Effect of Temperatuer on density,Viscosity and Refractive Index for Binary mixtures of Benzen with some non-polar Solvents at 293K, 298K and 303K

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Abstract

The studies of density (ρ), Viscosity (η) and refractive index (nD) are being increasing used as tools for investigation of the properties of pure component and the nature of intermolecular interactions between the liquid mixture constituents. Experimental results of density (ρ), Viscosity (η) and refractive index (nD) of binary liquid mixtures of (benzene+n-hexane), (benzene+toluene), (benzene+chloroform) and (benzene +carbontetra chlorid) have been determined for varying mole fraction of solvents components at 293,298, and 303 K under atmospheric pressure. The viscosity of these binary mixtures were calculated theoretical from pure component data by using various empirical relation.RM for pure component and Rm of binary component were calculated from density and refractive index of pure solvents. The results are farther discussed intermolecular interaction and structural of properties of binary liquid mixtures. The structural variation of binary mixtures have been discussed on the basis of the change in viscosity. The variation of these parameters with composition and temperature of the mixtures have been discussed in term of molecular interaction in the mixtures.

1 . Introduction

Binary liquid mixture due to their unusual behavior have attracted considerable ettention .Densities ,Viscosities, and refractive indexces over the miscible composition range of binary mixtures of (benzene+n-hexane), (benzene+toluene), (benzene+ chloroform) and (benzene + carbontetra chorid) at 293K,298K and 303K at atmospheric pressure have been measured The physical property data an mixed solvents,rather than single pure liquids are important for theoretical and applied areas of research and are frequently used in many chemical and industrial.arrangment occurring at molecular level in binary mixture can be understood by the structural and solvent-solvent interaction of their physical properties such as densities viscosities and refractive indexces.The aromatic hydrocarbon molecules (benzene, toluene) posses larga quadrupole moments, causing an orientational order in these liquid. Benzene an industrical solvent and chemical intermediate in many other processes is a non-polar organic solvents has slightly polar nature due to the doecalized electron cloud ,which results in the solute solvent molecular association ,benzene exists as dimer.

The structure making and breaking properties of some solvents in binary liquid mixture can be studied by measurments of their viscosity, and the viscosity have been regarded as a probe of intermolecular interaction and its a

nimportant physical property of liquid metals as well as density and refractive index [1-10]. Viscosity changes with shear rate, temperature, pressure and concentration all these can be amoledelled by equations.

2 . Experimental
2 . 1 Materials and Measurements

The solvents used in this inverestion are pure and supplied from BDH and used as received without any further purification ,the used solvents were absolute (benzene 99% ,n-hexan 98%,chloroform98% ,toluene 95% and carbontetra chlorid 99%.Different binary mixtures of solvents from by (1-10) (ml) volume were prepared in a clean test tubes closed carefuly and kept in thermostated water-bath (optima) for 15 min at the meaning temperature [11.12].

2 . 2 Density

The density of pure solvents and different solution mixtures were measured by using single capillary density bottle or pycnometer having volume of 5cm3 and capillary diameter of about 1mm. The pycnometer was calibrated with doubly distilled water.[10-14].

2 . 3 Viscosity

The viscosities of pure liquid and their binary mixtures were measured by using ybblelohde type suspended level viscometer.The time required for flow from upper mark lower mark were recorded with electronic stop watch with precision of (0.01 sec) for binary solvent was measured using ybbelhode viscometer and viscosities of different

solutions were determind from its flow time were accurate to ±0.15. the viscometer containing the test liquid was allowed to stand for about 15 minytes in a thermostatic water bath [2,3, 14,17].

2 . 4 Refractive index

The experimental values of refractive indexes of pure liquids and their binary mixtures were measured by using Abb refractometer with different temperature .The values of refractive indexes were obtained using sodium D light [8].The function such as RM,have been calculated by using the following relation .The Rm for pure solvents were calculated by using the equation [8,15,16]

$$RM=(n-1/n+2).M/\rho\text{--------------------}1$$

RM=molecular refeaction

Where (n)refractive indexes ,(M) molecular

weight and (ρ) the density of pure solvent in the mixture.Rm for binary mixtures were calculated by using the equation

$$Rm=x1RM1+x2RM2\text{-----------------}2$$

Rm=molare refeaction Where x1,x2 mole fraction and RM1,RM2 molecular fraction for components the mixtures.

