Ultrasonic velocity, Density and Viscosi binary liquid mixture of 1-butanol and 1-pentanol with O-Nitrotolune at 303.15 and 313.15 K.

R.D.Pawar [1], S.R.Patil [2], and G.P.Waghulde*[3]
[1]Department of Chemistry,A.C.S. College ,Yawal,M.S., India.
[2]P.G. Department of Chemistry,A.S.C. College ,Chopda,M.S., India.
[3]P.G. Department of Chemistry,D.D.N.Bhole College, Bhusawal,M.S., India.
rdpawar69@gmail.com
srpatil_001@rediffmail.com.

Abstract:-

Ultrasonic velocity, density and viscosity were reported for binary mixture of 1-butanol and 1-pentanol with O-nitro toluene over an entire range of composition at 303.15 and 313.15 K. The experimental data were used to calculate the excess molar volume, viscosity deviation and deviation in isentropic compressibility. The result was interpreted in terms of molecular interaction studies between the components of binary mixture. The deviation in ideal mixing law in most of calculated parameters are negative. This reveals the nature and magnitude of intermolecular interaction between unlike molecules and electron donating alkyl group.

Key Words: - Ultrasonic velocity, Density, Viscosity Excess molar volume, viscosity deviation, Isentropic Compressibility.

INTROCTION:-

The measurement of ultrasonic velocity, density and viscosity find wide applications in physic-chemical properties of liquid mixtures .It is also understanding in the molecular interaction studies of pure liquids and binary liquid mixtures[1-3]. The ultrasonic measurement can be used to provide information about physical nature and strength of molecular interactions in liquid mixtures[4-6]. The ultrasonic velocity is mainly related to binding forces between atoms or molecules.

The physic-chemical properties of pure liquids and of their binary liquid mixture at different temperature of whole composition are useful for the understanding the thermodynamics and transport properties as well as practical chemical engineering purposes The excess thermo-dynamic properties are applicable for the interaction between components of mixtures [7-10]

The study of ultrasonic velocity, density and viscosity measurement are widely used in characterising the physico- chemical properties .The alcohols are strongly self associated liquid with three dimensional network of hydrogen bond [1]. The investigation regarding the molecular association in organic binary mixture having one of the alkanol group. Since alkanol group is highly polar and can be association with any other group having some degree of polar attraction

EXPERIMENTAL:-

The chemicals 1-butanol and 1-pentanol with O-nitro toluene were of analytical grade (A.R) minimum assay of 99.9% obtained from s. d. fine chemicals India. Which are used as such without further purification. The densities of pure components and binary mixtures were measured by using a Bi-capillary pycnometer. The purities of the above chemicals were checked density determination. The binary liquid mixtures of different known concentration were prepared in stopper measuring flask. The weight of the sample was measured using electronic digital balance with an accuracy of ± 0.1mg. The viscosity was measured using Ubbelohde viscometer (20ml) and the efflux time was determined using a digital clock to within ± 0.015. The ultrasonic velocity (U) in liquid mixtures have been measured using an ultrasonic interferometer (Mittal type, model F-81) working at 2 MHz frequency The accuracy of sound velocity was ±0.1 ms^{-1}

THEORY AND CALCULATION:-

The molar excess volume of the binary mixture have been calculated from the value of density and mole fractions –

$$V^E = (M_1X_1+M_2X_2)/\rho_{12} -(M_1X_1) /\rho_1 - (M_2X_2) / \rho_2 \quad \text{-- (1)}$$

The viscosity of binary mixture can be determine by –

$$\ln\eta_m=X_1\ln\eta_1+X_2\ln\eta_2 \quad \text{--(2)}$$

The measured values of viscosities of binary mixture have been evaluated the viscosity deviation –

$$\Delta\eta_m=\eta_{12}-X_1\eta_1-X_2\,\eta_2 \quad \text{--(3)}$$

Deviation in isentropic compressibility have been calculated by following way –

$$\Delta k_S-k_S-(\Phi_1\, k_{S1} + \Phi_2\, k_{S2}) \quad \text{--(4)}$$

Where k_{S1}, k_{S2} and K_S are isentropic compressibility of liquid mixtures and Φ is volume fraction of pure i^{th} component in the mixture and is defined as

$$\phi= (xi\ Vi) / (\Sigma\ xi\ Vi) \quad \text{--(5)}$$

Where x_i and V_i are mole fraction and molar volume of ith component in the mixture

RESULT AND DISCUSSION:-

Determination of ultrasonic velocity and viscosity of alkanols with O-Nitro toluene gives reliable information about molecular interaction. In pure state alkanol get itself associate. The association of alkanols decreases with increase in chain length of alkanols .When alcohols are mixed with O-nitro toluene then there is interaction between individual functional groups .The presence of electron withdrawing nitro group deceases the electron densities. The polarity of alcohol is less hence degree of self association is less.

