



## COMPARATIVE STUDY OF DIELECTRIC PARAMETERS OF ETHANOL, METHANOL AND PROPANOL WITH ATARAX USING TIME DOMAIN REFLECTOMETRY

A. K. Dongare<sup>1</sup>, S. B. Sayyad<sup>2</sup>, A. C. Kumbharkanae<sup>3</sup>, P. W. Khirade<sup>4</sup>.

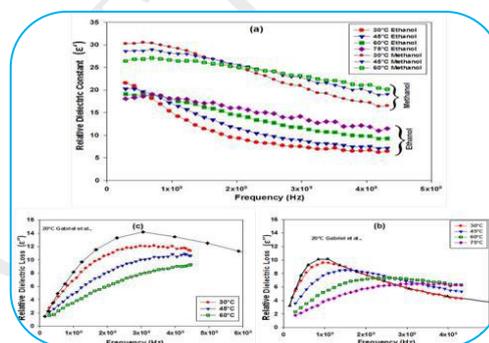
<sup>1</sup>Department of Physics, Vasantdada Patil College, Patoda, India.

<sup>2</sup>Department of Physics, Milliya Arts, Science & Management Science College, Beed, India. <sup>3</sup>Department of Physics, S. R. T. M. University Nanded, India.

<sup>4</sup>Department of Physics, Dr. B. A. M. University, Aurangabad, India.

### ABSTRACT:

The dielectric relaxation study for hydroxyzine hydrochloride (Atarax) with Ethanol, Methanol and Propanol binary mixture has been carried out using the time domain reflectometry (T.D.R.) technique at temperature 283K, 288K, 293K and 298K and at different concentrations, in the frequency range of 10MHz to 50GHz. Further, Fourier transform, least squares fit method and Debye model have been used to obtain dielectric parameter viz. static permittivity, relaxation times, excess permittivity, excess inverse relaxation time. The investigation shows the systematic change in dielectric parameters of the system with change in temperature and concentrations. There is almost linear relationship between the values of  $\epsilon_s$ , however  $\tau$  is nonlinear suggest weak intermolecular interaction. And its excess parameters values are positive and negative respectively. The results obtained are used to interpret the nature and kind of solute-solvent interaction.



**KEYWORDS:** Dielectric constant, Permittivity, Relaxation time, Atarax.

### INTRODUCTION

The study of the dielectric behavior of liquid is very significant in understanding the structure and molecular interactions in the liquid. The dielectric constant specifies the solvent's ability to decrease the field strength of the electric field surrounding the charged particle impressed with it. This decrease is then compared with the field strength of the charged particle in vacuum

[1]. Macroscopic parameters such as dielectric constant have been extensively used for explanation of solvent effects. The dielectric constant is one of the fundamental properties that must be known to utilize theories of electrolyte solutions [2]. The dielectric constant is an important physicochemical parameter, as it is related to many important physical and biological applications [3-8]. The dielectric constant of a solvent is a relative measure of its polarity and its

measurements are often used for evaluation of the characteristics of the liquid solutions [9].

**Physical constant of pure liquids.**

Name of Compound	Mol. Formula	Literature Value of $\epsilon_s$	Mol. Wt. g/mol	Density in g/cm <sup>3</sup>	Dipole Moment $\mu$ D
Atarax	C <sub>21</sub> H <sub>29</sub> Cl <sub>3</sub> N <sub>2</sub> O <sub>2</sub>	N.A.	374.904	1.18	N.A.
Ethanol	C <sub>2</sub> H <sub>5</sub> OH	24.3	46.03	0.789	1.69
Methanol	CH <sub>3</sub> OH	32.7	32.04	0.792	1.69
Propanol	C <sub>3</sub> H <sub>8</sub> O	20.1	60.09	0.803	1.68

**Experimental****A. Chemical and sample preparation**

The chemical used in the present work is Atarax, Ethanol, Methanol and Propanol, are of spectroscopic grade, obtained commercially with 99% purity and used without further purification. The solutions were prepared at six different compositions in steps of 20 % by volume. These volume fractions are converted to mole fractions for further calculations. Using this volume percentage the weight fraction is calculate [10] as

$$X_A = \frac{V_A \rho_A}{[(V_A \rho_A) + (V_B \rho_B)]} \quad (1)$$

where,  $V_A$  and  $V_B$  are the volume and  $\rho_A$  and  $\rho_B$  is the density of liquid A (Atarax) and B (other chemical) respectively.

