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Density, viscosity and IR spectroscopy studies of binary mixture of aniline and nitrobenzene with 2-methyl-2 propanol at 298.15 k

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ABSTRACT : The density, viscosity and infrared spectroscopy of binary liquid mixture of nitro benzene and aniline with 2-methyl-1-Propanol at 298.15k using these parameters, the excess volume (V^E), Deviation in viscosity ($\Delta\eta$), have been calculated. The recently proposed jouyban accre model is used to correlate the experimental values of density and viscosity at 298.15k. At the different mole fraction IR spectroscopy of nitrobenzene and aniline with 2-methyl-2- propanol are discussed.
Keywords : The density, viscosity and infrared spectroscopy the excess volume (V^E), Deviation in viscosity ($\Delta\eta$).

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I. INTRODUCTION :

A series of density viscosity and IR spectroscopy data were measured for organic mixture in our laboratory. The present work is a continuation of our experimental chemical properties of binary mixture, at 298.15k. The nature of interaction between the constituent were discussed in present work. The effect of molecular size and geometrical fitting of molecules on the volumetric and viscometric properties of binary mixture containg nitrobenzene and aniline with 2-methyl-1-propanol at 298.15 k. The studies of density, viscosity and IR spectroscopy are being increasingly used, for studing properties of pure and mixture of compentens and the nature of intermolecular interaction between unlike molecules. A lot of work has been reported in the literature. (1-5).

II. EXPERIMENTAL :

Aniline, Nitrobenzene and 2-methyl 2-propanol (S.d fine chem. Purity max than 99%) were used after single distillation. The experimental density and viscosity of pure component are in agreement with literature values, as can be seen in table-1.

Table 1 : Comparison of experimental and literature values for density (p) and viscosity (η) of the pure component at 298.15 k.

Liquid	Temp (k)	$p \times 10^{-3}$ kg m^{-3}		η /m pas	
		Exp.	Lit	Exp.	Lit
2-mehyl -2-propanol	298.15	0.7810	0.7812[6]	4.445	4.444[6]
Aniline	298.15	1.0171	0.0172[9]	3.775	3.774[10]
Nitrobenzene	298.15	1.1982	1.1981[7]	1.801	1.791[8]

The binary mixture were prepared by mixing the appropriate volume of liquid in airtight stoppered glass bottles, which were weight on single pan electronics balance to an accuracy of ± 0.01 mg care was taken to avoid evaporation and contamination during mixing, the experimental uncertainty in the mole fraction was estimate to be less than ± 0.0001 g.

III. DENSITY MEASUREMENT :

The density measurement of pure solvent and the mixture were performed by using bicapillary pyconometer having a bulb volume of 15 cm^3 and capillary box with an internal diameter of 1mm in a transparent glass walled water bath having a thermal stability of ± 0.01 k (11-13).
The pyconometer was calibrated using conductivity water with 0.99705 cm^3 as its density at $T = 298.15$ k. The density values were producible within $5 \times 10^{-5} gcm^{-3}$.

Viscosity measurement :

The kinematic viscosity of pure component and their mixture were determined at

temp. 298.15 k by using an ubbelohde suspended level viscometer (14-15) having a capacity of about 15 ml a length of about 90 mm and 0.5 mm internal diameter. The viscometer was calibrated using double distilled water. At least three repetitions of each data reproducible to ± 0.05s were obtained and result were averaged, because all flow time greater than 200 s. The uncertainties in dynamic viscosities are of the order ± 0.003 mpas

FTIR measurement : FTIR spectra of all the sample reported in this work were recorded on a BROKER IFS 66 FITR spectrometer.
This instrument is equipped with an MCT detector, a kBr beam splitter and global source Boxcar apodization was used for 250 averaged interferogram collected for the sample. This instrument has resolution of 0 ± 1 cm^{-1}.

IV. RESULT AND DISCUSSION :

The density, ρ kinematic viscosities (η) were measured at temperature 298.15 k and the measured value present in Table 2.1 and 2.2 IR frequencies for binary mixture of were measured at different mole fraction in table 3.1 and 3.2

The density value have been used to calculate excess molar volume (V^E) using following equation.

$$V_m^E = (X_1M_1 + X_2M_2)/\rho_{12} - (X_1M_1/\rho_1)$$
.....(i)

Where ρ_{12} is the density of the mixture and $X_1M_1\rho_1$ and $X_2M_2\rho_2$ are the mole fraction, the molecule weight and densities of pure components 1 and 2 respectively.
The viscosity deviation $\Delta\eta$ was calculated using

$$\Delta\eta = \eta_{12} - X_1\eta_1 - X_2\eta_2$$
.....(ii)

It is seen that excess molar volume values for the mixture of 2-methyl-2-propanol with nitrobenzene and aniline are negative follow the order aniline > nitrobenzene. It has been shown that the excess molar values are determined by three mains contribution namely physical, chemical and structural contribution.