3 . Result and Discussion:-

3.1:InThe experimental values of measured densities and viscosities of the pure liquid at 293K , 298K and 303K along with literature values are given in Table (1) and found to be in good agreement. The experimental values of densities and viscosities of studied binary mixtures at 293K, 298K and 303K are given over the whole composition rang expressed by mole fraction x1 of benzene at different temperature are listed in Table (2-5) Table.

Table (2) was shows that the densities and viscosities of the binary mixtures decreased with increased of temperature and increase with increasing of mole fraction of benzene, Fig(1), while Table (3-5) show that the densities and viscosities of the binary mixtures decreased with increased of temperature

and decreased with increasing of mole fraction of benzene[1-9,12], Fig (2-4).The trend in density and viscosity indicates the intermolecular interaction. The aromatic hydrocarbon molecules are (non-polar) solvents like benzene having π-electrons on the ring which be mix with another non-polar aromatic solvents like toluene and aliphatic like n-hexane, chloroform and carbontetra chloride over the known base (like dissolve like) and that's observed with increase the density ,viscosity and refractive index between benzene and n-hexane because the similarity in structure and dielectric constant decrease density and viscosity for benzene with chloroform and carbonteta chloride and the toluene. The interaction is present between these non-polar solvents are weak forces like van-der-waals or dispersion forces.

Table 1 : densities and viscosities and refractive indexces of the pure component and their comparision with literature[2] value of 298K

component	ρ (g . cm^{-3})		η (p)		n_D	
	Exp	**Lit**	**Exp**	**Lit**	**Exp**	**Lit**
Benzene	0.871	0.879	0.700	0.652	1.5059	1.500
n-hexane	0.659	0.655	0.402	0.300	1.422	1.388
chloroform	1.408	1.498	1.661	2.667	1.677	1.490
carbontetracloride	1.602	1.584	1.206	0.900	1.421	1.460
toluen	0.862	0.867	0.611	0.559	1.487	1.496

**Table 2: Experimental values of densities and viscosities of   (Benzen + n-hexane)
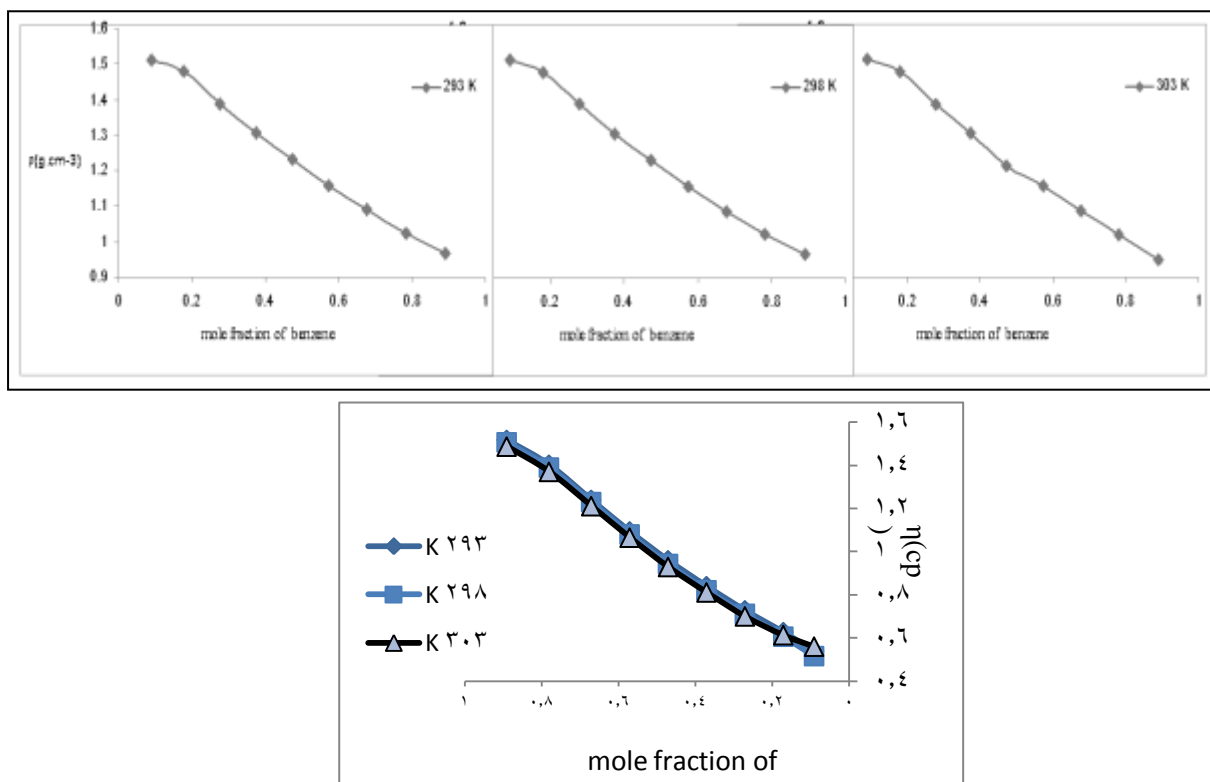at 293K , 298K , and 303K**