The experimental values of density (ρ) viscosity (η) ultrasonic velocity (U), Excess volume (V^E), viscosity deviations and ($\Delta\eta$), deviation on isentropic compressibility (Δk_S) for binary Systems of 1-butanol and 1-pentanol (1) with o-nitro toluene(2) at 303.15 and 313.15 K are reported in Tables1 and 2 respectively. The variation of excess parameters with mole fraction of alkanols at 303.15 and 313.15K are plotted in Figure 1-4.The figure 1-4 shows that curve for ultrasonic velocity,excess molar volume ,viscosity deviation and deviation in isentropic compressibility are plotted against mole fractions at 303.15K formixture of 1-butanol and 1-pentanol with O-nitrotolune. Figure 2-4 shows that curve for excess molar volume ,viscosity deviation and deviation in isentropic compressibility are negative over entire mole fraction of alkanols at given temperature.In studied work the excess molar volume (V^E) values have been observed negative which attributed strong molecular interaction between the unlike molecules. Generally when two solvents are mixed the molecular interaction held will be depend upon the type and nature of molecules. The positive excess volumes attribute structure breaking interactions while negative excess volumes attribute structure making interactions [13] .

The observed V^E values may be analysed in terms of several effects which may be categorised as physical, chemical and geometrical contributions [12].The physical interactions compromise mainly dispersion forces and non specific physical interaction giving positive contribution. The chemical interaction involves the charge transfer complexes, resulting in contraction of volume, geometrical or structural contribution arising from the geometrical fitting of one component into other .[8] The negative, viscosity deviation and deviation in isentropic compressibility may be attributed to existence of dispersion dipole forces between unlike molecules and related to the difference in size and shape of molecules [14]. Increase of temperature disturbs hetero and homo association of molecules which increase the fluidity of the liquid. The values of viscosity deviation are more negative for 1-pentanol which provides additional evidences for existence of interaction of weak magnitude like dipole –induced dipole type between components of liquid[15]. The magnitude of viscosity deviation and deviation isentropic compressibility the sign and extent of deviation of these properties from idealist depends upon the strength of interaction between unlike molecules. According to fort

et. al. the excess viscosity gives the molecular interaction between interacting molecules. For the system where dispersion, induction and dipolar forces which are operated by values of excess viscosity are found to be negative, the large negative values of excess viscosity for the system can be attributed to the presence of dispersion, induction and dipolar forces between the components. The positive isentropic compressibility which indicates loosely packed molecules in the binary system. The 1-pentanol has more negative viscosity deviation but less negative isentropic compressibility values this is due to structural differences in these two alcohol molecules.

CONCLUSION:-

The experimental data of density, viscosity and ultrasonic velocity are reported for binary mixtures of 1-butanol and 1-pentanol with O-nitro toluene over entire range of mole fractions at 303.15 K and 313.15K. Calculated, viscosity deviation, excess molar volume and deviation in isentropic compressibility shows large negative deviations for most investigated binary system. This reveals the existence of molecular interaction in binary system. The present investigation shows that greater molecular interaction exist in 1-pentanol and O-nitrotolune binary mixture which may be due to presence of more carbon –carbon linkage than 1-butanol.

Table.1. Values of densities,viscosities,ultrasonic velocity,Excess molar volumes and Deviation in viscocity and deviation in isentropic compressibility for binary system of 1-butanol and O-nitrotolune at 303.15 and 313.15 K.