The excess molar volume values of 2-methyl-2-propanol with aniline and nitrobenzene are negative indicating a contraction in volume when two components are mixed. This implies that the interaction between unilike molecule are stronger compared with the intramolecular interaction.

The deviation in viscosity value ($\Delta\eta$) are also negative for mixture of 2-methyl-2-propanol with aniline and nitrobenzene. The negative values of $\Delta\eta$ are characteristics for system in which despersive force like rupture of the self association in 2-methyl 2-propanol are predominant.

The IR measurement for mixture of 2-methyl 2-propanal with aniline and nibtrobenzene over the entire composition range has been carried out. In case of mixer of 2-methyl-2-propanol with nitrobenzene the symmetrical $\nu(Ar - NO_2)$ changes from 1348 cm^{-1} in pure nitrobenzene to 1365 cm^{-1} for 0.2 but there after it shows no chages from pure values but asymmetrical $\nu(Ar - NO_2)$ value show changes for different mole fraction.
for 2-methyl-2-propanol with aniline $\nu(Ar - NH_2)$ symmetrical frequencies decreases, it is concluded that there is variable degree of nitermolecular H-bonding between the component of the mixture.

Table 2.1 : Density (ρ), Viscosity (η), Excess molar volume, (V^E) and deviation in viscosity ($\Delta\eta$) for 2-methyl-2propanol + Aniline at 2.98.15 k.

Temp. K	x_1	ρ x10^{-3} kg.m^{-3}	η mPa.s	V^Ex10^6 m^3.mol^{-1}	Δη mPa.s
298.15	0.0000	1.0171	3.375	0.000	0.000
	0.1007	0.9946	3.293	-0.190	-0.190
	0.1985	0.9723	3.028	-0.325	-0.559
	0.2962	0.9496	2.829	-0.410	-0.863
	0.3979	0.9257	2.707	-0.459	-1.094
	0.4986	0.9018	2.716	-0.469	-1.193
	0.5998	0.8776	2.826	-0.441	-1.191
	0.6998	0.8535	3.050	-0.373	-1.074
	0.7992	0.8295	3.365	-0.277	-0.865
	0.9003	0.8051	3.831	-0.154	-0.507
	1.0000	0.7810	4.445	0.000	0.000

Table 2.2 : Density (ρ), Viscosity (η), Excess molar volume, (V^E) and deviation in viscosity (Δη) for 2-methyl-2propanol + nitrobenezene at 2.98.15 k.