Mole fraction solvent (benzene+ n-hexane)		ρ (g . cm⁻³)			η (cp)		
X1	X2	293K	298K	303K	293K	298K	303K
0.1394	0.8605	0.5828	0.5814	0.5803	0.324	0.202	0.092
0.2681	0.7318	0.6522	0.6510	0.6495	0.388	0.302	0.191
0.3858	0.6141	0.6908	0.6876	0.6858	0.436	0.401	0.204
0.4945	0.5054	0.7566	0.7537	0.7517	0.500	0.491	0.299
0.5948	0.4050	0.8026	0.8002	0.7974	0.590	0.579	0.378
0.6876	0.3123	0.8238	0.8218	0.8193	0.671	0.678	0.488
0.7740	0.2257	0.8476	0.8458	0.8428	0.734	0.773	0.587
0.8549	0.1457	0.8490	0.8468	0.8436	0.803	0.852	0.709
0.9303	0.0696	0.8754	0.8728	0.8705	0.878	0.940	0.797
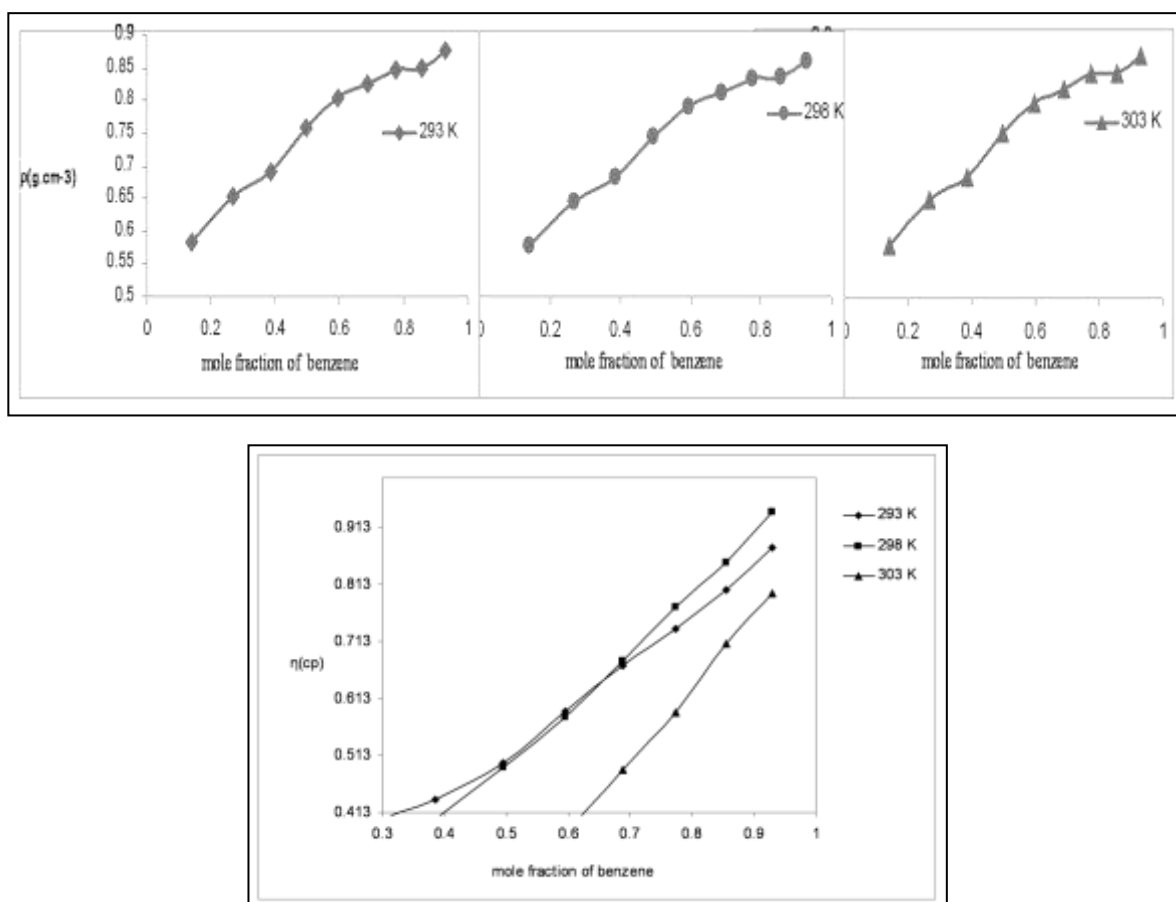
**Fig(1):- variation of density and viscosity of binary non-polar mixtures (Benzen+ n-hexane)
with mole fraction of benzen at 293 K,298 K and 303 K.**

