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# Study of Static Dielectric Constant and Relaxation Time of Brucine-Chloroform Solution using Time Domain Reflectometry

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***Abstract: The complex permittivity, static dielectric constant and relaxation time of Brucine – Chloroform solution for different concentration have been studied using time domain Reflectometry at temperature 298°K, in frequency range 10 MHz to 30 GHz. The effect of Brucine concentration in non-polar solvent chloroform on static dielectric constant ($\varepsilon_0$) and relaxation time ($\tau$) was studied. The static dielectric constant slightly decreases and relaxation time increases with concentration of Brucine.***
***Index Terms: Brucine; Dielectric constant; Relaxation time; TDR.***

## I. INTRODUCTION

Brucine was discovered in 1819 by Pelletier and Caventou in the bark of Strychnos nux vomica tree. It comes under the Indole- II group of alkaloid [1]. It is a natural alkaloid. It was closely related to Strychine [2]. Brucine is large chiral molecule, it is used in chiral solution. It is also called 2-3 Dimethoxystrychnine. Brucine is used for medical use. It has anti-tumor properties [3]. It is poisonous alkaloid, hence it is also used as a pesticide. [4, 5] . Molecular formula is $C_{23}H_{26}N_2O_4$. It dissolves in alchohol and chloroform. It's molecular mass is 394.46 gm/Mole. As per use in medical and agricultural field, it is necessary to study in depth. In this paper, I present effect of Brucine concentration on static dielectric constant and relaxation time at temperature 298°K using time domain Reflectometry. .

## II. EXPERIMENTAL

### *A. Material*

Brucine (2-3 Dimethoxystrychnine) was obtained from OTTO Chemie India. Considering the molecular mass and solubility of Brucine in chloroform, molar solutions 0M, 0.06M, 0.12M, 0.18M,0.24M, 0.3M were prepared. Chloroform is non-polar solvent.

### *B. Experimental Setup*

Digital serial Analyser sampling oscilloscope DSA-8200 (Tektronics), sampling TDR module 80E08 with step generator was used. Bandwidth of DSA-8200 is 50 GHz [6,7]. To maintain temperature 298°K, temperature control system was used. The Fig. 1 shows block diagram of TDR.

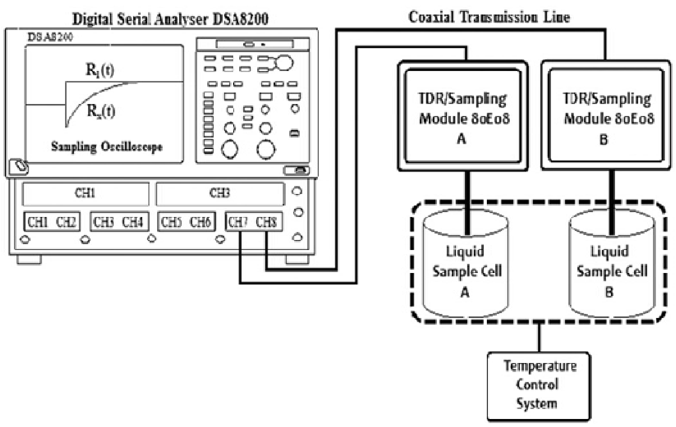


Fig. 1 Experimental setup of TDR

### C. Experimental Procedure

By maintaining temperature 298°K constant, the reflected pulse without sample $R_1$ (t) and with sample $R_x$ (t) were recorded in time window 5 ns and Considering the digitized in 2000 points for Brucine-chloroform solution of different concentration using TDR technique between frequency range 10 MHz to 30 GHz.

## III. RESULT AND DISCUSSION

The complex coefficient ρ*( ω) over frequency range 10MHz to 30GHz determined as

$$\rho*(\omega) - \frac{c \;\; p(\omega)}{j\omega d\, q(\omega)} \qquad \text{-- (1)}$$

Where, p(ω) and q(ω) are Fourier Transform of time domain p(t) and q(t). If The reflected pulse without sample is $R_1(t)$ and with sample is $R_x(t)$. Then,

$$p(t) = [R_1(t)-R_x(t)] \qquad \text{-- (2)}$$

$$q(t) = [R_1(t)+R_x(t)] \qquad \text{-- (3)}$$

p(ω) and q(ω) in equation (1), obtained by summation and Samulon method [7, 8]

$$p(\omega) = T \sum_{n=0}^{N} \exp(-i\omega nT)p(nT) \qquad \text{-- (3)}$$

$$q(\omega) - \frac{T}{1-\exp(-j\omega T)} \left[\sum_{n=0}^{n}(q(nT) - q(n-1)T)\exp(-j\omega nT)\right] \qquad \text{-- (4)}$$

The complex permittivity spectra ε*(ω) is obtained from reflection coefficient spectra ρ*( ω) by using Bilinear calibration method suggested by Cole [10-12].

