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## Dielectric Relaxation Study of DPG Using a TDR at 20°C

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### ABSTRACT

Study of Dipropylene Glycol (DPG)-water mixture have been studied by time domain Reflectometry technique in the frequency range of 10MHz to 30GHz. The measurements have been done at temperature 20°C at different volume fractions. The dielectric parameters such as static dielectric constant and relaxation time for mixture have been reported here. The molecular interaction between Dipropylene Glycol and water is discussed using Kirkwood correlation factor ( $g^{\text{eff}}$ ) and dielectric constant for mixtures. The dielectric relaxation behavior of binary mixtures of Dipropylene glycol-water has been fitted with Cole-Davidson model having an asymmetric distribution of relaxation time. These parameters have been fitted to the Bruggeman mixture formula in the non-linear case.

**Key words:** Dielectric relaxation, Time Domain Reflectometry, Glycol, Kirkwood correlation factor

### I. INTRODUCTION

Over the past several years, the aqueous mixtures of glycols and alcohols have been extensively investigated by means of the dielectric relaxation as a function of -OH group to understand the significance of hydrogen bond interaction. [1-2] Dipropylene glycol (DPG) reveals a strong tendency to form H bonds. Terminal hydroxyl groups of DPG may participate in two types of hydrogen bonds: end-to-end and end-to-ether (C-O-C) groups [3] both can lead to inter and intra molecular structures.

The dielectric relaxation study is very helpful for the understanding of intermolecular interaction and the hydrogen bonding interaction in aqueous mixture due to dipole-dipole interaction. The main interest of the study is to understand the structural and dynamical behavior of aqueous DPG using Time Domain Reflectometry (TDR) Technique. Previously different techniques were used for characterization such as light scattering [4-6], optical Kerr-effect [7] as well as photo thermal. Moreover some physical properties of aqueous mono, di and tri propylene glycol have been reported. [8] The dielectric spectra of propylene glycol and tri-propylene glycol have been studied earlier [9-10] using TDR technique.

The objectives of the present work are to investigate temperature dependent dielectric relaxation properties of DPG-water systems using TDR technique in the frequency range of 10 MHz to 30 GHz. The static dielectric constant, relaxation time, Bruggeman factor, Kirkwood correlation factors, excess dielectric permittivity and thermodynamic parameters have been reported for DPG-water mixtures.



## II. EXPERIMENTAL DETAILS

### Materials and sample preparation

DPG (100% pure) was purchased from Merck India Limited and used without further purification. The HPLC grade double distilled water was used in preparation of aqueous DPG mixtures. 11 different Samples of total volume 5ml each were prepared such that; a volume fraction 0.1 indicates 0.5ml of DPG added to 4.5ml of water, a volume fraction of 0.2 indicates 1.0ml of DPG added to 4.0ml of water and vice versa. For the measurement samples were placed in an electronically temperature-controlled bath within accuracy of  $\pm 0.1$  °C.

The step pulses recorded without sample  $R_1(t)$  and with sample  $R_x(t)$  and are subtracted and added to get

$$p(t) = [R_1(t) - R_x(t)] \quad 1$$

$$q(t) = [R_1(t) + R_x(t)] \quad 2$$

The complex reflection coefficient  $\rho^*(\omega)$  over a frequency range of 10 MHz to 30 GHz were determined as follows.

$$\rho^*(\omega) = \frac{c}{j\omega d} \frac{p(\omega)}{q(\omega)} \quad 3$$

Where  $p(\omega)$  and  $q(\omega)$  are Fourier transforms of  $p(t)$  and  $q(t)$  obtained using summation and Samulon methods [10] respectively,  $c$  is the velocity of light,  $\omega$  is angular frequency and  $d$  is effective pin length (0.16 mm). The complex permittivity spectra  $\epsilon^*(\omega)$  was obtained from reflection coefficient spectra  $\rho^*(\omega)$  by applying the bilinear calibration method suggested by Cole [11]. Figure 1 shows frequency dependent complex permittivity spectra  $\epsilon^*(\omega)$  for DPG–water mixtures at 20 °C.

## III. RESULTS AND DISCUSSIONS

### Dielectric Constant and Relaxation time

Dielectric relaxation for aqueous DPG is described by the Havriliak–Negami equation [12]

$$\epsilon^*(\omega) = \epsilon_\infty + \frac{\epsilon_0 - \epsilon_\infty}{[1 + (j\omega\tau)^{1-\alpha}]^\beta} \quad 4$$

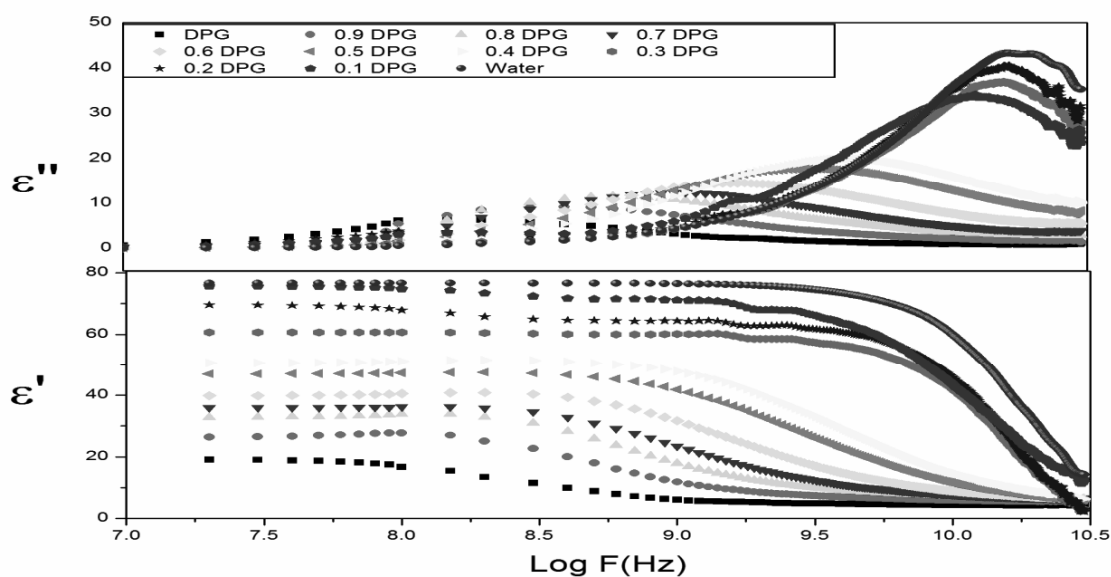
Where  $\epsilon_0$  is the static permittivity,  $\epsilon_\infty$  is the permittivity at high frequency,  $\tau$  is the relaxation time,  $\alpha$  and  $\beta$  are the empirical parameters for the distribution of relaxation times with values between 0 and 1. Temperature dependent dielectric relaxation parameters for aqueous solutions of DPG are listed in Table 1. The errors in the least significant digit are also reported.

