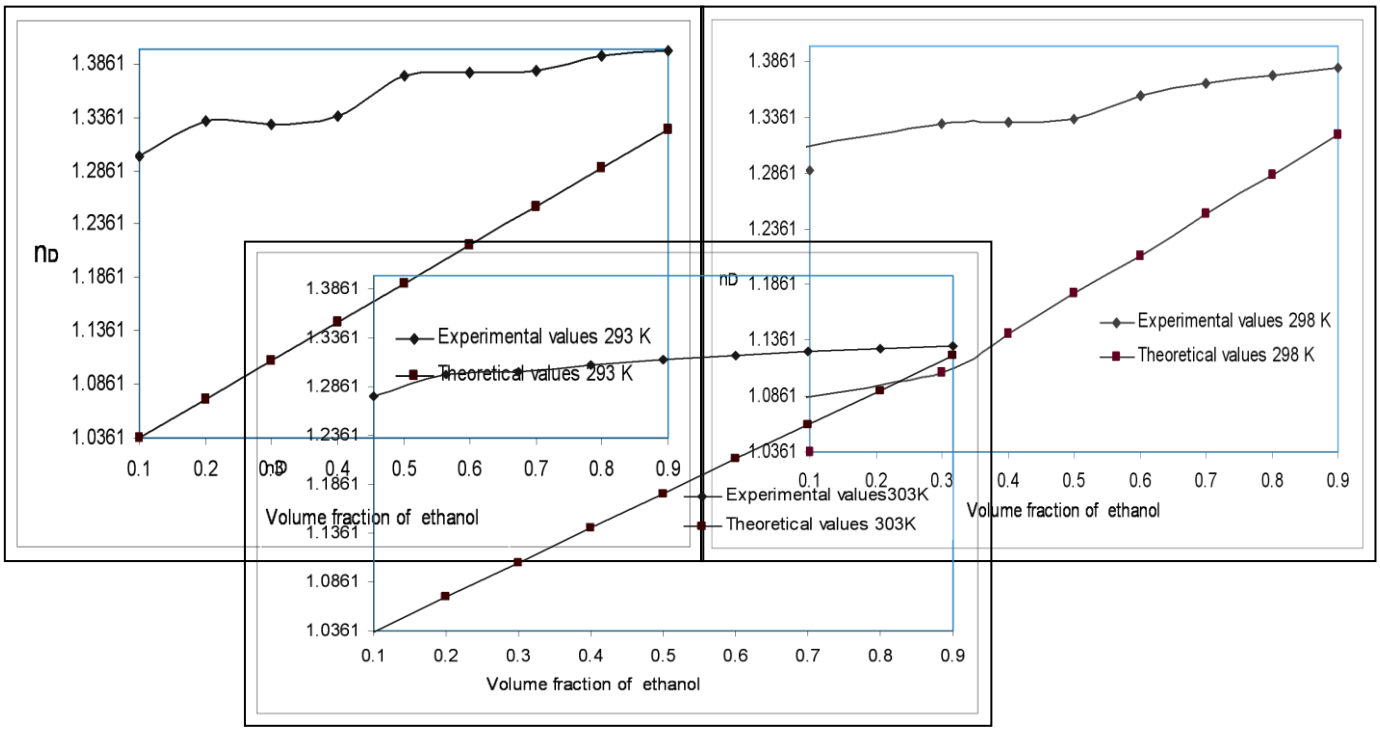
Fig(3-a-b):- variation of density and viscosity of sinary mixtures N-N Dimethyl Formamide –water with volume of N-N Dimethyl Formamide

3 . 2 experimental values and theoretical values of Refractive indexces of studied solvents – mixtures at 293K , 298K and 303K are given in Tble (3 – 2 – a) , Tble (3 – 2 – b) and (3 – 2 – c) Tble .

