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Study Of Dielectric Parameter Of Atropine-Ethanol Solution Using Time Domain Reflectometry Technique

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Abstract:

This paper consists of the work undertaken of the study of dielectric parameter of non-aqueous solution of Atropine-Ethanol for various concentrations. The time domain reflectometry technique is used for the study in the frequency range from 10 MHz to 30 GHz. The relaxation time (τ), The static dielectric constant (ε_0), dielectric constant at higher frequency (ε_∞) of mixture of Atropine with Ethanol have evaluated at 25^0c.

Key words: Alkaloids, Dielectric constant, Relaxation time, Thermodynamic parameter & TDR.

Introduction:

Atropine is a tropane alkaloid and anticholinergic medication used to treat certain types of nerve agent and pesticide poisonings. It contains a hydroxyl group and behaves as a saturated compound. It is also called Daturin. Its molecular formula is $C_{17}H_{23}NO_3$ [1]. The molecular structure of Atropine as shown figure (1).

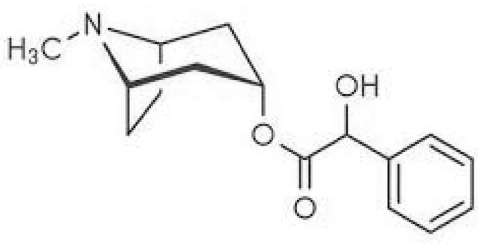

Figure No.:1 molecular structure of Atropine.

The dielectric constant is one of the important physiochemical properties of the mixed solvent, which enhance most of the biological, pharmaceutical, chemical, physical, analytical laboratory applications etc. [2, 3,4]. In the present work we have studied the dielectric constant and relaxation time of Atropine with Ethanol mixtures at various concentrations at 25^oc is studied using Time Domain Reflectometry Technique infrequency range 10 MHz to 30 GHz. The dielectric behavior of this solution is explained by Cole-Devidson model.

Experimental Method:

A) Materials: Atropine 98% was obtained commercially from Anand Agency, Pune, made by Acros organics thermofisher scientific India pvt Ltd. And used without further purification. The solutions were prepared by mixing the Atropine – Ethanol.

B) Measurements: The dielectric constants and relaxation time of various mixtures of solutions was measured by TDR, the Tektronix model No. DSA8200 digital serial analyzer sampling mainframe along with the sampling module 80E08.TDR dielectric measurement systems consist of step generator, which is produce fast rising pulse of the order of picoseconds. A train of suitable fast rising pulses is applied to a transmission line usually a co-axial line with characteristic impedance 50 Ω. A co-axial line is connected to sampling device the systematic block diagram of the experimental set up for TDR is shown in Figure (2). A suitable fast rising pulse $R_1(t)$ is applied to a transmission line and incident to the sample under study and its reflected part $R_X(t)$ from the sample solution in the sample holder is shown in figure (2) [5,6,7].

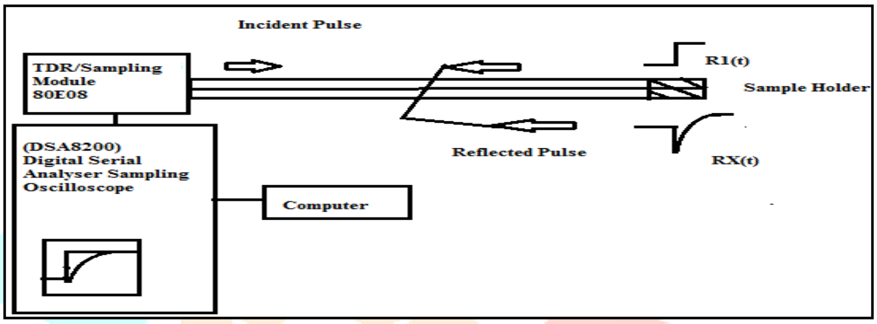

Figure No: 2 Systematic Block Diagram of Time Domain Reflectometry.

