# Volumetric, Viscometic and Ultrasonic Velocity studies of Binary mixtures of 2- Propanol and 1-Heptanol with o-Nitrotolune at 298.15 and 308.15k

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**Abstract :**

The physicochemical properties like ultrasonic velocities, viscosities and densities of binary liquid mixtures of 2-propanol and 1-heptanol with o-nitrotolune were reported at 298.15 and 308.15 K. The Excess molar volume ($V^E$), Isentropic compressibility($\Delta Ks$) and viscosity deviation ($\Delta\eta$) have been calculated. These values were fitted with Redlich –Kister type polynomial equation. The results were interpreted in terms of molecular interaction between the components of the mixtures.

**Keyword**: Ultrasonic velocity, viscosity, density, Excess molar volume ($V^E$), Isentropic compressibility(Ks) viscosity deviation ($\Delta\eta$) molecular interactions.

## Introduction

The viscosity ,Density and Ultrasonic velocities measured find various application in chararacterising the physico-chemical properties of liquid mixtures [1-3] and the study of molecular interaction . The ultrasonic velocity of liquid is related to the binding forces between atoms in the molecules .Ultrasonic velocity has been also employed in understanding the nature of molecular interactions in pure liquid [4]and binary mixtures .The method studying the molecular interaction from the knowledge of variation thermodynamics parameters and their excess value with composition gives an insight into the molecular process [5-7] . The investigation regarding the molecular association in organic binary mixtures having one alkanol group as one of the components is of particular interest since 1- alkanol is highly polar and can associate with any other group having some degree of polar attraction. O-nitrotolune is strongly associated due to highly polar N=0 gro

In view of the importance mentioned , an attempt has been made to elucidate the molecular interactions the mixture of O-nitrotolune with 2- propanol and 1 – heptanol respectively at 298.15 and 308.15K further in the excess values of some of associated ultrasonic velocity , density and viscosity of mixture

## Materials and Methods:

The chemicals O-nitrotolune with 2- propanol and 1-heptanol used 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 Calculations:

Excess volumes of the mixtures have been calculated using density and mole fraction data given by equation:

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

Viscosity of Binary Mixtures is calculated by:

$$ln\eta_m=X_1ln\eta_1+X_2ln\eta_2 \quad --(2)$$

The measured viscosities of the mixtures have been used to obtain deviation in Viscosity parameters on the basis of linearity in following way,

Deviation in Viscosity of Binary Mixtures is calculated by :

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

Deviation in isentropic compressibility have been evaluated by using the equation

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

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

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

where $x_1$ and $V_i$ are mole fraction and molar volume of ith component in the mixture

## Results and Discussion

In pure state , the self association of alkanols decreases with increasing chain length , when alkanols mixed with o- nitrotolune then there is interaction between their individual functional groups (-OH and $-NO_2$ ) . The presence of electron withdrawing group on benzene ring decreases electron densities. The polarity of alkanols is less hence there is degrees of self association is less an compare to nitrotolune[9].

The experimental values of density , viscosity and ultrasonic velocity and value of excess volume , viscosity deviation and deviation in isentropic compatibility parameter for the two binary liquid system at 298.15 and 308.15are given table 1 and 2 .

The excess volume and viscosity deviation are negative over the entire mole fraction of alkanol 298.15 and 308.15K temperature.

The excess of parameter of particular mole fraction of alkanols becomes less negative with increases of temperature. The negative value may be attributed to existence of dispersion and dipolar forces between unlike molecules and related to the differences in size and shape of molecules [10].

The magnitude of Δn and ΔKs, the sign and the extent of deviation of these properties depends on the strength of interaction between unlike molecules. According to Fort et.al. the excess viscosity gives the strength of the molar interaction between in molecules .

It is found that for the solution a good agreement was found in between Redlich - Kister parameters the solution of the fifth degree polynomial obtained with $V^E$ , Δn and ΔKs .

The measurement of viscosity in binary mixture yield some reliable in the study of molecular interaction from the given table it shows that the value of excess viscosity and deviation in isentropic compressibility decreases with increases in concentration of alkanols but however it found to increases with elevation of temperature.

## Conclusion

The experimental data of ultrasonic velocity, density and viscosity are reported by binary mixture of 2- propanol and 1- heptanol with 0-nirotolune over entire range of mole fraction at 298.15 and 308.15 K calculated viscosity deviation , excess molar volume and the change with isentropic compressibility are fitted with Redlich –Kister type polynomial equation . Very large negative deviation are observed for the both the investigated system. This reveals the existence of molecular interaction in the binary mixtures . The present investigation shown that greater molar interaction exist in binary mixtures.