Due to brucine concentration to the dielectric polarization, the dielectric spectra for brucine- chloroform solution are more complicated. The dielectric relaxation for Brucinr-Chloroform solution is described by Harilliak and Negami equation [13].

$$\varepsilon^*(\omega) = \varepsilon_\infty \mid (\varepsilon_0 \quad \varepsilon_\infty)/[1 + (j\,w\,\tau)^{1-\alpha}]^{\beta} \qquad \text{--(5)}$$

Where, $\varepsilon_0$ is static dielectric constant, $\varepsilon_\infty$ is dielectric constant at high frequency, τ is relaxatioon time, α and β are distribution parameter.

Brucine chloroform solution for all concentration could fit Debye type dispersion [14]. Therefore α =0 , β = 1 and experimental values ε*(ω) were fitted to Debye equation as

$$\varepsilon^*(\omega) = \varepsilon_\infty + \frac{(\varepsilon_0 - \varepsilon_\infty)}{(1+jw\tau)} \qquad \text{---(6)}$$

By using, nonlinear square fir method, static dielectric constant $\varepsilon_0$ an relaxation time τ for different concentration at 298°K are determined which is as shown in Table 1.

Table 1: Dielectric relaxation parameters for solution of Brucine – chloroform at different concentration at temperature 298°K

| 298$^0$K | | | |
|---|---|---|---|
| Concentration of Brucine in Molar (M) | $\varepsilon_\infty$ | $\varepsilon_0$ | τ(ps) |
| 0 | 2 (1) | 4.82 (1) | 6.87 (4) |
| 0.06 | 2.30 (3) | 4.41 (3) | 9.12 (7) |
| 0.12 | 2.04 (5) | 4.43 (4) | 10.08 (9) |
| 0.18 | 2.03 (3) | 4.36(3) | 11.04 (7) |
| 0.24 | 2.04 (7) | 4.34 (8) | 12.28 (15) |
| 0.3 | 2.62 (1) | 4.31 (3) | 13.52 (29) |

(Note – The number in bracket indicate error, for e.g. 6.87(4) means 6.87 ± (0.04))

Variation of static dielectric constant with molar concentration of Brucine at temperature 298° K is as shown in Fig. 2

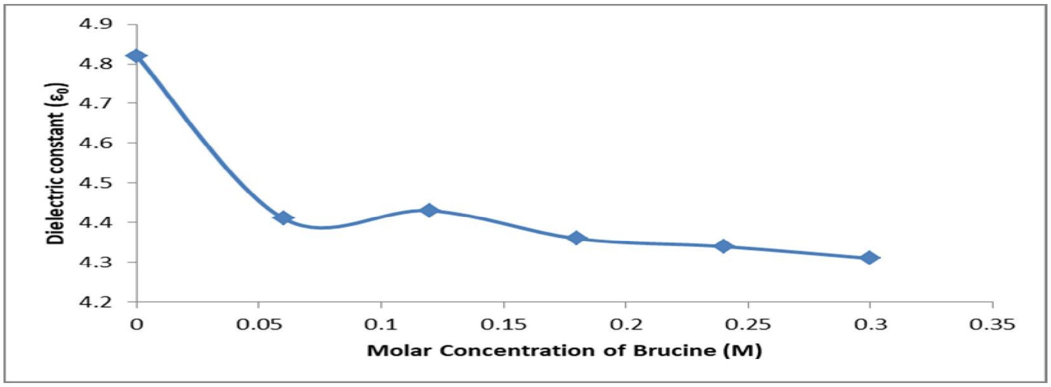


Fig.2 Variation of static dielectric constant with molar concentration of Brucine at temperature 298° K

Similarly, variation of relaxation time with molar concentration of Brucine in chloroform at 298° K is as shown in Fig.3

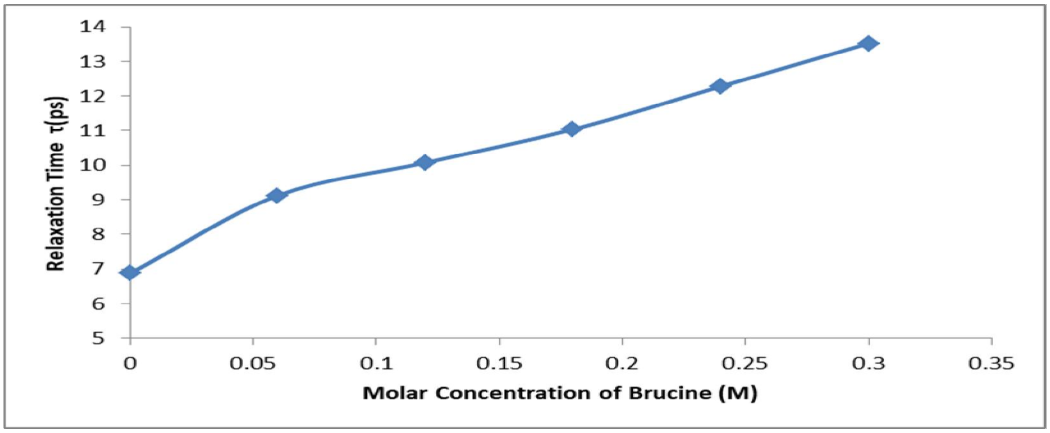


Fig.2 Variation of relaxation time with molar concentration of Brucine in chloroform at 298° K