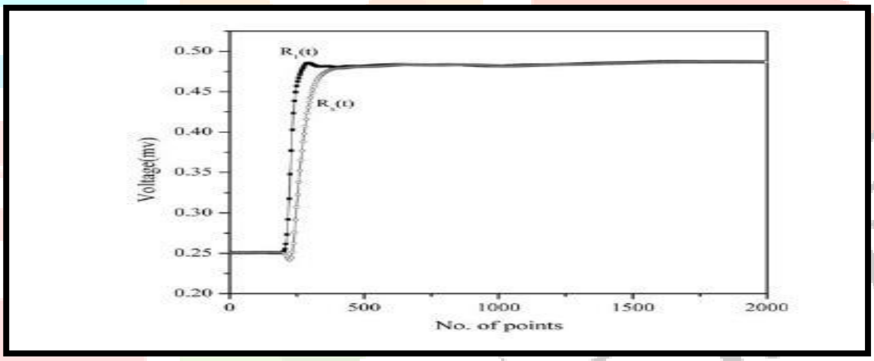

Figure No: 3 Reflected pulses without sample R_1 (t) and with sample R_X (t).

Result and Discussion:

The recorded pulses are added [$q(t) = R_1(t) + Rx(t)$] and subtracted [$p(t) = R_1(t) – Rx(t)$]. Further the Fourier transformation of p (t) and q (t) was obtained by Summation and Samulon method for the frequency range 10 MHz to 30 GHz. The complex reflection spectra were determined as follows.

$$\rho^*(\omega) = \frac{c}{j\omega d}\frac{p(\omega)}{q(\omega)}$$

Where p(ω) and q(ω) are Fourier transformation of p(t) and q(t) respectively, c is speed of light, ω is the angular frequency, d is effective length and j =√ 1

The complex permittivity spectrum of the mixtures solution is determined by the Harviliak- Negami (HN) equation [8, 10,11]. The complex dielectric permittivity data were fitted to HN model using non-linear least square fit method in order to extract dielectric relaxation time with the following expression [7, 8].

$$\varepsilon^*(\omega) = \varepsilon_\infty + \frac{(\varepsilon_0 - \varepsilon_\infty)}{[1+(j\omega\tau)^{(1-\alpha)}]^\beta}$$

Where ε_0 is the static dielectric constant, ε_∞ is the dielectric constantan high frequency. τ is relaxation time, the α&β are symmetric and asymmetric distribution of relaxation time respectively. The Havriliak-Negami equation includes the relaxation model as a limiting form [11,12, 13,].

1) If $\alpha = 0$ and $\beta = 1$ then single Debye equation.

2) $0 <= \alpha <= 1$ then it would be Cole – Cole model of symmetric distribution of relaxation times.

3) $\alpha = 0$ and β varied such that $0 <= \beta <= 1$ this behavior is identified as Cole Davidson (CD) asymmetric distribution of relaxation time.

The value of static dielectric constant (ε_0), dielectric relaxation time (τ) and dielectric constant high frequency (ε_∞) are reported in table-1 for Atropine-Ethanol mixture. The relaxation time observed to increases systematically as increase in concentration as shown in table 1.

Conc.	ε_0	τ(PS)	ε_∞	β
0	5.12	1.92	0.88	1.12
0.1	4.75	2.12	0.85	1.24
0.2	4.60	2.19	0.86	1.12
0.3	4.23	2.23	0.83	1.14
0.4	3.96	2.29	0.84	1.12
0.5	3.85	2.35	0.81	1.13

Table: - 1 Dielectric parameter of Atropine-Ethanol mixture.

Conc.	ΔH	ΔS
0.01	2.60	0.23
0.02	6.94	0.20
0.03	9.16	0.14

Table: - 2 Thermodynamic parameter of Atropine-Ethanol mixture.

The increase in τ values with increase concentration is indicating that number of dipoles increase in solution. The intermediate structure formed rotates slowly there by giving the increase value of τ in solution.

Conclusion:

The dielectric properties of Atropine-Ethanol mixture have studied using time domain reflectometry technique in the frequency range 10 MHz to 30 GHz at 25^0c temperature and various concentrations. The deviation in dielectric constant and relaxation times from ideality may be due to interaction in Atropine-Ethanol mixture dielectric constant decreases and relaxation time goes on increasing as concentration increases. From the observed result we can conclude that dielectric constant, relaxation time of Atropine-Ethanol mixture are depending on concentration.

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