IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Dielectric Study of Piperine-Water mixture Using TDR

S. D. Pawar

K. V. N. Naik Art's Commerce & Science College (Canada corner) Nashik.(MH)

Abstract:

This paper consists of the work undertaken of the study of dielectric constant of aqueous solution of Piperine 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 Piperine with water have evaluated at 25^0c.

Key words: Alkaloids, Dielectric constant, TDR, Relaxation time.

Introduction:

Piperine is basically an N-acyl pyridine molecule. It is a white crystalline alkaloid present in black pepper (piper nigrum). It has significant importance in traditional medicine from thousand of year. It is used in weight loss treatment, anti-leukemia treatment and treatment for snake venom. Its molecular formula is $C_{17}H_{19}NO_3$ [1].The molecular structure of piperine as shown figure (1). Piperine structure consist of methylenedioxyphenyl ring, side chain with conjugated double bonds, basic piperidine moiety attached through carbonyl amide linkage to side chain and possible number of conformers.

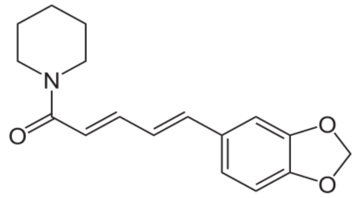

FIGURE NO.1 molecular structure of Piperine.

Very few researcher have worked on Piperine in various field. Hence we have chosen the Piperine for study. The dielectric properties of Piperine with water at various concentrations at 25^oC is studied using Time Domain Reflectometry Technique in frequency range 10 MHz to 30 GHz .The dielectric behavior of this solution is explained by Cole-Devidson model. The dielectric constant, dielectric loss, is evaluated. The dielectric constant is one of the important physiochemical properties of the mixed solvent, which enhance most of the biological, pharmaceutical, chemical, analytical laboratory applications etc. [2, 3]

Experimental Method:

A) Materials: Piperine 97% was obtained commercially from Anand Agency, Pune, made by Sigma-Alorich inc.(U.S.A). The solution was prepared by mixing the Piperine with water.

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 (sample holder), 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) [4,8].

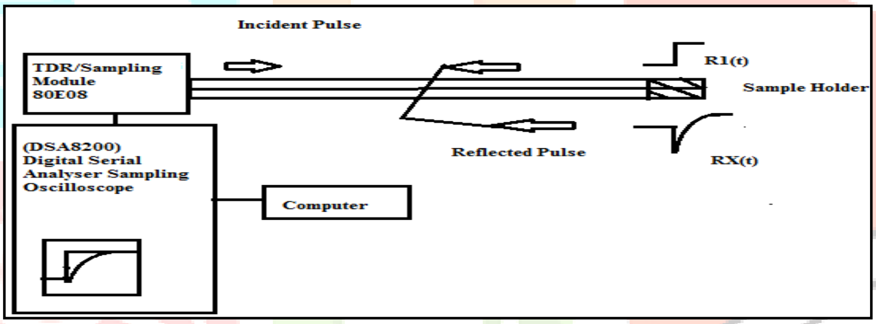

FIGURE NO.2 Systematic Block Diagram of Time Domain Reflectometry.

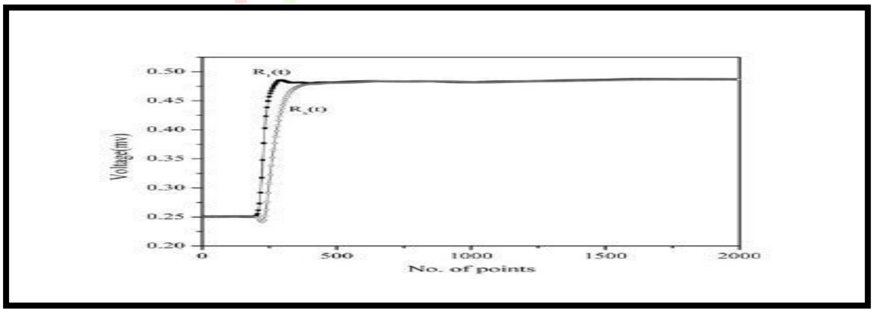

FIGURE NO.3 Reflected pulses without sample $R_1(t)$ and with sample $R_X(t)$.

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 =$\sqrt{1}$

The complex permittivity spectrum of the Nicotinic acid mixtures solution is an asymmetric shape and it is determined by the Harviliak – Negami (HN) equation [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 [6,11].

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

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 [9].

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 Piperine-water mixture. The relaxation time observed to increases systematically as increase in concentration as shown in table1.

Conc.	ε_0	τ(PS)	ε_∞	β
0.01	76.36	8.09	2.00	0.944
0.02	79.68	8.29	2.00	0.952
0.03	82.23	8.67	2.00	0.978

Table :- 1 Dielectric parameter of Piperine-water mixture.

With the increase in concentration of solution the increase in dielectric constant and systematic change in the dielectric parameters of the solution can be explain on the basis of molecular interaction. 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 Piperine-water 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 Piperine - water mixture dielectric constant and relaxation time goes on increasing as concentration increases.

From the observed result we can conclude that dielectric constant, relaxation time of Piperine- water mixture are depending on concentration.

References:

1 Http://enWivikipedia.org/Wiki/piperine,

2 S.X.Wang, Z.C.Tan, Y.Y.Dif,Xu,M.H.Wang,L.X.SunandT.Zhang J. of thermal analyser andvol. 76 (2004) 335,342.

3 J. B. Hasted Aqueous dielectric (Champman and Hill London) 1973.

4 G.R. Mahajan and A.C. Kumbharkhane Int. J. of Bioses Bioche. And Bioform Vol 2, No.2, March 2012.66, 793-802.

5 A.D. Vyas, V.A. Rana and D.S. Gadani Ind. J of Pure and App. Phys Vol 49.April 2011, 277-283.

6 M.N. Shinde, R.B. Talware, P.G. Hudge, Y.S. Joshi and A.C. Kumbharkhane pra. J. of Physics vol.78, No. 2 Feb. 20/12 PP. 297-308.

7 P.G. Hudge, M.P. Lokhande and A.C. Kumbharkhane, Ind J. Phys (Sept. 2012) 86(9)813-818.

8 C.S. Mali, S. D. Chavan,K. S. Kanse A. C. Kumbharkhane and S. C. Mehrotra; Indian J. of Pure & App. Physics Vol 45, May 2007, pp. 476-481.

9 Y.S. Joshi, A.C. Kumbharkhane J. Mol. Liq 161 (2011) 120-124.

10 M. B Swami , V.P.Pawar, P.G.Hudge,A.C.Kumbrkhane.pro.NCMTA.-2013,178.

11 Havriliak S. Negami S.J. Polym. Sci. (1966)14, 99-117.