**B. T.D.R. specification, Time domain reflectometry set up and data acquisition.**

The Tektronix DSA8300 sampling oscilloscope sampling main frame with the dual channel sampling module 80E10B has been used for time domain reflectometry. The sampling module provides 12ps incident and 15ps reflected rise time pulse. The coaxial cable used to feed pulse has 50 Ohm impedance, inner diameter of 0.28mm and outer diameter of 1.19mm. Sampling oscilloscope monitors changes in pulse after reflection from end of line. Reflected pulse without sample  $R_1(t)$  and with sample  $R_x(t)$  were recorded in time window of 5 ns and digitized in 2000 points. To minimize the signal to noise ratio the signal reflected is obtained from 512 samples after an optimum average of 100 times for each record. The subtraction [ $p(t) = R_1(t) - R_x(t)$ ] and addition [ $q(t) = R_1(t) + R_x(t)$ ] of these pulses are done in oscilloscope memory. These subtracted and added pulses are transferred to PC through compact disc for further analysis.[11]

**C. Data analysis**

The time dependent data were processed to obtain complex reflection coefficient spectra,  $\rho^*(\omega)$  over the frequency range from 10 MHz to 50 GHz using Fourier transformation[12,13] as

$$\rho^*(\omega) = \left[ \frac{c}{j\omega d} \right] \left[ \frac{p(\omega)}{q(\omega)} \right] \quad (2)$$

Where,  $\rho(\omega)$  and  $q(\omega)$  are Fourier transforms of [ $R_1(t) - R_x(t)$ ] and [ $R_1(t) + R_x(t)$ ], respectively.  $C$  is the velocity of light,  $\omega$  is angular frequency and  $d$  is the effective pin length and  $j = \text{root}(-1)$ . The complex permittivity spectra[14] $\epsilon^*(\omega)$  were obtained from reflection coefficient spectra  $\rho^*(\omega)$  by applying a bilinear calibration method. The experimental values of  $\epsilon^*(\omega)$  are fitted by Debye equation[15].

$$\epsilon^*(\omega) = \epsilon_\infty + \frac{\epsilon_0 - \epsilon_\infty}{1 + j\omega\tau} \quad (3)$$

where,  $\epsilon_0$ ,  $\epsilon_\infty$  and  $\tau$  as fitting parameters. The value of  $\epsilon_\infty$  was kept to be constant as the fitting parameters are not sensitive to  $\epsilon_\infty$ . A non-linear least squares fit method [16,17] used to determine the values of dielectric parameters.

## RESULT AND DISCUSSION

### Permittivity and Relaxation Time

The frequency dependent complex permittivity  $\epsilon^* = \epsilon' - j \epsilon''$  data was obtained by using calibration process by using dielectric parameters of raw data. The static dielectric constant ( $\epsilon_s$ ) and relaxation time ( $\tau$ ) for the mixture obtained by fitting experimental data with the Debye equation at four different temperatures have been given in table.

**Table: 1. Temperature dependent dielectric parameters for binary mixture of Atarax + Ethanol.**

Mole Fraction of Ethanol	283 K		288 K		293 K		298 K	
	$\epsilon_s$	$\tau$ (ps)						
0	63.4	105	63.55	105.2	62.58	105.4	61.44	105.5
0.5765	41.52	86.14	41.77	86.18	41.69	81.63	42.36	81.77
0.7840	37.58	107.1	37.37	91.18	39.87	86.05	41.89	86.2
0.8909	36.37	122.6	32.86	98.9	34.91	92.51	33.36	92.43
0.9561	28.93	143.3	28.13	104.5	27.61	97.65	26.24	97.64
1	25.71	175.2	24.39	157	24.41	142.7	23.82	142.5