The Relaxation time increases systematically in aqueous solutions of DPG as shown in table 1 suggests that water structure is modified due to hydrogen bond by the DPG so as to produce an increase in relaxation time in the mixture. In DPG rich regions relaxation time increases rapidly this may due to higher viscosity of DPG as relaxation time and viscosity has linear relationship. [13]

**Table 1. Dielectric Relaxation Parameters for aqueous solution of DPG at 20°C**

| Of DPG | Vol. Fract.         |              | $\tau$ (ps) | $\beta$   |
|--------|---------------------|--------------|-------------|-----------|
|        | $\epsilon_{\infty}$ | $\epsilon_0$ |             |           |
| 0.0    | 3.92(3)             | 79.10(7)     | 8.82(1)     | 1.0000(1) |
| 0.1    | 2.000(1)            | 72.16(10)    | 13.16(03)   | 0.9723(1) |
| 0.3    | 2.000(1)            | 58.98(08)    | 10.47(02)   | 1.0000(1) |
| 0.2    | 2.000(1)            | 63.35(22)    | 11.57(04)   | 1.0000(1) |
| 0.4    | 2.237(2)            | 52.32(08)    | 36.00(01)   | 0.8451(1) |
| 0.5    | 2.425(2)            | 48.48(08)    | 48.28(02)   | 0.8245(0) |
| 0.6    | 3.750(3)            | 42.00(14)    | 82.42(07)   | 0.7929(3) |
| 0.7    | 4.522(2)            | 37.91(15)    | 138.56(01)  | 0.7636(3) |
| 0.8    | 5.073(2)            | 35.17(18)    | 209.30(03)  | 0.7701(4) |
| 0.9    | 4.880(2)            | 28.47(16)    | 320.07(06)  | 0.7966(5) |
| 1.0    | 3.867(1)            | 20.16(13)    | 771.20(17)  | 0.7679(5) |

Note: Numbers given in parentheses denote uncertainties in the least significant digits obtained by the least square fit method, e.g. 20.59(14) means  $20.59 \pm 0.14$  and 0.7564(7) means  $0.7564 \pm 0.007$ .

**Figure 1 Complex permittivity spectra for DPG-water mixtures at 20°C**

### Kirkwood correlation factor

Static dielectric constant for the mixture can be explained using the Kirkwood-Frohlich equation as follows [14-15],

$$\frac{4\pi N\rho}{9kTM} g\mu^2 = \frac{(\epsilon_0 - \epsilon_\infty)(2\epsilon_0 + \epsilon_\infty)}{\epsilon_0(\epsilon_\infty + 2)^2} \quad 5$$

Where  $\mu$ ,  $\rho$  and  $M$  correspond to the dipole moment in gas phase, density and molecular weight respectively,  $k$  is the Boltzmann constant,  $T$  is the temperature and  $N$  is the Avogadro's number.

The Kirkwood correlation factor “ $g$ ” determined from the dielectric constant gives information on the collective orientation correlation between molecules.

$$\frac{4\pi N}{9kT} \left[ \frac{\mu_w^2 \rho_w}{M_w} V_a + \frac{\mu_A^2 \rho_A}{M_A} (1 - V_a) \right] g^{eff} = \frac{(\epsilon_{0m} - \epsilon_{\infty m})(2\epsilon_{0m} + \epsilon_{\infty m})}{\epsilon_{0m}(\epsilon_{\infty m} + 2)^2} \quad 6$$

With  $V_a$  and  $1 - V_a$  as volume fractions of liquids  $a$  (water) and  $b$  (DPG), respectively. In the mixtures the values of  $g^{eff}$  show (Table 2) decreasing trend with the increasing concentration of DPG molecules in the mixtures. This indicates the decrease in interaction between the molecules of the system with increase in volume fraction of DPG in the solution. The values of  $g^{eff}$  are greater than unity for all the concentration and all three temperatures suggesting parallel orientation of electric dipoles.

**Table 2. Kirkwood correlation factor for DPG Water Mixture at 200C.**

Volume Fraction of Solute

|     |          |     |          |
|-----|----------|-----|----------|
| 0.0 | 2.79(16) | 0.1 | 2.74(16) |
| 0.2 | 2.62(15) | 0.3 | 2.68(16) |
| 0.4 | 2.65(16) | 0.5 | 2.79(16) |
| 0.6 | 2.82(17) | 0.7 | 3.07(18) |
| 0.8 | 3.63(22) | 0.9 | 4.09(24) |
| 1.0 | 4.88(29) |     |          |

Note: Numbers given in parentheses denote uncertainties in the least significant digits, e.g. 2.79(16) means  $2.79 \pm 0.16$

### Bruggeman factor

The Bruggeman equation [16] is another parameter which may be used as an indicator of solute solvent interaction. The Bruggeman factor ( $f_B$ ) is given by,

$$f_B = \left[ \frac{(\epsilon_{0m} - \epsilon_{02})}{(\epsilon_{01} - \epsilon_{02})} \right] \left( \frac{\epsilon_{01}}{\epsilon_{0m}} \right)^{\frac{1}{3}} = 1 - V \quad 7$$

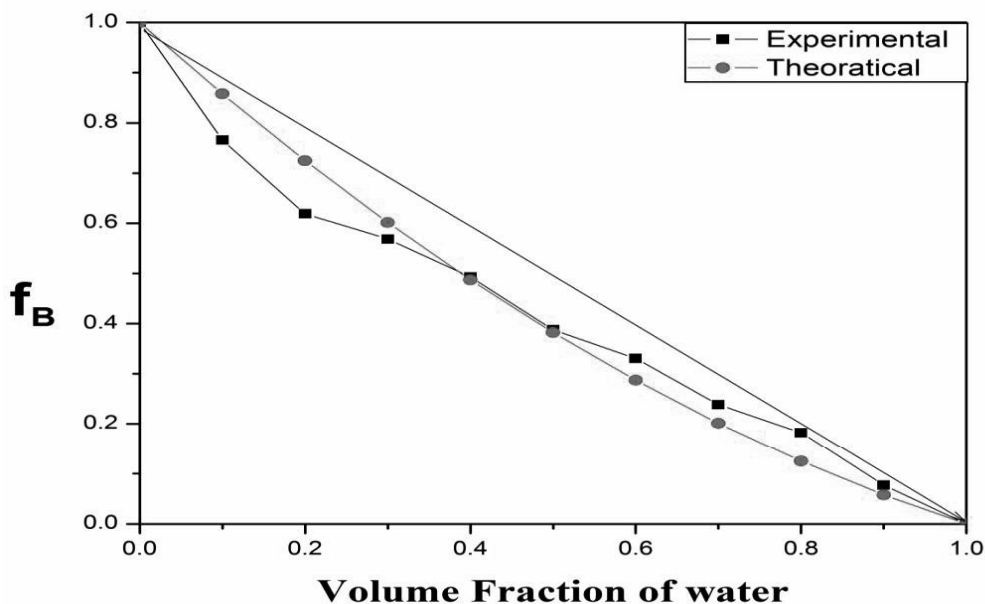


Figure2 Plot of Bruggeman factor ( $f_B$ ) as function of Volume fraction of water at 20°C