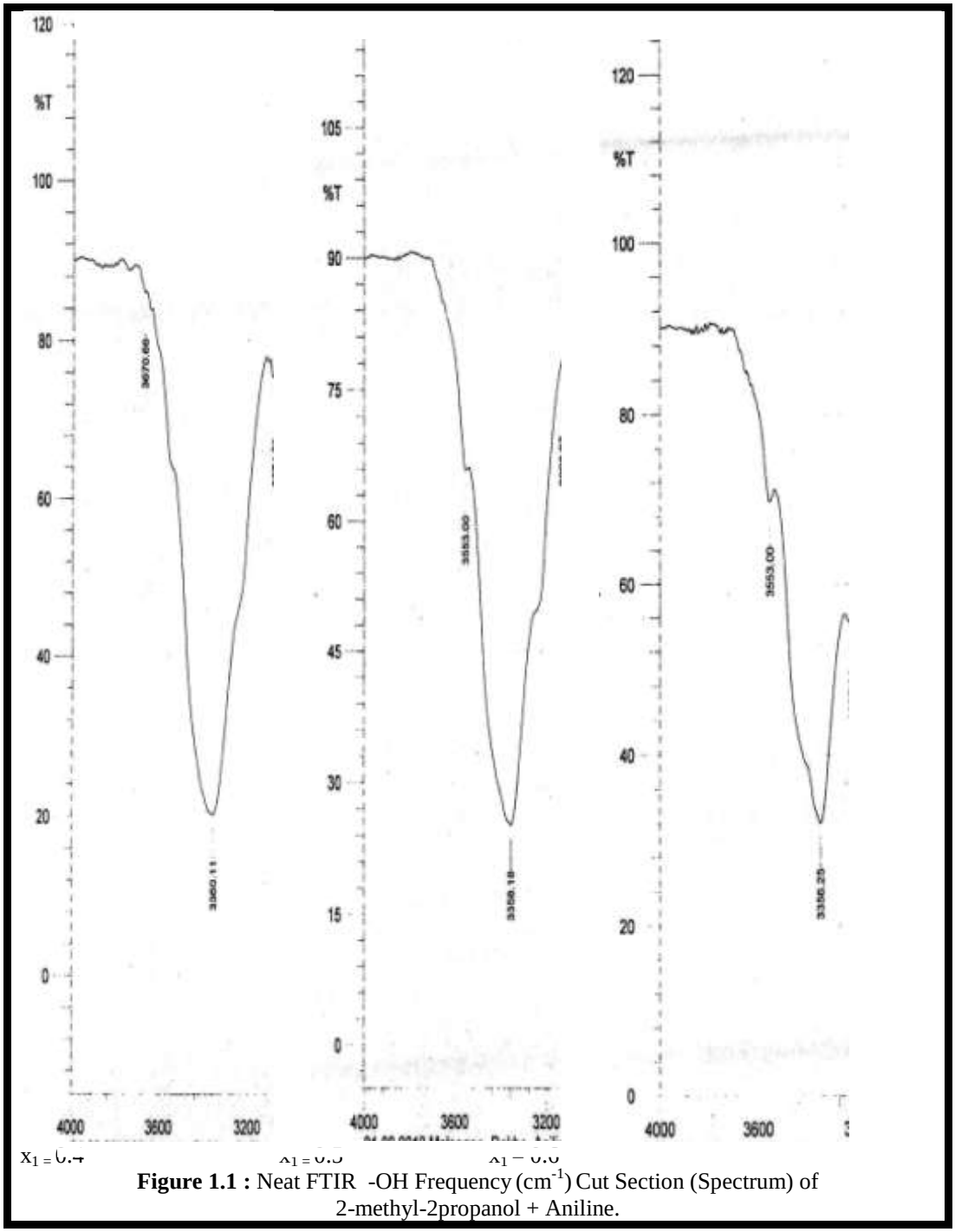
Temp. K	x_1	ρ x10^{-3} kg.m^{-3}	η mPa.s	$V^E x10^6$ $m^3.mol^{-1}$	Δη mPa.s
298.15	0.0000	1.1982	1.801	0.000	0.000
	0.0929	1.1633	1.509	-0.101	-0.538
	0.1964	1.1228	1.519	-0.129	-0.801
	0.3000	1.0818	1.601	-0.178	-0.993
	0.3940	1.0438	1.641	-0.204	-1.202
	0.5000	1.0004	1.649	-0.249	-1.474
	0.6008	0.9577	2.194	-0.220	-1.196
	0.6998	0.9148	2.652	-0.158	-0.999
	0.8009	0.8701	3.011	-0.070	-0.908
	0.8995	0.8256	3.556	0.049	-0.623
	1.0000	0.7810	4.445	0.000	0.000

Table 3.1 : IR Frequencies (v cm^{-1}) for 2-methyl-2propanol with With Aniline

Mole fraction of t-Butanol	**v** (O-H)	**v** (N-H)
Aniline	-	Symm - 3356.25 Asymm - 3433.41
0.2	3375.54	Symm - 3337.99 Asymm - 3078.49
0.4	3360.11	Symm - 3037.99 Asymm - 3074.63
0.5	3358.18	Symm - 3037.99 Asymm - 3074.63
0.6	3356.25	Symm - 3037.99 Asymm - 3372.71
0.8	3356.25	Symm - 3336.06 Asymm - 3372.71
t-Butanol	3377.47	-