From Tble (3 – 1 – a) , Table(3 – 1 –b) and (3 – 1 – c) it has been found the experimental values of refractive indexces decreased with increased of temperature , and refractive indexces of these binary mixtures were calculated the oretical from pure compont data by using empirical relations and the result were compared with the experimental values and are found to be in good a *greement* [5,9].*Fig (4-a-c) to Fig (6-a-*c)

Table (3 – 2 – a) : Experimental values and theoretical values of (ethanol + water) at 293K , 298Kand 303K

n_D						
Volume fraction Solvent ethanol -water	293K		298K		303K	
	Experimental values	Theoretical values	Experimental values	Theoretical values	Experimental values	Theoretical values
0.1	1.300	1.0361	1.288	1.0356	1.276	1.0353
0.2	1.332	1.0722	1.298	1.0712	1.299	1.0706
0.3	1.333	1.1083	1.330	1.1068	1.302	1.1054
0.4	1.337	1.1444	1.332	1.1424	1.309	1.1412
0.5	1.375	1.1805	1.334	1.1781	1.314	1.1765
0.6	1.378	1.2166	1.356	1.2137	1.318	1.2118
0.7	1.379	1.2527	1.366	1.2493	1.322	1.2471
0.8	1.393	1.2888	1.373	1.2849	1.325	1.2824
0.9	1.398	1.3249	1.381	1.3205	1.328	1.3177



Fig(4-a-c):- Experimental values and theoretical values of refrctire indexces of sinary mixture ethanol water with volume of ethanol in 293K ,298 K and 303 K.

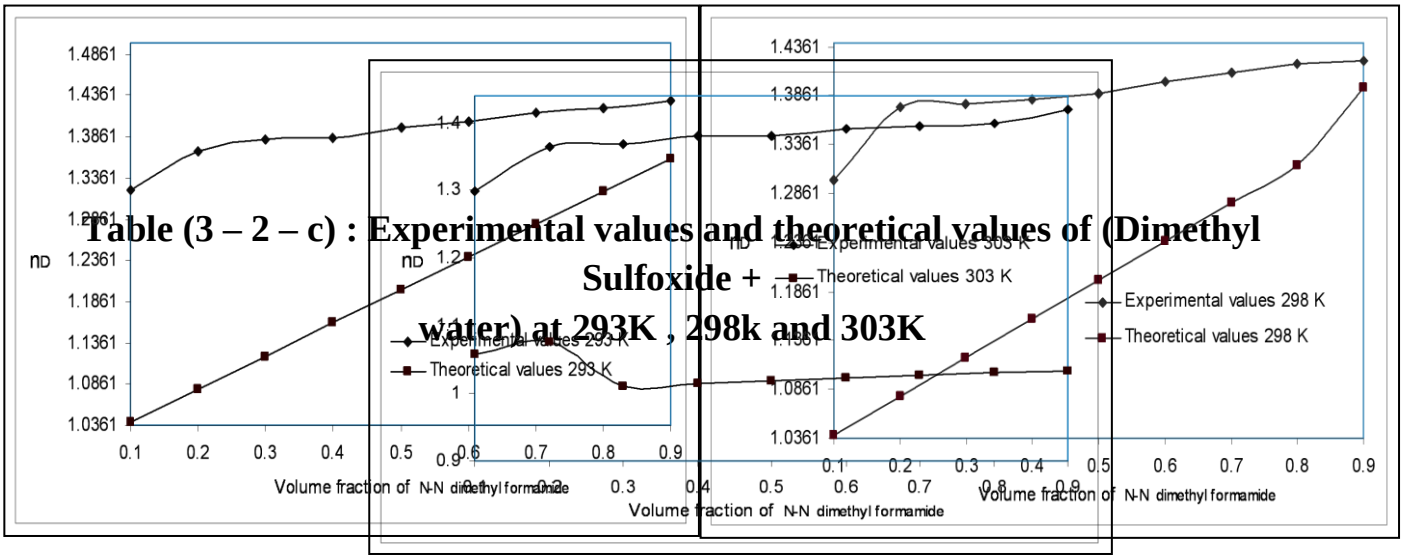
Volume fraction Solvent Dimethyl Sulfoxide -water	n_D					
	293K		298K		303K	
	Experimental values	Theoretical values	Experimental values	Theoretical values	Experimental values	Theoretical values
0.1	1.390	1.0468	1.389	1.0423	1.385	1.0398
0.2	1.392	1.0937	1.391	1.0846	1.389	1.0796
0.3	1.401	1.1406	1.400	1.1269	1.391	1.1194
0.4	1.406	1.1875	1.140	1.1693	1.395	1.1593
0.5	1.412	1.2344	1.410	1.2116	1.399	1.1991
0.6	1.415	1.2812	1.412	1.2539	1.401	1.2389
0.7	1.418	1.3281	1.417	1.2963	1.411	1.2788
0.8	1.422	1.3750	1.420	1.3386	1.419	1.3186
0.9	1.443	1.4219	1.423	1.3809	1.420	1.3584