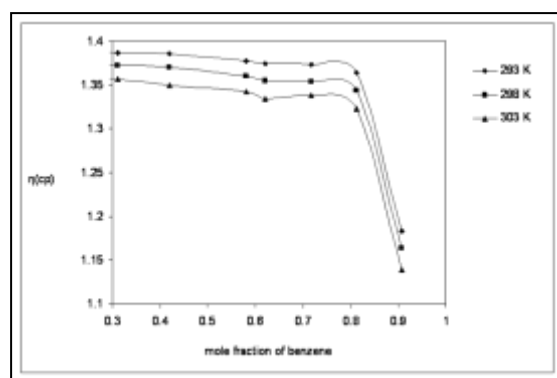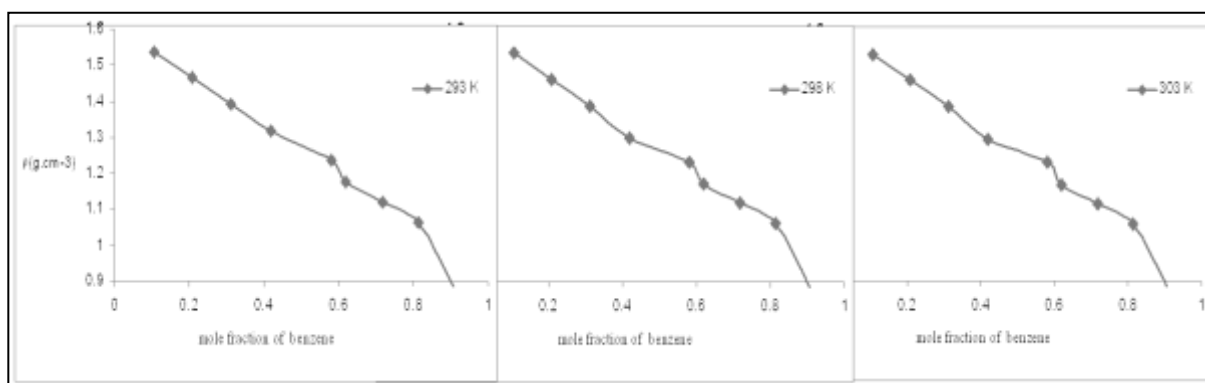**Table 3 : Experimental values of densities and viscosities of (benzene+chloroform)**

Mole fraction		ρ (g . cm^{-3})			η (cp)		
X1	X2	293K	298K	303K	293K	298K	303K
0.0901	0.9098	1.5128	1.5118	1.5104	1.518	1.507	1.487
0.1794	0.8205	1.4796	1.4781	1.4766	1.403	1.390	1.370
0.2775	0.7224	1.3894	1.3874	1.3863	1.240	1.230	1.211
0.3742	0.6261	1.3074	1.3050	1.3035	1.094	1.080	1.065
0.4731	0.5275	1.2322	1.2304	1.2124	0.960	0.943	0.929
0.5733	0.4266	1.1588	1.1573	1.1573	0.840	0.821	0.811
0.6766	0.3235	1.0892	1.0876	1.0875	0.728	0.712	0.700
0.7823	0.2181	1.0228	1.0214	1.0210	0.627	0.616	0.613
0.8903	0.1103	0.9678	0.9655	0.9478	0.5396	0.516	0.560

Fig(2):- variation of density and viscosity of binary non-polar mixtures (Benzen + chloroform) with mole fraction of benzen at 293 K,298 K and 303 K.