Where  $\epsilon_{0m}$ ,  $\epsilon_{01}$  and  $\epsilon_{02}$  are the static dielectric constant corresponding to mixture, solute and solvent respectively;  $V$ - is the volume fraction of solvent (water). From above equation, the linear relation is expected from a plot  $f_B$  Vs Volume fraction of water. But in binary liquids, there is non-linear relationship.

$$f_B = \left[ \frac{(\epsilon_{0m} - \epsilon_{02})}{(\epsilon_{01} - \epsilon_{02})} \right] \left( \frac{\epsilon_{01}}{\epsilon_{0m}} \right)^{\frac{1}{3}} = 1 - [a - (a-1)V]V \quad 8$$

In this equation, volume fraction ( $V$ ) is changed by a factor ' $a - (a-1)V$ ' of the mixture.

Figure 2 shows variation of Bruggeman factor at 20°C with volume fraction of water. The value of ' $a$ ' equal to 1 corresponds to ideal mixture with no additional interaction between two liquids and reduces to Bruggeman's equation. The value of ' $a$ ' determined by least square fit method is found to be 1.47; its deviation from unity indicates the molecular interaction in the mixture.

#### IV. CONCLUSION

The values of static dielectric constant, relaxation time, Kirkwood correlation factor and Bruggeman factor for DPG–water mixtures are also investigated. It suggests the formation of strong –H bonds between DPG and Water. The Kirkwood correlation factor value of pure Dipropylene is greater than unity, reveals the hydrogen bond interaction and presence of parallel associated molecules. Using Bruggemann factor the nonlinear relationship between DPG and water molecules has been also studied.

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## Dielectric Dispersion Study of Binary Mixtures of Polysorbate-40 with Aqueous Solutions

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### ABSTRACT

The complex relative dielectric properties of polysorbate-40 with water at various concentrations have been measured using Precision LCR meter in the frequency range of 20Hz to 2 MHz at 25°C. The electrical and dielectric properties of the binary mixtures are represented in terms of complex dielectric function  $\epsilon^*(\omega)$ , electrical modulus  $M^*(\omega)$ , electrical conductivity  $\sigma^*(\omega)$ . All these parameters are used to explain the various processes associated with the electric and dielectric properties of the binary mixtures of polymer in aqueous solutions.

**Keywords:** Precision LCR meter, complex permittivity, electric modulus.

### I. INTRODUCTION

The investigation of dielectric parameters of the material in the spectral range from 20 Hz to 2 MHz provide the useful information about the intra and inter molecular dynamics, the degree of intermolecular H-bond interaction, cooperative nature between like and unlike molecules. The information regarding ionic and electrode polarization processes related to the molecular structures also can be studied [1-3]. Polysorbate-40 (P-40) is polymer having molecular formula  $C_{62}H_{122}O_{26}$ . P-40 is also known as polyoxymethylene sorbitan monopalmitate consists of sorbitol, palmitic acid and ethylene oxide. P-40 is the yellow or orange viscous liquid at room temperature. It has wide range application in cosmetic preparation, cleaning compound, pharmaceuticals, personal care product, emulsifier or surfactant to help mix oil and water.

P-40 is miscible with water in a wide concentration range. As oxygen atoms and -OH groups are present, respectively in the molecular chain and at the ends of the chain, due to which these molecules have several hydrogen bonding sites. They can enter into intra- and intermolecular hydrogen bonding giving rise to several conformations in water mixtures. Extensive experimental attempts have been made to study the dielectric behaviour of polymer molecules and their oligomers at radio waves and microwaves [4-9]. In the present study, dielectric measurement of P-40 in aqueous solutions have been carried out in the frequency range of 20Hz to 2MHz using precision LCR meter and various processes associated with these parameters were discussed.

## II. EXPERIMENTAL DETAIL

### Materials

P-40 was obtained from RLCC with purity 99% and water with HPLC grade made by Fisher Scientific India Pvt Ltd. They were used without further purification. The solutions were prepared at different mole fraction of water in polysorbate-40.

### Measurement:

The complex dielectric function  $\varepsilon^*(\omega)$  of liquid sample were determined by Agilent Technologies, E4980 using precision LCR meter. A four terminal liquid dielectric test fixtures (Agilent16452 A) were used for capacitance and parallel resistance measurement in the frequency range 20 Hz to 2 MHz the capacitance and parallel resistance of the liquid dielectric test fixture without and with samples were measured to compensate for short. The test fixture correction coefficient was also considered to cancel the effect of stray capacitance during the evaluation of the value of the complex dielectric function. The complex dielectric function  $\varepsilon^*(\omega)$  of the material is determined using Eq. (1).

$$\varepsilon^*(\omega) = \varepsilon'(\omega) - j\varepsilon''(\omega) = \alpha \left[ \frac{C_p}{C_0} - j \frac{1}{\omega C_0 R_p} \right] \quad (1)$$

Where  $\omega = 2\pi f$  is the angular frequency and  $\alpha$  is the correction coefficient of the cell. All measurements were made at 25°C.

## III. RESULT AND DISCUSSIONS:

### Dielectric Spectra:

The frequency dependent spectra of the real part of dielectric permittivity for P-40 and its binary solutions with water are shown in Fig.1. In present study, the static dielectric permittivity values of corresponding liquids samples are recorded at 2 MHz. From the plot it can be observed that, the dielectric permittivity ( $\varepsilon'$ ) values for pure P-40 and its binary solutions with water are very high at lower frequency and these values lowers with increase in frequency. The higher values of  $\varepsilon'$  at lower frequencies are due to the domination of electrode polarization effect which can be explained with the help of  $\tan\delta$  plot (Fig. 2).