## IV. CONCLUSION

The Dielectric constant is mainly dependent on dipole moment and number of molecules per unit volume. Static dielectric constant ($\varepsilon_0$) decreases with increase in concentration of Brucine. The relaxation time increases with increase in concentration of Brucine.

## V. ACKNOWLEDGEMENT

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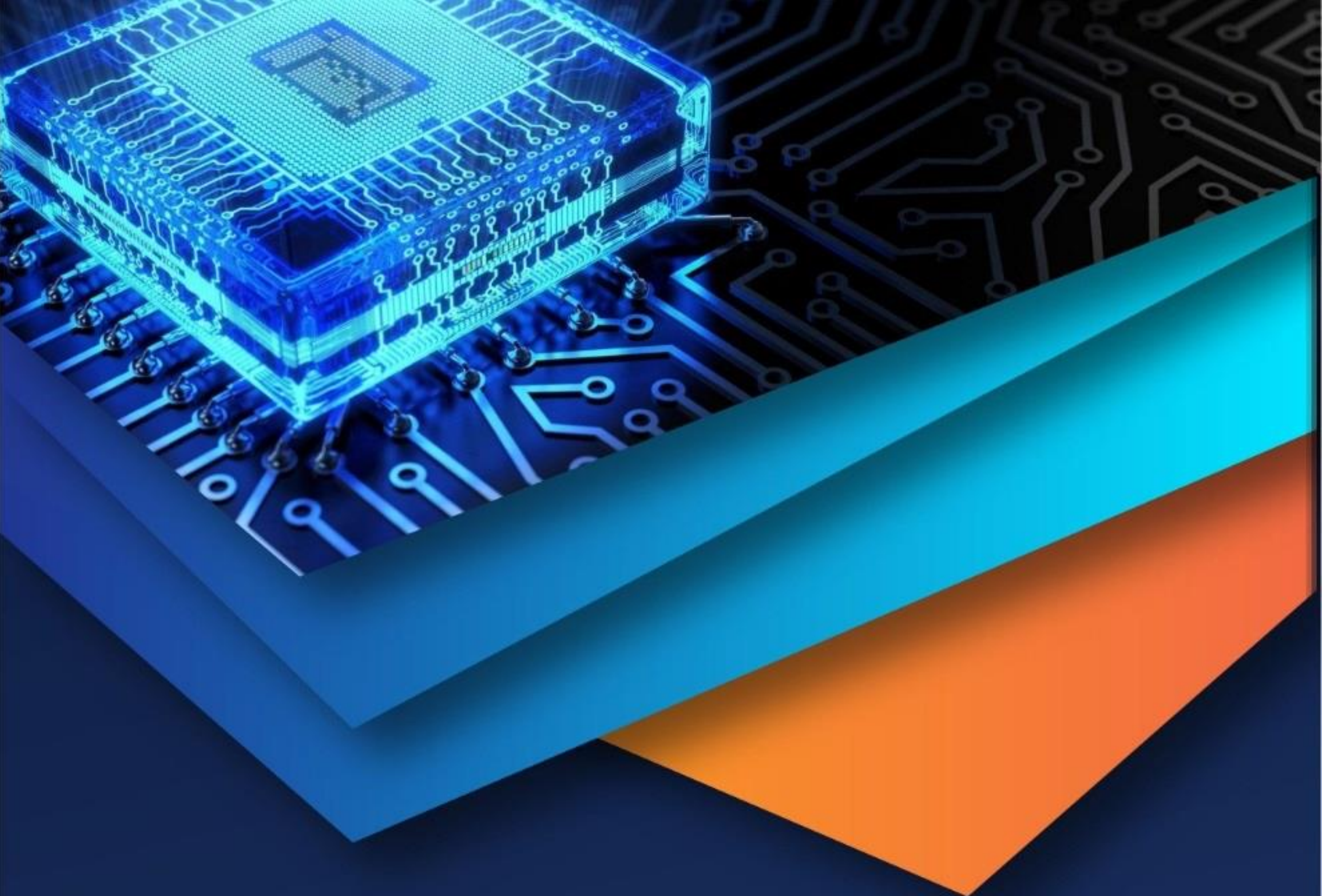


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