Table 4: Experimental values of densities and viscosities of (benzen+carbon tetrachloride) at 293K , 298k and 303K

Mole fraction		ρ (g . cm^{-3})			η (cp)		
X1	**X2**	**293K**	**298K**	**303K**	**293K**	**298K**	**303K**
0.1057	0.9010	1.5368	1.5357	1.5345	1.392	1.381	1.370
0.2091	0.7889	1.4640	1.4627	1.4615	1.389	1.374	1.361
0.3119	0.6805	1.3916	1.3896	1.3881	1.387	1.372	1.357
0.4195	0.5805	1.3180	1.2990	1.2970	1.386	1.370	1.350
0.5808	0.4192	1.2354	1.2331	1.2309	1.377	1.360	1.342
0.6201	0.3816	1.1742	1.1717	1.1698	1.374	1.355	1.334
0.7166	0.2833	1.1198	1.1177	1.1161	1.373	1.354	1.338
0.8126	0.1873	1.0638	1.0610	1.0589	1.364	1.344	1.323
0.9070	0.0929	0.8842	0.8827	0.8810	1.1833	1.164	1.139

Fig(3):- variation of density and viscosity of binary non-polar mixtures (Benzene + carbon tetrachloride) with mole fraction of benzen at 293 K,298 K and 303 K.

Table 5 : Experimental values of densities an dviscosities of (benzene +toluene)
at 293K , 298k and 303K

Mole fraction		ρ (g . cm⁻³)			η (cp)		
X1	X2	293K	298K	303K	293K	298K	303K
0.1180	0.8825	0.9104	0.9090	0.9078	1.338	1.334	1.332
0.2321	0.7678	0.9100	0.9086	0.9075	1.332	1.330	1.331
0.3417	0.6582	0.9084	0.9066	0.9046	1.329	1.328	1.336
0.4469	0.5530	0.9056	0.9055	0.9038	1.328	1.327	1.325
0.5481	0.4518	0.9053	0.9035	0.9033	1.327	1.325	1.320
0.6450	0.3549	0.9040	0.9035	0.9016	1.324	1.321	1.317
0.7365	0.2634	0.9031	0.9029	0.9020	1.317	1.309	1.308
0.7637	0.2362	0.9019	0.9000	0.8999	1.303	1.237	1.228
0.9160	0.0839	0.9010	0.8991	0.8979	1.208	1.201	1.200
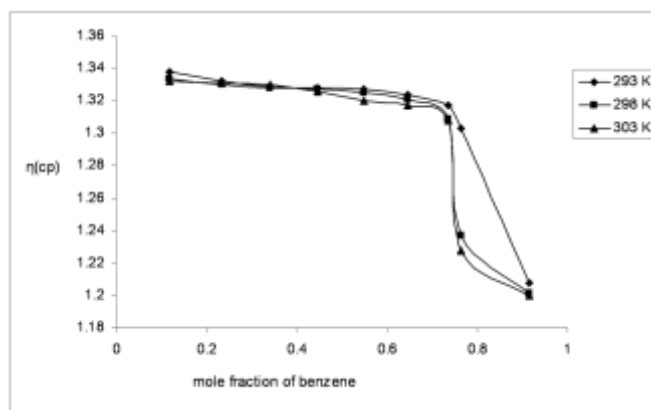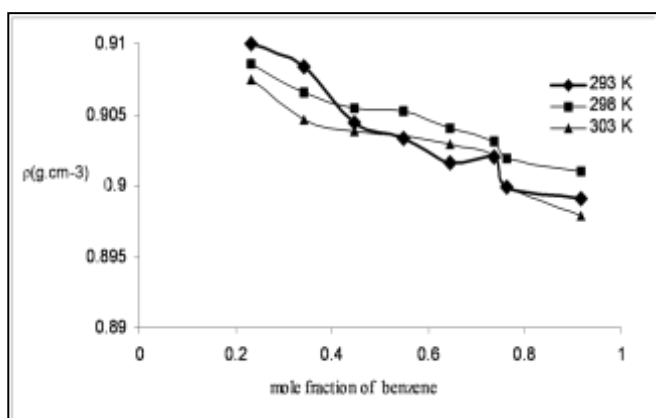
Fig(4):- variation of density and viscosity of binary non-polar mixtures (Benzene + toluene)
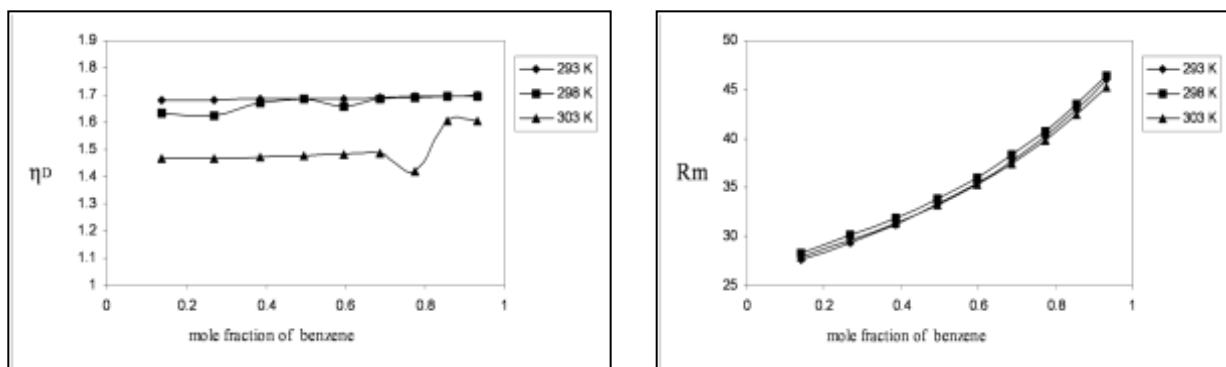**with mole fraction of benzen at 293 K,298 K and 303 K.**