Table.1. Values of densities,viscosities,ultrasonic velocity,Excess molar volumes and Deviation in viscocity and deviation in isentropic compressibility for binary system of 2-propanol and O-nitrotolune at 298.15 and 308.15 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) | $\Delta \eta x10^3$(K g $m^{-1}s^{-1}$) | $\Delta ksx10^{11}$ ($m^2N^{-1}$) |
|---|---|---|---|---|---|---|---|
| | 0.0000 | 0.78350 | 2.08560 | 1387.7 | 0.0000 | 0.000 | 0.00 |
| | 0.0466 | 0.81010 | 1.85160 | 1400.8 | -0.4924 | -22.694 | -2.59 |
| | 0.0991 | 0.83560 | 1.69940 | 1443.6 | -0.7602 | -37.094 | -24.57 |
| | 0.1583 | 0.86810 | 1.61090 | 1483.2 | -1.5956 | -45.020 | -40.65 |
| | 0.2270 | 0.89470 | 1.52700 | 1582.5 | -1.6993 | -52.337 | -80.88 |
| 298.15 | 0.3049 | 0.93150 | 1.50610 | 1623.2 | -2.7000 | -53.211 | -81.07 |
| | 0.3972 | 0.97230 | 1.49910 | 1655.7 | -3.9114 | -52.471 | -71.67 |
| | 0.5058 | 1.02060 | 1.46730 | 1681.7 | -5.7272 | -53.955 | -56.33 |
| | 0.6375 | 1.02880 | 1.45500 | 1699.1 | -3.4271 | -53.130 | -18.65 |
| | 0.7980 | 1.04500 | 1.35240 | 1715.9 | -1.5128 | -60.884 | 20.14 |
| | 1.0000 | 1.06920 | 1.92950 | 1932.0 | 0.0000 | 0.000 | 0.00 |
| | | | | | | | |
| | 0.0000 | 0.77480 | 1.45920 | 1365.8 | 0.0000 | 0.000 | 0.00 |
| | 0.0466 | 0.80130 | 1.41450 | 1389.5 | -0.5004 | -5.176 | -17.48 |
| | 0.0991 | 0.82700 | 1.31860 | 1399.2 | -0.8000 | -15.545 | -16.55 |
| | 0.1583 | 0.85910 | 1.28920 | 1450.0 | -1.6187 | -19.364 | -49.36 |
| | 0.2270 | 0.88530 | 1.22250 | 1480.2 | -1.6889 | -27.053 | -53.93 |
| 308.15 | 0.3049 | 0.92190 | 1.20010 | 1496.9 | -2.6927 | -30.449 | -50.46 |
| | 0.3972 | 0.96180 | 1.18030 | 1590.2 | -3.8401 | -33.799 | -85.70 |
| | 0.5058 | 1.01040 | 1.17260 | 1637.8 | -5.7178 | -36.181 | -88.01 |
| | 0.6375 | 1.01870 | 1.16990 | 1642.0 | -3.3734 | -38.405 | -49.95 |
| | 0.7980 | 1.04940 | 1.13030 | 1666.4 | -3.0338 | -44.747 | -25.17 |
| | 1.0000 | 1.06030 | 1.60760 | 1719.2 | 0.0000 | 0.000 | 0.00 |

Table.2. Values of densities, viscosities, ultrasonic velocity, excess molar volumes and Deviation in viscosity and deviation in isentropic compressibility for binary system of 1-heptanol and O-nitrotoluene at 298.15 and 308.15 K.

| Temp K | $X_1$ | ρ (gm /cm$^3$) | η(10$^{-3}$ (Nsm$^{-2}$) | U (M S$^{-1}$) | $V^E$ x10$^6$ (m$^3$ mol$^{-1}$) | $\Delta\eta$ (10$^{-3}$ Kg m$^{-1}$ s$^{-1}$) | $\Delta\kappa_s$ (10$^{-10}$ cm$^2$/N) |
|---|---|---|---|---|---|---|---|
| 298.15 | 0.0000 | 0.83570 | 5.14390 | 1469.3 | 0.0000 | 0.000 | 0.00 |
| | 0.0863 | 0.83270 | 4.98020 | 1463.2 | -2.0458 | -45.197 | 7.49 |
| | 0.1750 | 0.83130 | 4.26110 | 1567.8 | -1.6845 | -91.840 | 27.39 |
| | 0.2662 | 0.82940 | 3.77290 | 1616.1 | -1.6439 | -95.846 | 5.55 |
| | 0.3609 | 0.93350 | 3.28970 | 1653.5 | -4.2036 | -168.014 | 1.81 |
| | 0.4585 | 0.95640 | 2.88330 | 1653.3 | -3.9613 | -161.395 | 4.49 |
| | 0.5599 | 1.01500 | 2.09960 | 1672.4 | -8.0920 | -151.356 | -3.01 |
| | 0.6640 | 1.00070 | 2.40630 | 1682.7 | -12.3506 | -80.646 | -4.56 |
| | 0.7716 | 1.00630 | 2.10070 | 1707.4 | -9.4644 | -36.129 | 9.68 |
| | 0.8841 | 1.09700 | 2.02170 | 1717.3 | -7.0041 | -35.082 | 30.03 |
| | 1.0000 | 1.06920 | 1.92950 | 1931.0 | 0.0000 | 0.000 | 0.00 |
| | | | | | | | |
| 308.15 | 0.0000 | 0.81390 | 4.22880 | 1553.9 | 0.0000 | 0.000 | 0.00 |
| | 0.0863 | 0.84550 | 3.72660 | 1574.4 | -2.0388 | -27.641 | -16.76 |
| | 0.1750 | 0.86380 | 3.21210 | 1599.5 | -1.6543 | -55.841 | -25.78 |
| | 0.2662 | 0.89150 | 2.86000 | 1604.8 | -2.5902 | -67.146 | -26.40 |
| | 0.3609 | 0.92700 | 2.51220 | 1612.2 | -4.4385 | -77.805 | -29.63 |
| | 0.4585 | 0.94830 | 2.29520 | 1660.9 | -3.9518 | -73.220 | -44.23 |
| | 0.5599 | 1.00610 | 1.70280 | 1664.7 | -8.1005 | -105.883 | -48.62 |
| | 0.6640 | 1.07170 | 1.99200 | 1669.6 | -12.4513 | -49.675 | -52.43 |
| | 0.7716 | 1.07700 | 1.76820 | 1682.9 | -9.5132 | -43.851 | -38.04 |
| | 0.8841 | 1.08800 | 1.70680 | 1689.2 | -7.0812 | -20.502 | -21.02 |
| | 1.0000 | 1.06030 | 1.60760 | 1719.2 | 0.0000 | 0.000 | 0.00 |