**Table: 2. Temperature dependent dielectric parameters for binary mixture of Atarax + Methanol.**

Mole Fraction of Methanol	283K		288K		293K		298K	
	$\epsilon_s$	$\tau$ (ps)						
0	63.4	105	63.55	105.2	62.58	105.4	61.44	105.5
0.6626	52.86	92.05	52.76	82.09	52.72	82.13	53.21	78.02
0.8396	51.64	84.78	50.15	81.75	50.32	73.9	49.11	62.28
0.9218	48.69	73.62	47.9	70.22	47.2	52.87	46.77	58.08
0.9691	42.25	63.67	41.16	59.77	41.1	55.48	41.02	51.81
1	33.27	56.25	32.03	51.7	31.69	49.94	32.12	48.81

**Table: 3. Temperature dependent dielectric parameters for binary mixture of Atarax + Propanol.**

Mole Fraction of Propanol	283 K		288 K		293 K		298 K	
	$\epsilon_s$	$\tau$ (ps)						
0	63.4	137	63.55	125.2	62.58	115.4	61.44	105.5
0.5149	48.58	92	48.09	90.04	47.55	86.43	48.81	81.92
0.7389	37.2	116.9	38.08	107.2	38.69	96.34	40.81	86.34
0.8643	30.26	197	31.43	196.6	31.37	174.7	31.2	156.6
0.9444	25.79	225.2	24.14	217.8	23.26	197.9	22.55	175.7
1	21.65	324.9	21.61	315.9	20.79	291.2	20.1	263.4

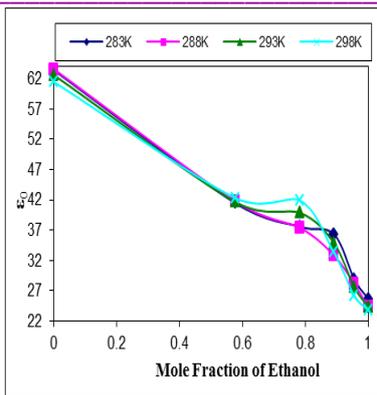


Figure 1. Variation of static dielectric constant ( $\epsilon_s$ ) as a function of mole fraction of Ethanol, at temperatures 283, 288, 293 and 298K with Atarax.

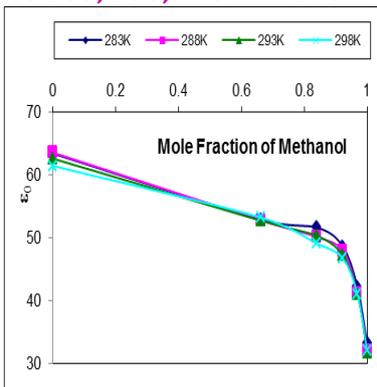


Figure 2. Variation of static dielectric constant ( $\epsilon_s$ ) as a function of mole fraction of Methanol at temperatures 283, 288, 293 and 298K with Atarax.

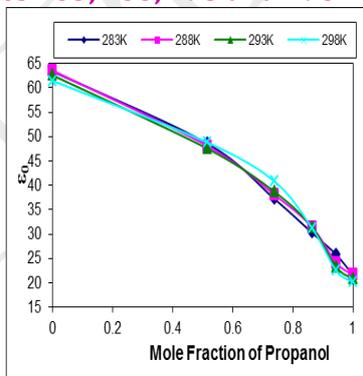


Figure 3. Variation of static dielectric constant ( $\epsilon_s$ ) as a function of mole fraction of Propanol at temperatures 283, 288, 293 and 298K with Atarax.

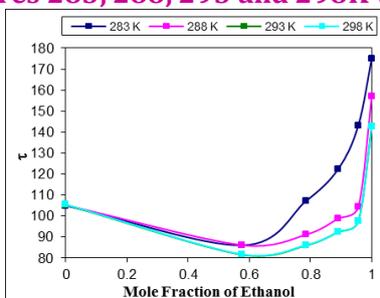


Figure 4. Variation of relaxation time ( $\tau$ ) as a function of mole fraction of Ethanol at temperatures 283, 288, 293 and 298K with Atarax.