3.2-The experimental values and theoretical values of Refractive indexes of studied solvents

mixtures at 293K, 298K and 303K are given in Table(6-9) Table (6) shows that the experimental values of refractive indexces and molar refractive indexces of these binary mixture decreased with increased of temperature , and indexces with increased of mole fraction (X_1) of benzene ,Fig(5). Table (7,9) showed that the experimental values of refractive indexces and molar refractive indexces which were calculated from pure component data by using empirical relations decreased with increased of temperature , and decresed with increased of mole fraction (X_1) of benzene ,Fig(6,8).

Table 6 : Experimental values of refractive indexces and moler refractive indexces of (benzene +n-hexane) at 293K , 298k and 303K

Mole fraction solvent (benzene +n-hexane)		n_D			Rm		
X1	X2	293K	298K	303K	293K	298K	303K
0.1394	0.8605	1.680	1.612	1.465	28.344	27.881	27.645
0.2681	0.7318	1.682	1.622	1.468	30.104	29.575	29.428
0.3858	0.6141	1.684	1.632	1.472	31.909	31.312	31.259
0.4945	0.5054	1.685	1.647	1.476	33.895	33.272	33.223
0.5948	0.4050	1.686	1.656	1.481	35.963	35.418	35.261
0.6876	0.3123	1.691	1.666	1.486	38.312	37.749	37.473
0.7740	0.2257	1.695	1.670	1.490	40.798	40.269	39.865
0.8549	0.1457	1.696	1.685	1.504	43.490	42.997	42.456
0.9303	0.0696	1.698	1.697	1.550	46.490	45.981	45.289

Fig(5):- variation of refractive indexces and molar refractive indexces of binary non-polar mixtures (benzene+n-hexane).

Table 7 : Experimental values of refraction indexces and moler refraction indexces of (benzene +chloroform) at 293K , 298k and 303K

Mole fraction solvent (benzene +chloroform)		n_D			Rm		
X1	X2	293K	298K	303K	293K	298K	303K
0.0901	0.9098	1.478	1.464	1.449	30.246	29.629	29.173
0.1794	0.8205	1.476	1.463	1.451	29.832	29.346	28.896
0.2775	0.7224	1.473	1.456	1.422	29.378	29.036	28.592
0.3742	0.6261	1.444	1.433	1.418	28.942	28.743	28.303
0.4731	0.5275	1.440	1.427	1.408	28.493	28.439	28.005
0.5733	0.4266	1.437	1.419	1.400	28.101	28.008	27.673
0.6766	0.3235	1.4336	1.415	1.398	27.780	27.535	27.359
0.7823	0.2181	1.431	1.409	1.394	27.455	27.055	27.039
0.8903	0.1103	1.406	1.384	1.379	27.120	26.710	26.561
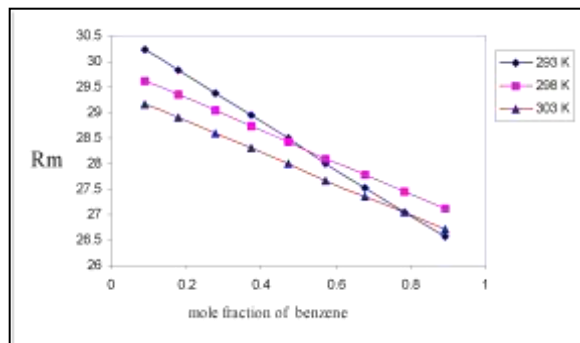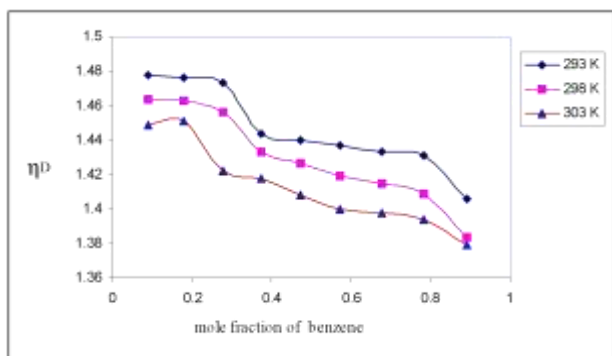
Fig(6):- variation of refractive indexces and molar refractive indexces of binary non-polar mixtures (benzene+chloroform).