Temp K	X_1	P (gm /cm^3)	$\eta 10^3$ (Nsm^{-2})	U (M S^{-1})	$V^E x10^6$(m^3/mole)	$\Delta \eta x10^3$(Kg m^{-1}s^{-1})	$\Delta ksx10^{11}$ (m^{2}N^{-1})
303.15	0.0000	0.80160	2.24870	1448.8	0.0000	0.000	0.00
	0.0569	0.82930	2.06770	1467.2	-0.8344	-15.286	-32.57
	0.1193	0.85560	1.87300	1499.0	-1.3877	-31.645	-50.33
	0.1880	0.88830	1.78100	1531.4	-2.5243	-37.421	-44.93
	0.2651	0.92100	1.71180	1533.6	-3.4877	-40.497	-44.81
	0.3511	0.95330	1.68990	1549.8	-4.2698	-38.400	-67.84
	0.4480	1.05220	1.66350	1566.7	-11.4781	-36.210	-60.98
	0.5578	1.06720	1.57400	1600.0	-10.3508	-39.686	-65.45
	0.6838	1.10600	1.62190	1650.9	-11.3410	-28.615	-53.29
	0.8296	1.14280	1.65230	1674.2	-12.0101	-18.307	-13.89
	1.0000	1.06470	1.75020	1682.9	0.0000	0.000	0.00
313.15	0.0000	0.79390	1.83730	1399.4	0.0000	0.000	0.00
	0.0569	0.82080	1.70140	1453.6	-0.2415	-10.611	-42.63
	0.1193	0.84630	1.54910	1433.5	-0.1471	-22.554	-18.74
	0.1880	0.87920	1.70990	1481.0	-0.7035	-2.855	-48.18
	0.2651	0.91210	1.43760	1493.1	-1.0026	-26.023	-45.82
	0.3511	0.94390	1.42070	1532.5	-0.9565	-23.183	-55.42
	0.4480	1.04230	1.41330	1502.3	-7.3618	-18.818	-48.02
	0.5578	1.05750	1.39210	1603.5	-5.2170	-15.154	-69.46
	0.6838	1.09550	1.43000	1634.2	-4.9806	-4.726	-56.62
	0.8296	1.13130	1.46130	1650.0	-4.2102	6.085	-31.67
	1.0000	1.13740	1.31050	1682.4	0.0000	0.000	0.00

Table.2. Values of densities,viscosities,ultrasonic velocity,Excess molar volumes and Deviation in viscocity and deviation in isentropic compressibility for binary system of 1-pentanol and O-nitrotolune at 303.15 and 313.15 K.

Temp K	X_1	P (gm /cm^3)	$\eta 10^3$ (Nsm^{-2})	U (M S^{-1})	$V^E x10^6$(m^3/mole)	$\Delta \eta x10^3$(Kg m^{-1}s^{-1})	$\Delta ksx10^{11}$ (m^{2}N^{-1})
303.15	0.0000	0.81920	3.10600	1498.0	0.0000	0.000	0.00
	0.0670	0.83110	2.68220	1532.1	0.9875	-33.327	-16.32
	0.1387	0.85890	2.48580	1549.9	-0.0046	-43.246	-28.50
	0.2160	0.88780	2.19330	1596.8	-0.9770	-62.016	-54.92
	0.3004	0.93700	2.13260	1599.8	-4.1935	-56.643	-62.21
	0.3913	0.95130	1.98690	1613.6	-3.0901	-58.889	-57.27
	0.4907	0.98410	1.87870	1616.8	-4.0094	-56.232	-53.03
	0.6005	0.99640	1.63810	1635.4	-2.3462	-65.405	-46.04
	0.7197	1.13500	1.82470	1670.2	-14.1357	-30.584	-84.10
	0.8526	1.13330	1.78870	1677.2	-11.0451	-16.166	-63.47
	1.0000	1.06470	1.75020	1631.2	0.0000	0.000	0.00
313.15	0.0000	0.81160	2.59240	1467.0	0.0000	0.000	0.00
	0.0670	0.82310	2.22710	1468.4	1.6681	-27.967	10.23
	0.1387	0.85080	2.07240	1549.9	1.3216	-34.246	-43.57
	0.2160	0.87900	1.83510	1558.1	1.1243	-48.067	-42.63
	0.3004	0.92840	1.76310	1599.5	-1.4090	-44.448	-67.03
	0.3913	0.94250	1.66890	1600.0	0.5707	-42.215	-49.08
	0.4907	0.97510	1.63260	1610.4	0.5686	-33.103	-41.79
	0.6005	0.98770	1.41110	1613.8	3.2333	-41.178	-20.09
	0.7197	1.12520	1.59070	1653.4	-7.5474	-7.938	-53.63
	0.8526	1.12360	1.55540	1664.3	-3.1863	5.569	-24.68
	1.0000	1.13740	1.31050	1682.4	0.0000	0.000	0.00

Fig. 1) Ultrasonic velocity against mole fraction for 1-butanol and 1-pentanol at 303.15 K