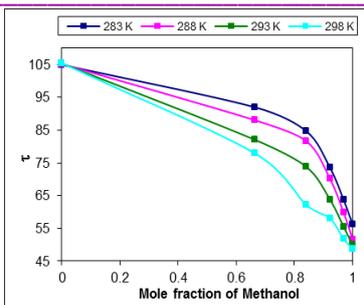


Figure 5. Variation of relaxation time ( $\tau$ ) as a function of mole fraction of Methanol at temperatures 283, 288, 293 and 298K with Atarax.

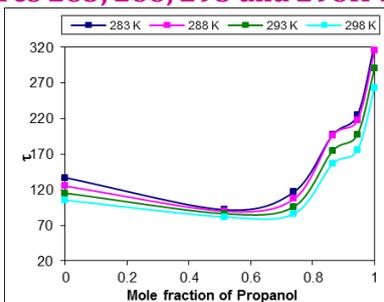


Figure 6. Variation of relaxation time ( $\tau$ ) as a function of mole fraction of Propanol at temperatures 283, 288, 293 and 298K with Atarax.

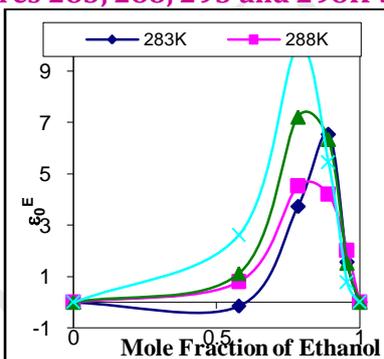


Figure 7. Variation of excess permittivity ( $\epsilon_0^E$ ), as a function of mole fraction of Ethanol at 283, 288, 293 and 298K with Atarax.

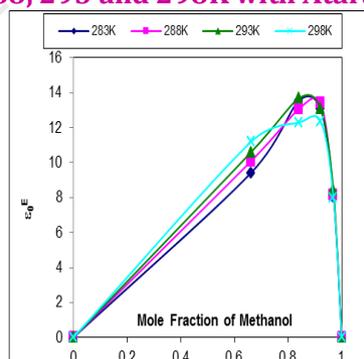


Figure 8. Variation of excess permittivity ( $\epsilon_0^E$ ), as a function of mole fraction of Methanol at 283, 288, 293 and 298K with Atarax.

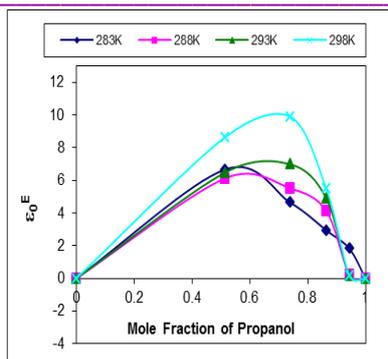


Figure 9. Variation of excess permittivity ( $\epsilon_0^E$ ), as a function of mole fraction of Propanol at 283, 288, 293 and 298K with Atarax.

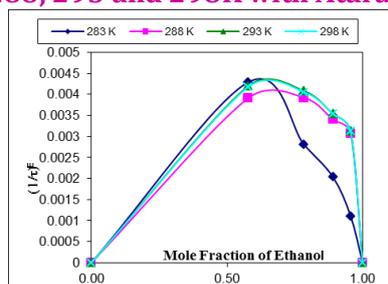


Figure 10. Variation of excess inverse relaxation time  $(1/\tau)^E$ , as a function of mole fraction of Ethanol at 283, 288, 293 and 298K with Atarax.

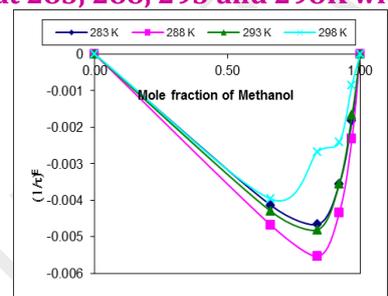


Figure 11. Variation of excess inverse relaxation time  $(1/\tau)^E$ , as a function of mole fraction of Methanol at 283, 288, 293 and 298K with Atarax.