Table 8 : Experimental values of refraction indexces and moler refraction indexces of (benzene + carbontetrachloride) at 293K , 298k and 303K

Mole fraction solvent (benzene +n-hexane)		η_D			Rm		
X1	X2	293K	298K	303K	293K	298K	303K
0.1057	0.9010	1.534	1.522	1.505	37.064	37.032	36.320
0.2091	0.7889	1.512	1.501	1.496	35.459	34.873	34.834
0.3119	0.6805	1.500	1.498	1.484	34.202	34.012	33.547
0.4195	0.5805	1.496	1.489	1.464	33.547	33.281	33.009
0.5808	0.4192	1.494	1.483	1.462	32.661	31.468	31.072
0.6201	0.3816	1.488	1.472	1.455	31.091	30.665	30.544
0.7166	0.2833	1.482	1.467	1.445	29.937	29.438	29.428
0.8126	0.1873	1.475	1.457	1.439	28.858	28.385	28.285
0.9070	0.0929	1.468	1.447	1.426	27.797	27.359	27.151
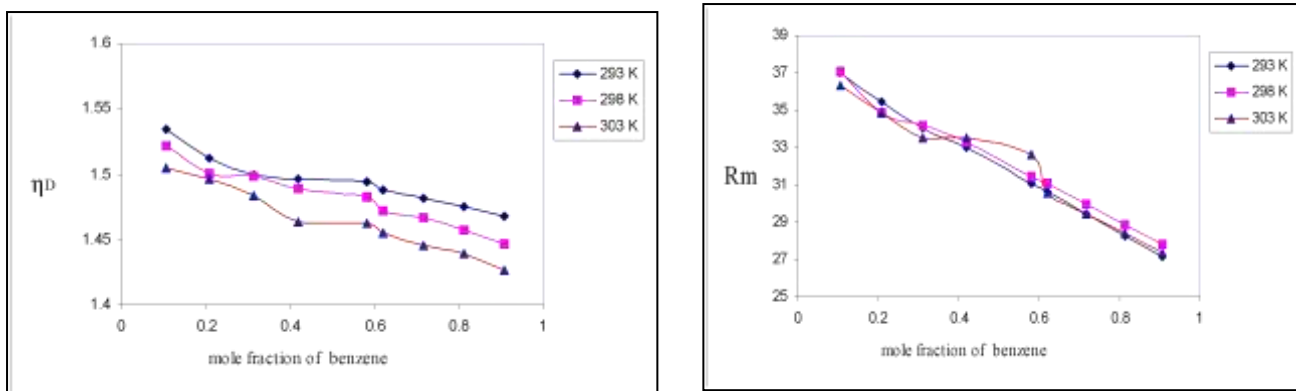
Fig(7):- variation of refractive indexces and molar refractive indexces of binary non-polar mixtures (benzene+ carbontetrachloride).