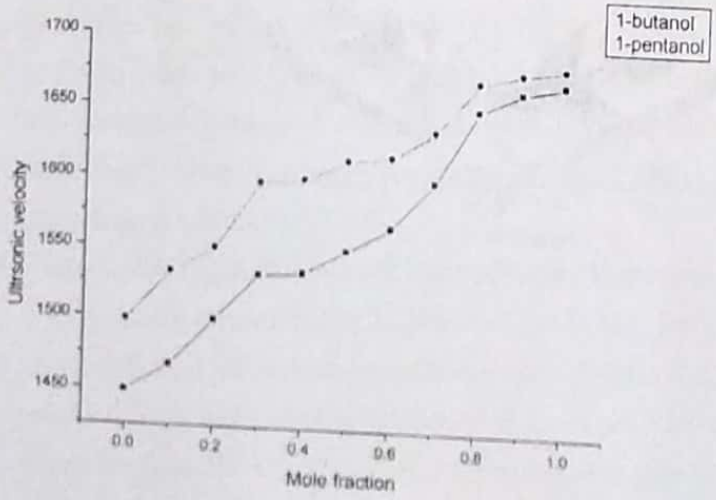


Fig. 2 V^E against mole fraction for 1-butanol and 1-pentanol at 303.15 K

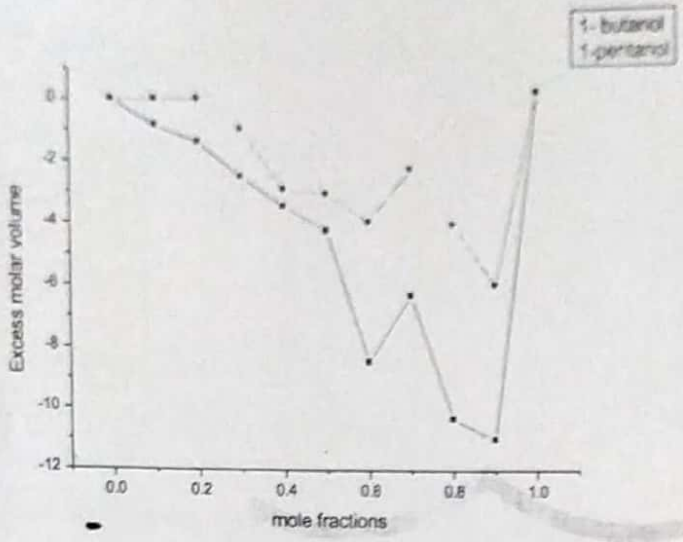


Fig. 3 Δn against mole fraction for 1-butanol and 1-pentanol at 303.15 K

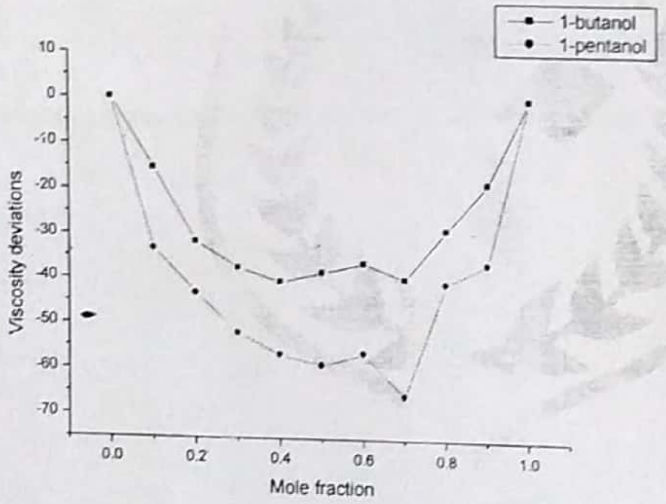
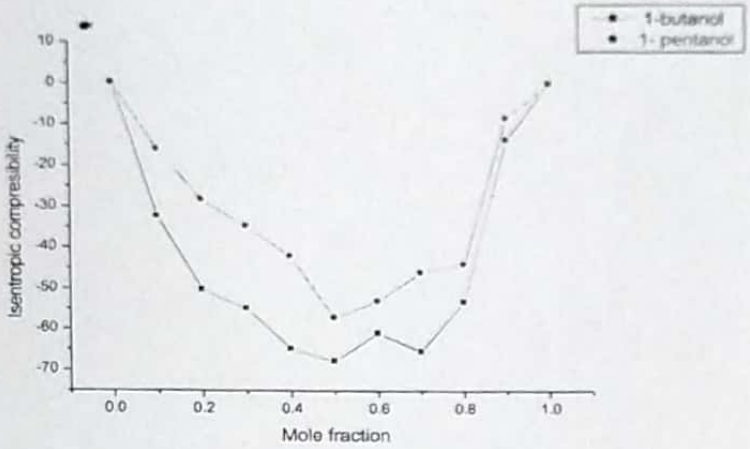


Fig. 4 ΔKs against mole fraction for 1-butanol and 1-pentanol at 303.15 K



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