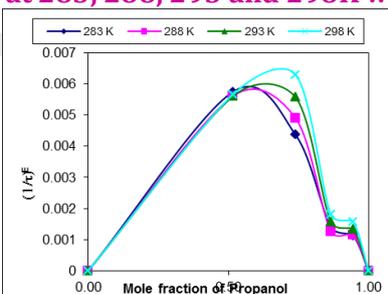


Figure 12. Variation of excess inverse relaxation time  $(1/\tau)^E$ , as a function of mole fraction of Propanol at 283, 288, 293 and 298K with Atarax.

**CONCLUSION**

It can be seen from figure 1, 2 and 3 that there is an almost linear relationship between the values of static dielectric constant ( $\epsilon_s$ ) and concentrations of Ethanol, Methanol and Propanol in the mixtures with Atarax. However from figure 4, 5 and 6 the relationship for the relaxation time  $\tau$  shows linear increase in Ethanol and Propanol but in Methanol linear decrease is observe in the mixtures with Atarax.

From figure 7 it is seen that  $(\epsilon_s)^E$  is positive for all concentration of Ethanol except at 283K, and from figure 8 and 9 it is seen that  $(\epsilon_s)^E$  is positive for all concentration of Methanol and Propanol in the mixture for all temperature studied. This indicates that the molecules of mixture may form multimers structures in such a way that the effective dipoles get reduced. This is due to the opposite alignment (antiparallel) of the dipoles in the mixture.

The behavior in  $(1/\tau)^E$  is seen from figure 10 and 12 the values of  $(1/\tau)^E$  are positive for all concentrations of Ethanol and Propanol at all temperatures. This suggests that the molecular interaction produces a cooperative field and the effective dipoles have more freedom of rotation. Whereas in Methanol the behavior in  $(1/\tau)^E$  is as shown in figure 11 the values of  $(1/\tau)^E$  are negative for all concentration of Methanol at all temperatures. This suggests that the molecular interaction produces a non-cooperative field and the effective dipoles have less freedom of rotation.

### ACKNOWLEDGEMENT

The authors wish to acknowledge the Department of Physics Dr. Babasaheb Ambedkar Marathwada University Aurangabad. School of Physics Swami Ramanand Teerth Marathwada University Nanded. Department of Physics Milliya Atrs, Science and Management Science College Beed.

### REFERENCES

- [1] Mohsen-Nia, M., Amiri, H., and Jazi, B., (2010). *J. Solution Chem.*, 39, 701-707.
- [2] Wang, P., and Anderko, A. (2001). *Fluid Phase Equilib.* 186, 103-110.
- [3] Nelson, S. O. (2006). *IEEE Transactions on Dielectrics and Electrical Insulation*, 13, 688-702.
- [4] Nelson, S. O. (1980). *Transactions of the ASAE*, 23, 1314-1317.
- [5] Dennis, S., et al., (2006). Washington, Institute of shortening and edible Oils.
- [6] Fakhree, M. A. A., Delgado, D. R., Martínez, F., and Abolghasem, J. (2010). *AAPS Pharm. Sci. Tech.* 11, 1726-1729.
- [7] Gorman, W. G., and Hall, G. D. (1963). *Journal of Pharmaceutical Sciences*, 52 (5), 442-446.
- [8] Shukla, A. K., Sampath, S., and Vijayamohan, K. (2000). *Current Science*, 79 (12), 1656-1661.
- [9] Hansen, J. P., and McDonald, I. R., (1986). *Theory of Simple Liquids, Second ed. Academic*, New York.
- [10] P.B.Undre, S.N.Helambe, S.B. Jagdale, P.W.Khirade and S.C. Mehrotra. *Pramana J. Physics.* 68. 851 (2007).
- [11] Manual T.D.R. Tektronix DSA8300.
- [12] C.E.Shannon, *Proc. Inst. Radio Eng.* 37, 10(1949).
- [13] H.A. Samulan. *Proc. IRE*, 39, 175 (1951).
- [14] S. Mashimo, S. Kuwabara, S. Yoghara, and K. Higasi, *J. Chem. Phys.* 90, 3292(1989).
- [15] P.Debye. *Polar Molecules*, Chemical Catalog. Co. New York. (1929).
- [16] P.R.Bevington. *Data Reduction and Error Analysis for the Physical Sciences*, McGraw Hill, New York(1969).
- [17] <http://shodhganga.inflibnet.ac.in/jspui/handle/10603/89385>