In the real part of dielectric permittivity spectra (Fig. 1),  $\varepsilon'$  values for P-40 becomes steady around 1 KHz while that for the binary mixtures with water becomes frequency independent from few KHz to 0.3 MHz. Frequency dependent dielectric loss tangent ( $\tan\delta = \varepsilon''/\varepsilon'$ ) is plotted in Fig. 2. The electric double layer capacitance formation taken place due to the free charge built up at the interface between the dielectric material and electrode surface. This gives rise to the electrode polarization (EP). The electrode polarization frequency corresponds to the peak in  $\tan\delta$  spectra (Fig. 2). The EP phenomenon can be separated from the bulk material by using the EP relaxation frequency. The loss peak of  $\tan\delta$  is corresponding to the EP relaxation frequency  $f_{EP}$ , which can be used to evaluate the EP relaxation time,  $\tau_{EP} = (2\pi f_{EP})^{-1}$  which is associated with the overall dynamics of the absorbed ions on the electrode surfaces in the alternating electric

field. On addition of water in P-40, the loss peaks are shifting towards the higher frequency side up to mole fraction of water ( $X_w$ ) = 0.993. Above this concentration again the dielectric loss peak shifts toward the higher frequency.

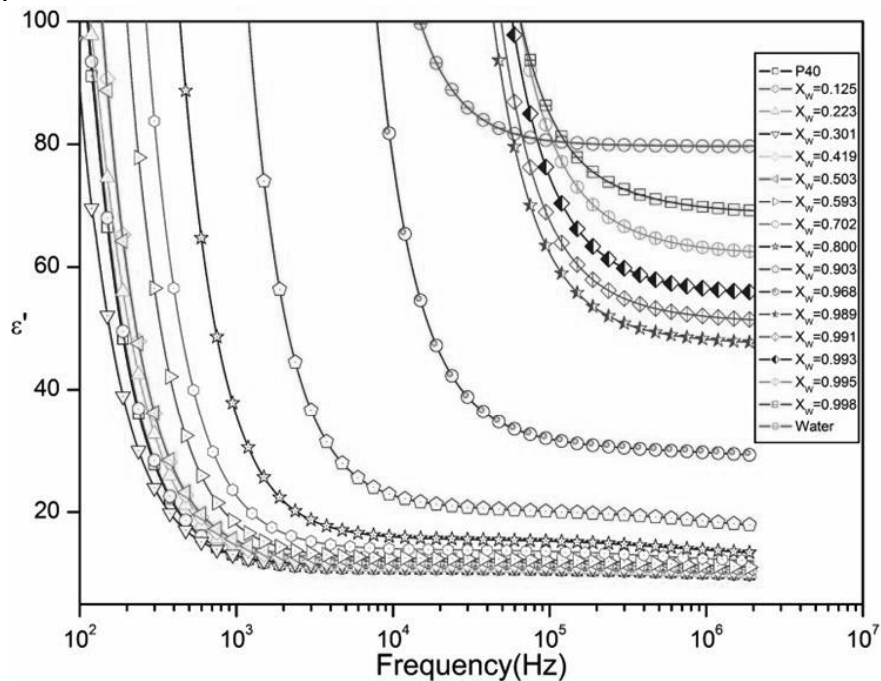


Fig. 1 : Dielectric permittivity spectra ( $\epsilon'$ ) for binary mixtures of P-40 with water at 25°C.

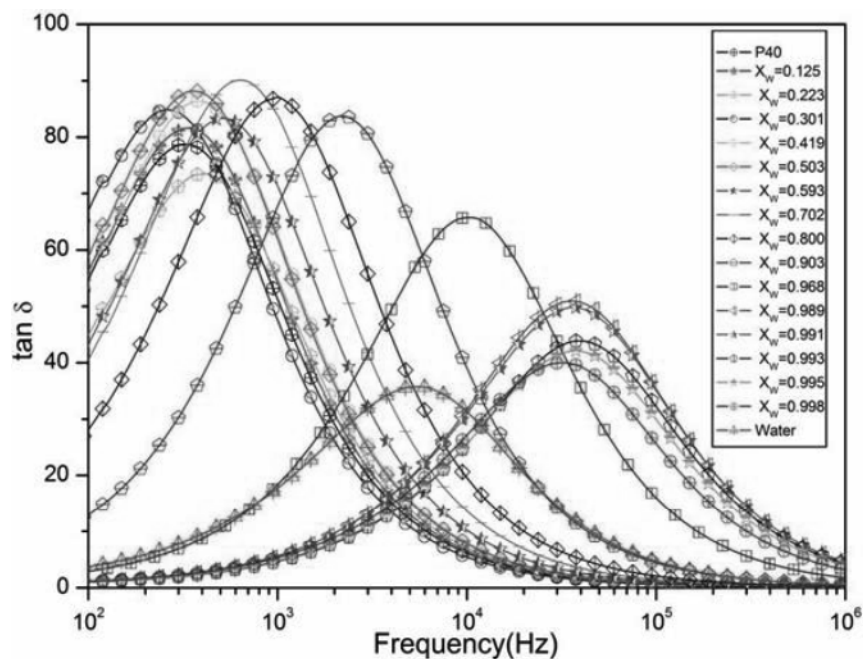


Fig 2: Dielectric loss ( $\tan \delta$ ) for binary mixtures of P-40 with water at 25°C.



The static dielectric permittivity ( $\epsilon_s$ ) values of pure P-40, water and their binary solutions are obtained from the permittivity spectra is plotted and shown in Fig.3. The non linear nature of this plot indicates certain interaction among the unlike molecules. In the polymer rich region ( $0 \leq X_W \leq 0.8$ ), the values of  $\epsilon_s$  are increasing very slowly. It can be attributed as P-40 structure is dominant in the binary solutions whereas for the concentrations  $X_W > 0.8$ , the values of  $\epsilon_s$  increasing rapidly. It may possible due to water molecules try to form hydrogen bonding with the P-40 molecules. The structure of pure P-40 starts to break and may form complexes of heteromolecules in this region.