Volume fraction Solvent N.N-dimethyl formamide -water	n_D					
	293K		298K		303K	
	Experimental values	Theoretical values	Experimental values	Theoretical values	Experimental values	Theoretical values
0.1	**1.322**	**1.0400**	**1.300**	**1.0394**	**1.299**	**1.0570**
0.2	**1.368**	**1.0800**	**1.374**	**1.0789**	**1.365**	**1.0750**

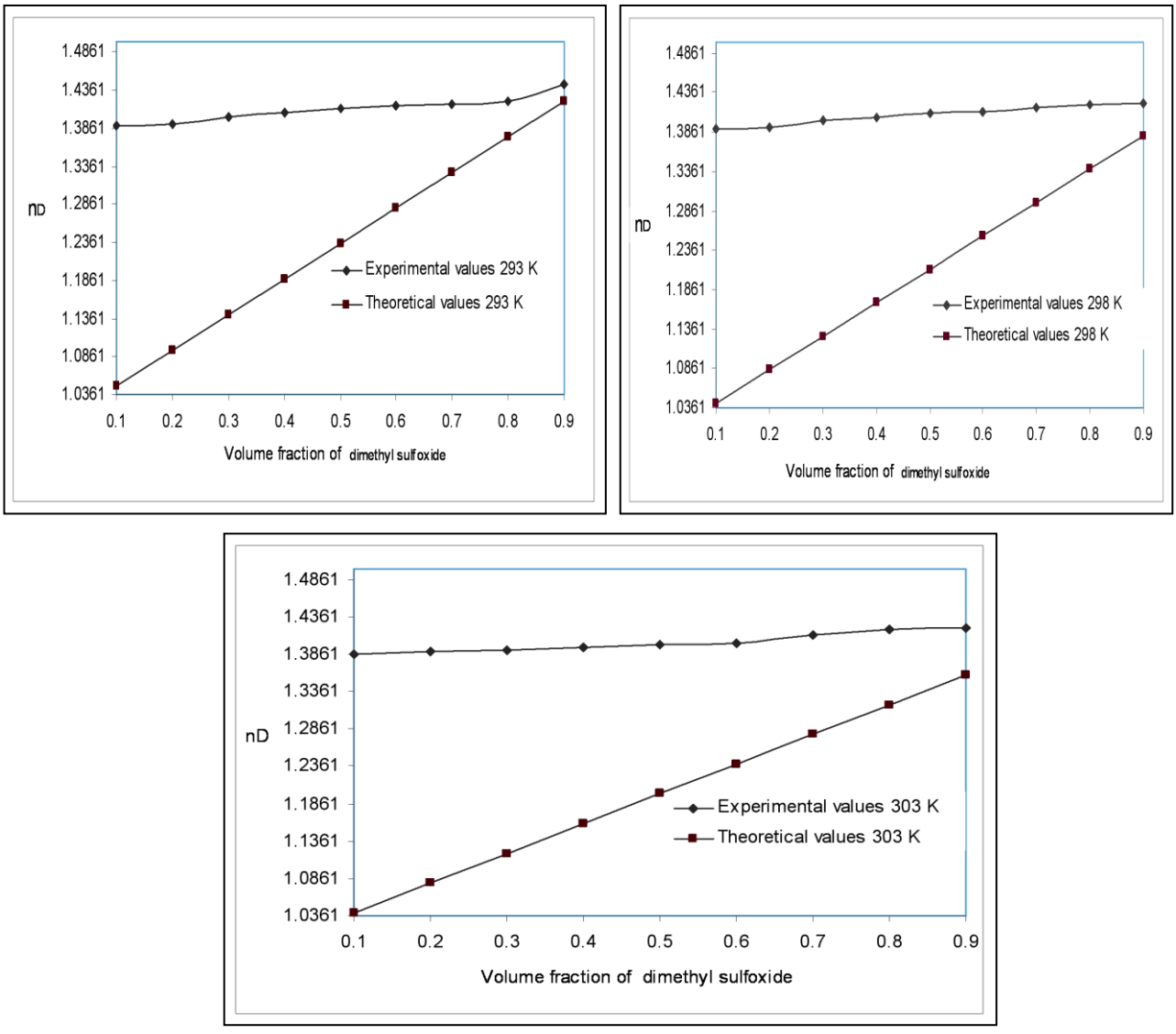
Table (3 – 2– b) : Experimental values and theoretical values of (dimethyl formamide + water) at 293K , 298k and 303K