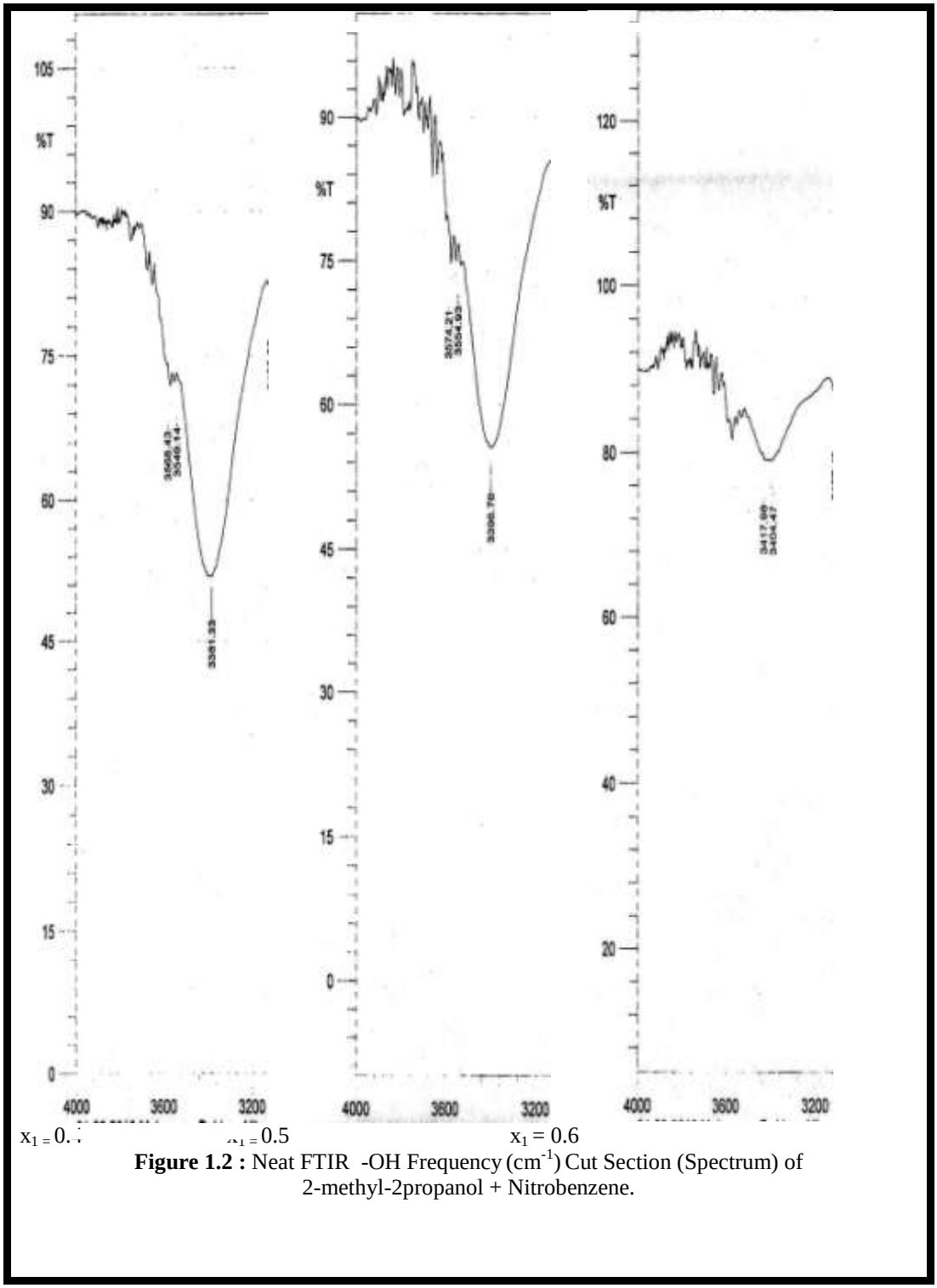
Table 3.2 : IR Frequencies (v cm^{-1}) for 2-methyl-2propanol with Nitrobenzene

Mole fraction of t-Butanol	**v** (O-H)	**v** (Ar-No_2)
Nitrobenzene	-	Symm - 1348.29 Asymm - 1518.03
0.2	3377.47	Symm - 1365.65 Asymm - 1529.60
0.4	3381.33	Symm - 1348.29 Asymm - 1527.67
0.5	3396.76	Symm - 1348.29 Asymm - 1527.67
0.6	3417.98	Symm - 1348.29 Asymm - 1525.75
0.8	3574.21	Symm - 1348.29 Asymm - 1523.82
t-Butanol	3377.47	-



$x_1 = 0.4$ $x_1 = 0.5$ $x_1 = 0.6$

Figure 1.1 : Neat FTIR -OH Frequency (cm^{-1}) Cut Section (Spectrum) of 2-methyl-2propanol + Aniline.



$x_1 = 0.5$ $x_1 = 0.6$

Figure 1.2 : Neat FTIR -OH Frequency (cm^{-1}) Cut Section (Spectrum) of 2-methyl-2propanol + Nitrobenzene.

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