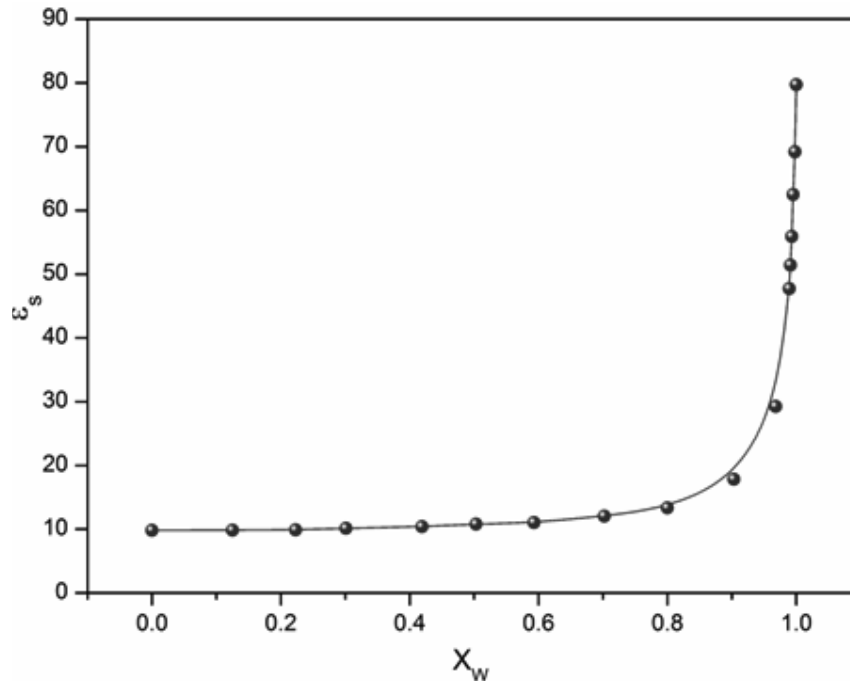


Fig. 3: Static dielectric permittivity ( $\epsilon_s$ ) Vs. Mole fraction of water ( $X_W$ )

### Electric Modulus [ $M^*(\omega)$ ]

The frequency dependent values of  $M^*(\omega)$  is obtained using Eq. (2) [10-12]

$$M^*(\omega) = \frac{1}{\epsilon^*(\omega)} = M' + jM'' = \frac{\epsilon'}{\epsilon'^2 + \epsilon''^2} + j \frac{\epsilon''}{\epsilon'^2 + \epsilon''^2} \quad (2)$$

The plots for real and imaginary parts of electric modulus vs. frequency are shown in Fig. 4 and Fig.5. It can be observed in Fig. 4 that  $M'$  approaches to zero at lower frequencies. This nature confirms the existence of electrode polarization at lower frequencies. The  $M'(\omega)$  increases with increase in the frequency nonlinearly. From the Fig. 5, frequency corresponds to the  $M''$  peak value has gradually shifted towards higher frequency with decrease in the P- 40 concentration in water. Value of the  $M''$  peak frequency  $f\sigma$  can be used to evaluate the ionic conductivity relaxation time  $\tau\sigma$  ( $= 1/2\pi f\sigma$ ) [13].

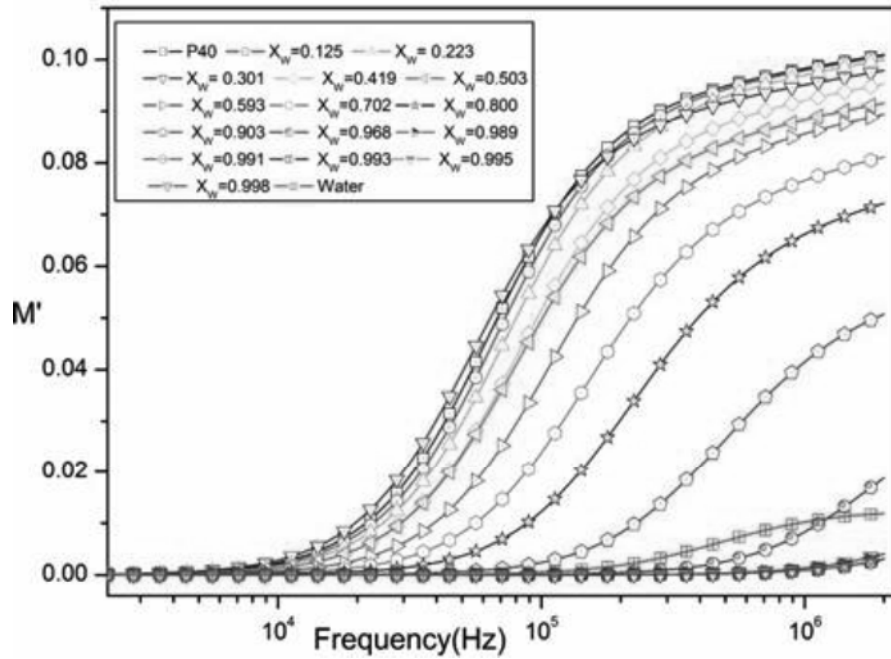


Fig 4. Real Part of electric modulus ( $M'$ ) vs. Frequency.

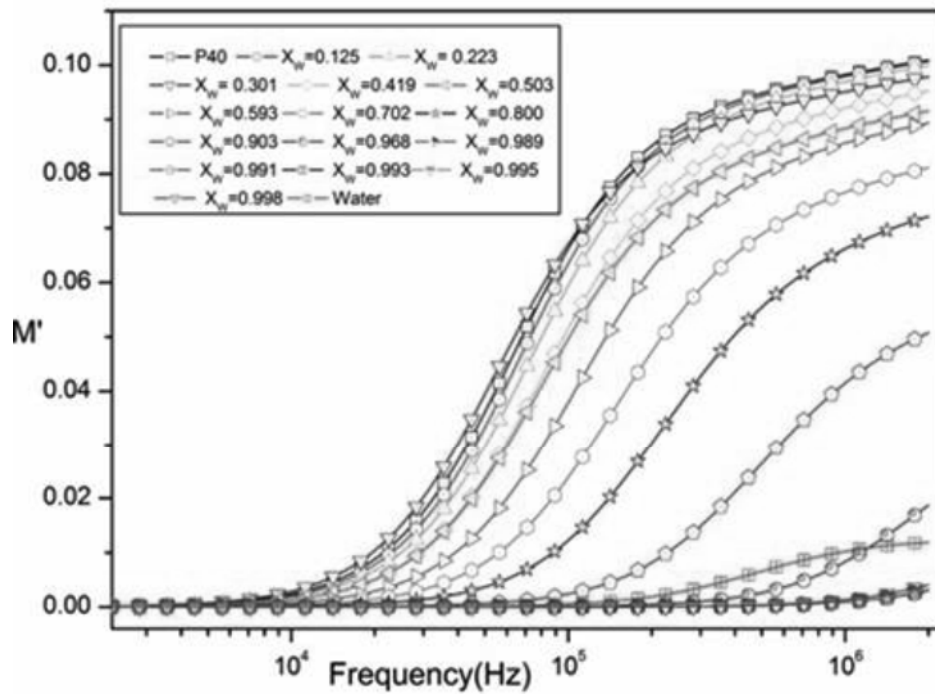


Fig. 5. Imaginary part of electric modulus ( $M''$ ) vs. Frequency

### Complex Electrical Conductivity ( $\sigma_{ac}$ )

The alternating current (ac) complex conductivity  $\sigma^*(\omega)$  which is the resultant of real part  $\sigma'$  and the imaginary part  $\sigma''$  of the liquid samples obtained from the following Eq.(3)

$$\sigma^*(\omega) = \sigma' + j\sigma'' = \omega \varepsilon_0 \varepsilon'' + j\omega \varepsilon_0 \varepsilon' \quad (3)$$

Here  $\varepsilon_0$  is free space dielectric permittivity. Fig.6 shows the  $\sigma_{ac}(\omega)$  spectra for polysorbate- 40 at different concentrations with water. It can be observed that the value of ac conductivity values are almost frequency independent in this frequency range for the pure P-40 and its binary concentrations of water around  $XW = 0.903$ . After this, for the concentration  $0.968 \leq XW \leq 0.998$  the values of ac conductivity are increasing rapidly upto few KHz and then it becomes independent of frequency. For pure water, very small variation in the values of  $\sigma_{ac}$  at lower frequencies is observed and remains almost steady above 100Hz.