0.3	**1.382**	**1.1200**	**1.378**	**1.1184**	**1.368**	**1.0112**
0.4	**1.385**	**1.1600**	**1.382**	**1.1578**	**1.381**	**1.0150**
0.5	**1.398**	**1.2001**	**1.388**	**1.1973**	**1.380**	**1.0188**
0.6	**1.405**	**1.2401**	**1.401**	**1.2368**	**1.391**	**1.0225**
0.7	**1.416**	**1.2801**	**1.410**	**1.2762**	**1.394**	**1.0263**
0.8	**1.420**	**1.3201**	**1.419**	**1.3157**	**1.400**	**1.0300**
0.9	**1.429**	**1.3601**	**1.422**	**1.3947**	**1.420**	**1.0338**

Table (3 – 2 – c) : Experimental values and theoretical values of (Dimethyl Sulfoxide + water) at 293K , 298k and 303K



Fig(5-a-c):- Experimental values and theoretical values of refrctire indexces of sinary mixture N-N dimethyl formamide water with volume of N-N dimethyl formamide in 293K ,298 K and 303 K.



Fig(6-a-c):- Experimental values and theoretical values of refrctire indexces of sinary mixture dimethyl sulfoxide water with volume of dimethyl sulfoxide in 293K ,298 K and 303 K.

Effect of Temperature :

The result show that the measured properties of density , viscosity and refractive index in table of mixtures are found to decrease as the temperature increase .

This is prove that the solvent – solvent interaction process decrease as the temperature increase . [5,10 , 14]

Conclusion :-

The intensive properties (density , viscosity and refractive index)for these mixtures can be summarized that the interaction solvent – solvent process depend on the nature of the solvent as specific forces between molecules like hydrogen bonds , dipole – dipole interaction between the mixing component and on its physical properties such as dielectric constant , dipole moment .

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دراسة بعض الخصائص المركزة لبعض المذيبات القطبية الثنائية في درجات حرارية مختلفة

نهلة شاكر سلمان

قسم الكيمياء / كلية التربية / جامعة القادسية

الخلاصة :

تضمن البحث دراسة بعض الخصائص الفيزيائية المركزة من كثافة ، لزوجة ومعامل الانكسار لبعض المذيبات الثنائية القطبية .

هذه الأنظمة الثنائية تتكون من مزيج مذيبات قطبية (قطبي-قطبي (ايثانول ماء) ومزيج من مذيبات قطبيه(لاقطبي- قطبي)(داي مثيل سلفوكسايد-ماء وN – N – داي مثيل فورما مايد – ماء) .

كما تم دراسة تأثير درجات الحرارة على هذه الخصائص ومن خلال النتائج التجريبية التي تم الحصول عليها تم معرفة طبيعة التداخلات الجيزئية الحاصلة بين جزيئات الأمزجة الثنائية .

كما تم المقارنة بين معامل الانكسار التي تم الحصول عليه بصورة عملية وبين معامل الانكسار المحسوب نظريا ووجد أن هنالك تقاربا بين القيم العملية والنظريه .