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Fig. 1) Ultrasonic velocity against mole fraction for 2-propanol and 1-heptanol at 298.15 K

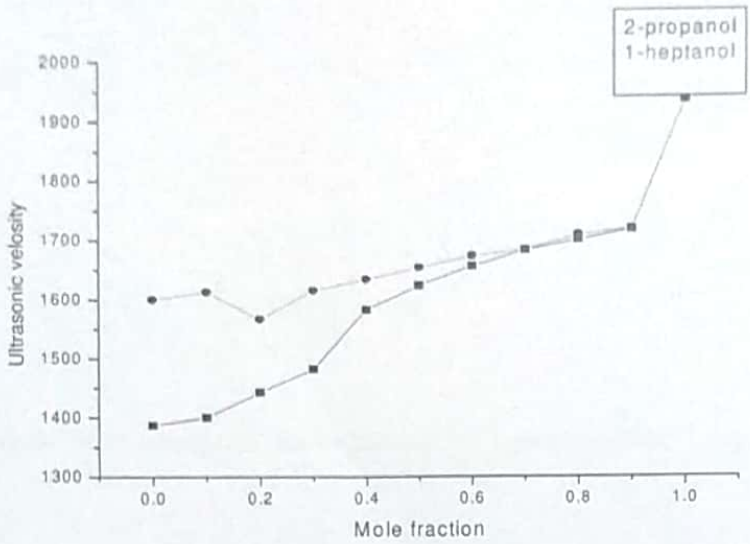


Fig. 2) Excess molar volume against mole fraction for 2-propanol and 1-heptanol at 298.15 K

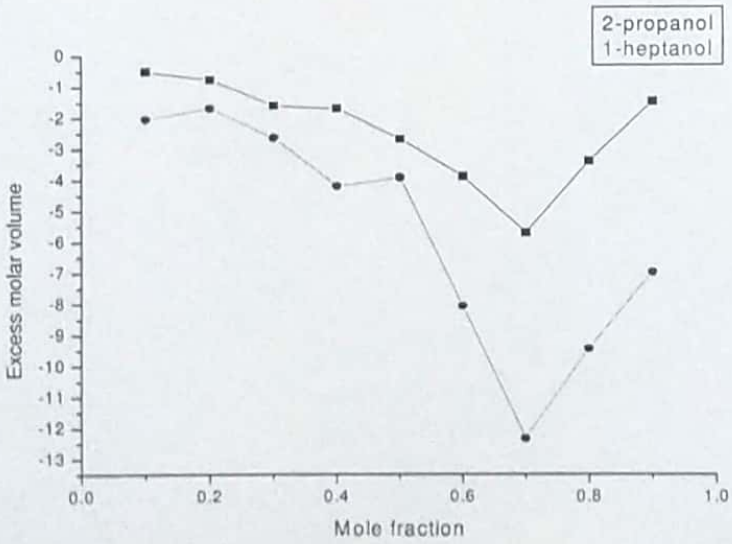

Fig. 3) Viscosity deviation against mole fraction for 2-propanol and 1-heptanol at 298.15 K

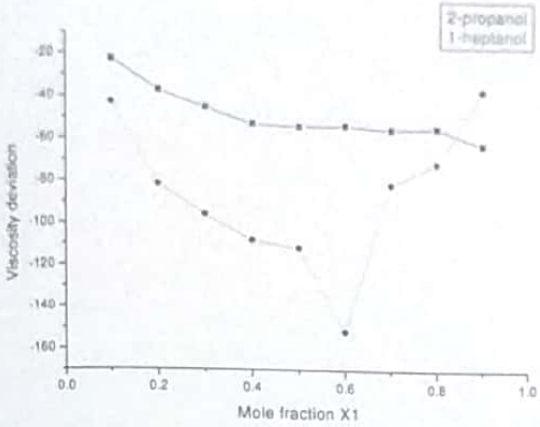


Fig. 4) Viscosity deviation against mole fraction for 2-propanol and 1-heptanol at 298.15 K