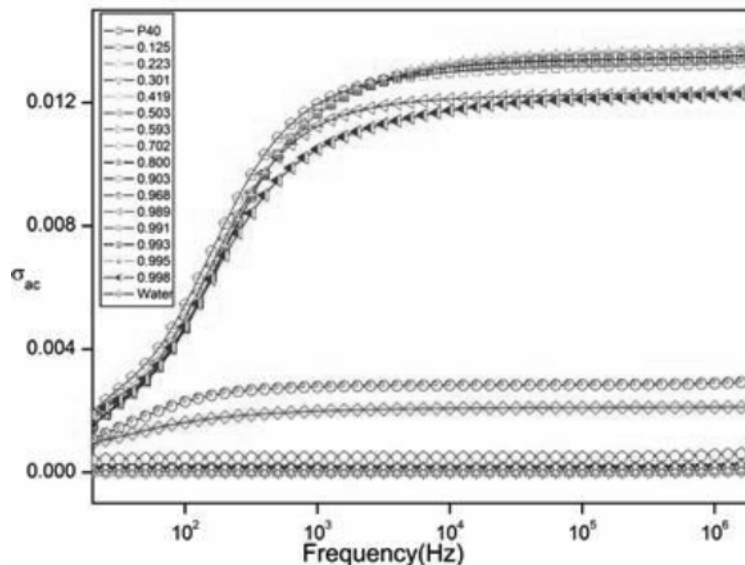


Fig. 6.  $\sigma_{ac}$  for various concentration of P-40 with Water vs. Frequency

### IV. CONCLUSION

The dielectric measurement of P-40 with Water mixtures at temperature 25°C have been done in the frequency range of 20 Hz to 2 MHz using precision LCR meter. The electrical and dielectric properties of binary mixtures are plotted in terms of dielectric permittivity  $\varepsilon^*(\omega)$ , electrical modulus  $M^*(\omega)$ , electrical conductivity  $\sigma^*(\omega)$ . All these parameters are used to explain the various processes associated with the electric and dielectric properties of the binary mixtures of polymer in aqueous solutions.

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## Dielectric Relaxation Studies of Aqueous Polyvinyl Pyrrolidone

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### ABSTRACT

Structural and dynamical properties of Polyvinyl-pyrrolidone (PVP K-30)[ $C_6H_9NO$ ]<sub>n</sub> in the solution state with water has been studied in the frequency region of 10 MHz to 30 GHz over the temperature range of 298.15 K-283.15 K using Time domain Reflectometry(TDR). Dielectric parameters such as static dielectric constant ( $\epsilon_j$ ), relaxation time ( $\tau_j$ ), dipole moment ( $\mu$ ), correlation factor ( $g_j$ ), has been calculated and expressed in terms of molecular interaction and hydrogen bonding. The dielectric permittivity spectra and relaxation behavior of PVP in different concentrations were analyzed using Cole-Cole model.

**Keywords:** Polyvinylpyrrolidone, Time Domain Reflectometry, Dipole moment.

### I. INTRODUCTION

The chemical and physical properties of polymer solutions are determined by the dynamics of solvent molecules and the micro-Brownian motion of polymer chains. Furthermore, the dynamics of polymer solutions can be efficiently considered as a basic model system with molecular motions directly related to biopolymer functionalities [1].PVP is an amorphous polymer. It contains an asymmetric electrical charge distribution in its monomer units, with distinct atoms (N, O, C, and H) close one other. PVP may form complexes with a wide range of substances by forming hydrogen bonds with the hydroxyl groups of solvents such as water, alcohols, ethylene glycol oligomers, and glycerol, among others and its carbonyl group[2].PVP, a flexible and randomly coiled polymer that is easily soluble in water, was used to study the water structure surrounding the coiled polymer. Dielectric measurements are simple to do for such a non-electrolytic solution [3].

### II. EXPERIMENTAL

#### MATERIALS

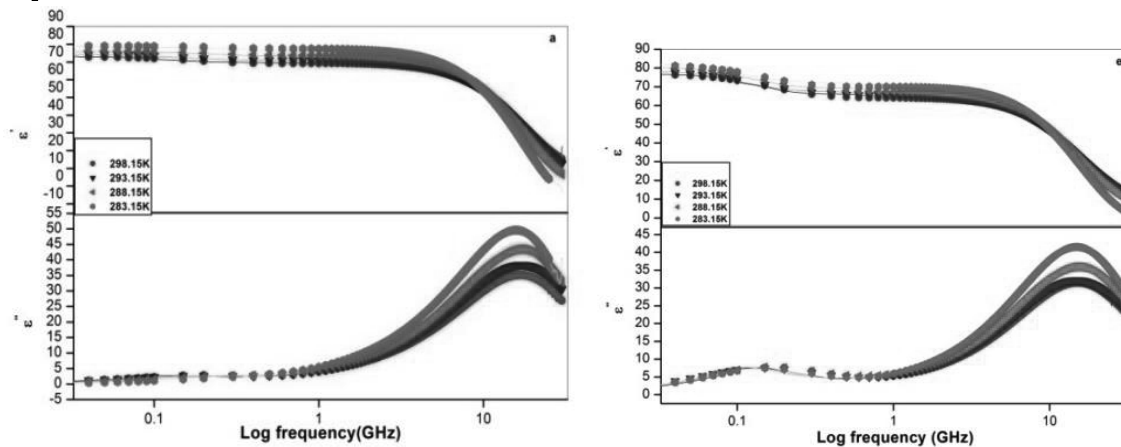
PVP K-30, a polyvinylpyrrolidone with an average molecular weight of 40,000 g mol<sup>-1</sup>, was acquired from Sigma Aldrich and utilized without purification.