Table 9 : Experimental values of refraction indexces and moler refraction indexces of (benzene +toluene) at 293K , 298k and 303K

Mole fraction solvent (benzene +toluene)		n_D			Rm		
X1	**X2**	**293K**	**298K**	**303K**	**293K**	**298K**	**303K**
0.1180	0.8825	1.661	1.651	1.649	30.456	29.964	28.095
0.2321	0.7678	1.650	1.643	1.630	29.867	29.532	27.854
0.3417	0.6582	1.641	1.626	1.618	29.320	29.132	27.639
0.4469	0.5530	1.633	1.616	1.612	28.794	28.755	27.433
0.5481	0.4518	1.621	1.606	1.605	28.388	28.289	27.235
0.6450	0.3549	1.603	1.601	1.585	28.037	27.805	27.045
0.7365	0.2634	1.598	1.596	1.584	27.706	27.347	26.865
0.7637	0.2362	1.590	1.588	1.581	27.608	27.212	26.812
0.9160	0.0839	1.587	1.582	1.571	27.056	26.514	26.451
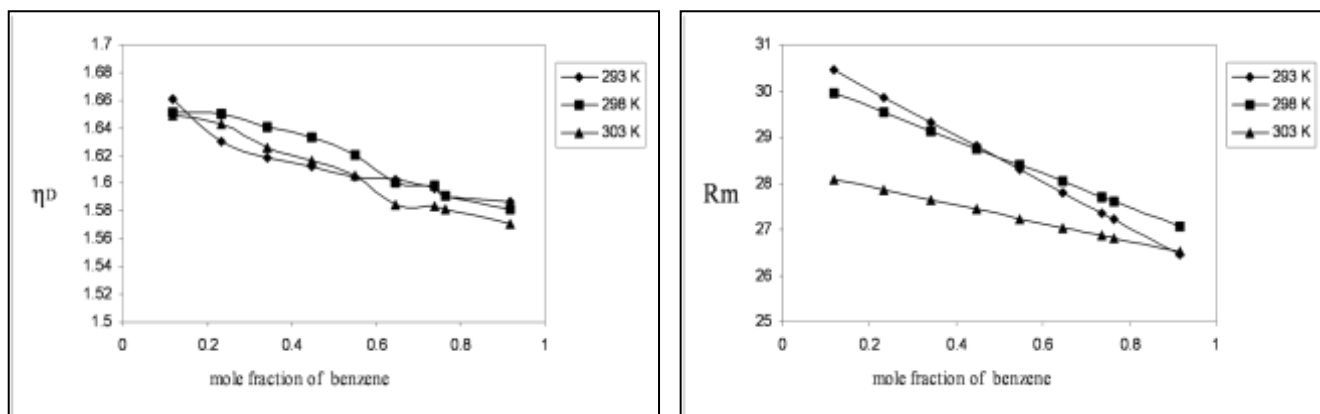
Fig(8):- variation of refractive indexces and molar refractive indexces of binary non-polar mixtures (benzene+ toluene).

Effect of temperature

The results show that the measured properties of density ,viscosity refractive index and molar rerfraction index in tables of binary mixtures are found to decrease as the temperature increase .This is dicates that the solvent-solvent interaction processes decrease as the temperature increase [5,10,12,14,16,17] .

Conclusions

The physical propertiese density ,viscosity refractive indexces and molar rerfraction indexces for these binary mixtures can be under stood by the interaction processes of solvent-solvent depend on the structure ,nature of the solvents, mole fraction and on its physical properties such as the dielectric constant and dipoel-dipole moment and these interaction processes occurring by weck forces like van-der-waals forces (dispersion forces) are primary responsible for the interaction between the compound molecules.

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تأثير درجات الحرارة على الكثافة والزوجة ومعامل الانكسار لمزيجات ثنائية من البنزين مع بعض المذيبات الغير قطبية في درجة حرارة293 و 298 و303 كلفن

نهلة شاكر سلمان
قسم الكيمياء / كلية التربية / جامعة القادسية

الخلاصة

تضمن البحث دراسة بعض الخصائص الفيزيائية المركزة من كثافة ولزوجة ومعامل الانكسار الجزيئي لبعض المذيبات النقية ومعامل الانكسار المولاري للمذيبات الثنائية. هذه الأنظمة الثنائية تتكون من مزيج مذيبات غير قطبية (بنزين –n). هكسان و(بنزين–كلوروفورم) و(بنزين-رابع كلوريد الكاربون) و(بنزين-تولوين). حسبت اللزوجة (η)، معامل الانكسار الجزيئي (RM) ومعامل الانكسار المولاري (Rm) من قيم الكثافة ومعامل الانكسار التي تم الحصول عليها بصورة عملية. كما تم دراسة تأثير درجات الحرارة على هذه الخصائص الفيزيائية من خلال النتائج التجريبية التي تم الحصول عليها معرفة طبيعة التداخلات الجزيئية الحاصلة بين جزيئات الامزجة الثنائية على اساس الاختلاف في التركيب والكسور المولية للمكونات الامزجة الثنائية.