### Dielectric Measurements

The dielectric permittivity( $\epsilon'$ ) and dielectric loss( $\epsilon''$ ) of pure liquid PVP solution were measured using time domain reflectometry at temperatures ranging from 298.15 K to 283.15 K, using the methodology and procedures reported elsewhere.

### III. RESULTS AND DISCUSSION

Dielectric experiments on PVP-Water mixtures were carried out at temperatures ranging from 298.15 K to 283.15 K, with PVP average molecular weights of around 40,000 g mol<sup>-1</sup>. As demonstrated in Fig. 1, the real ( $\epsilon'$ ) and imaginary ( $\epsilon''$ ) components of the dielectric functions of PVP-Water mixture are frequency dependent.



**Figure 1. Variation of Complex Permittivity Spectra of Polyvinylpyrrolidone K-30 solution with frequency at different temperatures. Dielectric permittivity ( $\epsilon'$ ) and dielectric loss ( $\epsilon''$ ) as a function of frequency (GHz) (Static Permittivity Spectra fig(a):  $1.67 \cdot 10^{-04}$  C(M) fig(e):  $8.34 \cdot 10^{-04}$  C(M))**

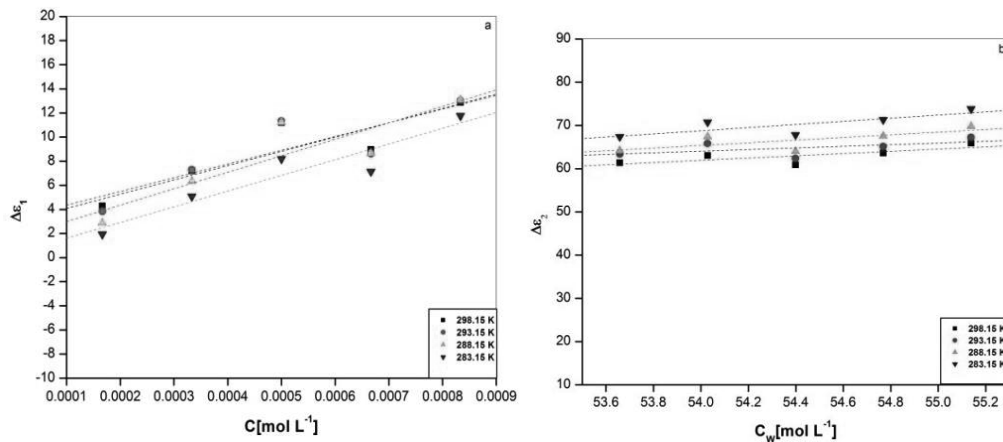
As illustrated in Fig. 1, the PVP-water mixture has two relaxation peaks. The primary relaxation process, which corresponds to the rotation of free water molecules, and the secondary relaxation process, which corresponds to the rotational motion of PVP molecules in the aqueous medium.

A sum of  $n$  Havriliak-Negami (HN) equations or its variants, the Dabye (D), the Cole-Cole (CC), and the Cole-Davidson (CD), is used to study different types of relaxation process [4].

$$\epsilon^*(\nu) = \sum_{j=1}^n \frac{\Delta\epsilon_j}{[1+(i2\pi\nu\tau_j)^{\beta_j}]^{\alpha_j}} + \epsilon_{\infty} \quad (1)$$

The 2-D model derived from eqn.(1) for the two relaxation processes is

$$\epsilon^*(\nu) = \frac{\Delta\epsilon_1}{1+i2\pi\nu\tau_1} + \frac{\Delta\epsilon_2}{1+i2\pi\nu\tau_2} + \epsilon_{\infty} \quad (2)$$

**Static Dielectric constant( $\epsilon$ ) :****Figure 2. Dielectric relaxation strength of low frequency and high frequency processes.**

Low frequency dielectric relaxation strength  $\Delta\epsilon_1(c)$  increases with increasing PVP concentration, indicating that the relaxation process in the low frequency region is mostly due to an increase in effective dipole-dipole antiparallel alignment of PVP molecules. Every PVP molecule is entirely surrounded by water molecules at low concentrations, shielding the interaction between PVP molecules; this can be seen in the correlation factor  $g_1$  which drops as concentration increases, indicating strong evidence of antiparallel dipole alignment. The value of  $\Delta\epsilon_1(T)$  drops as the temperature decreases.

At all measured temperatures, the concentration dependence of the high frequency relaxation strength  $\Delta\epsilon_2(c)$  decreases linearly, indicating that it is related with the cooperative relaxation of bulk-like water occurring in the same frequency range as pure water. This indicates the presence of water associated with PVP molecules and can be linked to the relaxation time ( $\tau_2$ ) of high frequency processes at higher solute concentrations. This could also be due to strong water-water interaction and the dominating high frequency dispersion that is clearly attributed to the rotation of 'bulk-like' water molecules [4,5].

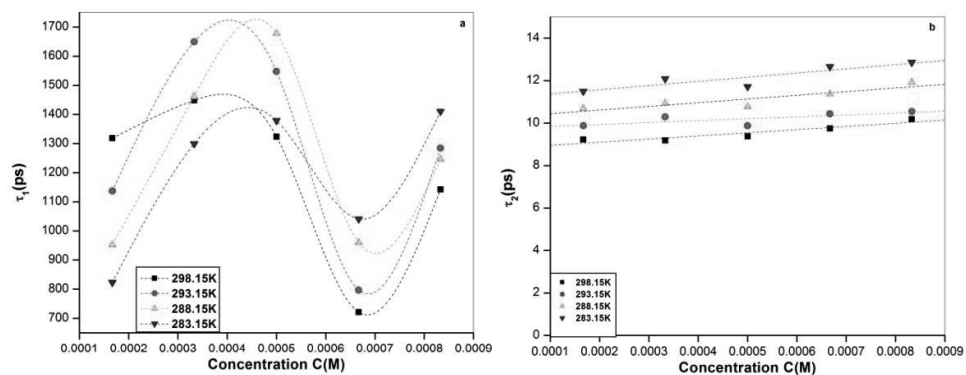
**Relaxation time:****Figure 3. Dielectric Relaxation times  $\tau_1$  (ps) and  $\tau_2$  (ps) Vs Concentration  $C_{PVP}$**

Figure 3 shows that the value of low frequency relaxation time  $\tau_1$  grows steadily with increasing solute concentration up to 0.000333 molar concentration, however there is a monotonous change in  $\tau_1$  value above this concentration. The high value of  $\tau_1$  for pure water is due to the reorientational motion of hydrogen bonded linear polymeric structure.

With decrease in temperature, the dielectric relaxation time ( $\tau$ ) for the high frequency relaxation process increases. The difference in relaxation time between pure water and all concentrations of the system recorded at room temperature ( $\sim 9$ ) could be attributed to molecular interaction between water and PVP in the system, which could enhance steric hindrance for the reorientation of water molecules.

We will use the Cavell equation for multimer system, which is an extension of the Onsager equation, to learn more about the solute-solute interaction in terms of dipole-dipole correlation [4].

$$\Delta\epsilon_j = \frac{\epsilon_s}{3(\epsilon_s + (1 - \epsilon_s)A_j)} \frac{N_A}{k_B T \epsilon_0} \frac{\mu_{eff,j}^2}{(1 - \alpha_j f_j)^2} C_j \quad (3)$$

Where  $\epsilon_s$  is the static permittivity,  $N_A$  is Avogadro's number,  $k_B$  is Boltzmann constant and  $\epsilon_0$  vacuum permittivity.  $A_j$  the shape parameter of reaction field and accounts for the shape of relaxing particle.  $f_j$  is so called cavity field factor and  $\alpha_j$  is the molecular polarizability and  $T$  is temperature.  $\mu_{eff,j}$  (the effective dipole moment of  $j^{th}$  species) is connected to the gas phase dipole moment  $\mu_{0,j}$  i.e.

$$\mu_{eff,j}^2 = g_j \mu_{0,j}^2 \quad (4)$$

Where  $g_j$  is an empirical factor which accounts for correlation between dipoles.  $g_j = 1$  indicates no orientational correlation between dipoles,  $g_j < 1$  implies a tendency towards anti-parallel alignment and  $g_j > 1$  a tendency towards parallel alignment of dipoles.

For the low frequency process, it is assumed that the polarizability ( $\alpha_L$ ) and the reaction field factor ( $f_L$ ) are independent of concentration  $c$ , so we can define

$$\hat{\mu} = \frac{\mu_{eff,L}}{(1 - \alpha_L f_L)} = \frac{g_L^{1/2} \mu_{0,L}}{(1 - \alpha_L f_L)} \quad (5)$$

The correlation factor  $g_j$  takes into account possible orientational correlation between the dipoles. Formula for calculating  $A_j$  and  $f_j$  are given in the literatures [5,6,7]. In our calculations, a spherical water molecule ( $A_j = 1/3$ ) with radius  $r = 0.1425$  nm was assumed and values of  $\mu_{eff}$

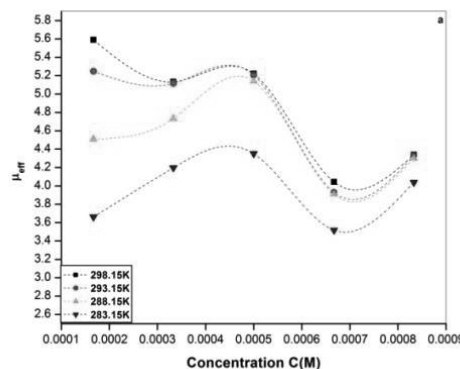
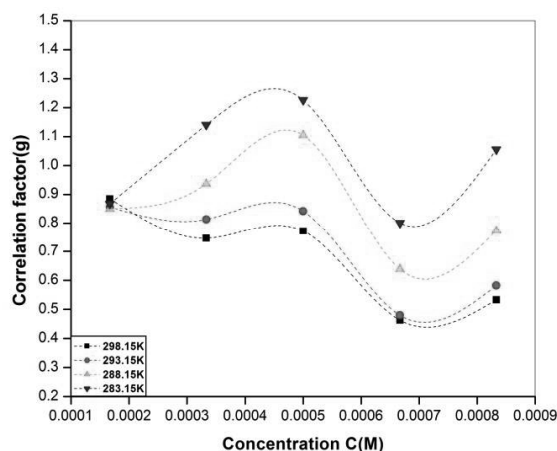


Fig.4. Dipole moment  $\mu$  using cavells equation



The measured values of effective dipole moment calculated using Cavell eqn. appear to be in good agreement with the previously obtained value [8]. Up to 0.0005 molar concentration of solute, the values of  $\mu_{eff}$  determined by eqn.(3) increases. Above this concentration, the values of  $\mu_{eff}$  vary. The formation of anti-parallel dipole-dipole interactions between the PVP molecules at greater concentrations is attributed to the decrease in  $\mu_{eff}$  values. The fact that  $\mu_{eff}(T)$  over all measured concentrations is increasing as temperature rises could be attributable to an increase in the induced solute-solute interaction through the hydration layer. At higher concentrations, values of  $\mu_{eff}(T)$  are more deviated, which could indicate enhanced solute-solute (PVP-PVP) interaction via the hydration layer.



**Figure 5. Correlation factor ( $g_1$ ) as a function of concentration at different temperatures.**

In addition to dipole moment, we have estimated the values of correlation factor ( $g_1$ ) in order to have insights into the magnitude of these anti-parallel alignment by using eqn.

$$\frac{\hat{\mu}(C_{MAX})}{\hat{\mu}(C \rightarrow 0)} \approx \frac{g_1^{1/2}(C_{MAX})}{g_1^{1/2}(C \rightarrow 0)} = g_1^{1/2} \quad (6)$$

Where  $g_1(C \rightarrow 0) = 1$ , because for infinite dilution, there is no correlation between the PVP molecules.  $C_{max}$  is the highest concentration used for PVP. Values of correlation factor ( $g_1$ ) have been calculated at highest concentration. For the low frequency process, values of correlation factor ( $g_1$ ) was found to be less than 1 for all concentrations and temperatures except at 298.15 K. The values of  $g_1$  lower than 1 suggests that there is reduced correlation between solute molecules.

#### IV. ACKNOWLEDGEMENTS

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## Dielectric Relaxation Studies of Potentised Homeopathic Medicines

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### ABSTRACT

Complex dielectric permittivity measurements in the frequency range 10MHz-30GHz has been carried out for homeopathic medicine Cuprum Metallicum using a time domain reflectometry (TDR) method at different temperatures. The static dielectric constants ( $\epsilon_0$ ), relaxation time ( $\tau$ ) were determined by using least square fit method. Also frequency dependent spectra of for Cuprum Metallicum studied at different potencies. These parameters are used to explain the various processes associated with the dielectric properties of Cuprum Metallicum.

**Keywords:** Dielectric permittivity; Relaxation time; Time domain reflectometry (TDR).

### I. INTRODUCTION

Ever since its discovery in the eighteenth century, the homeopathic system of medicine has been open to criticism from the scientific world as well as from the practitioners of the allopathic system. The practice of homeopathy was well accepted by the public from the very inception due to safety of medicine and effectiveness. Homeopathic medicine has been one of the world's most widely practiced alternative therapies. The popularity of homeopathy spread across the globe even during the life time of its founder. It was considered as one of the refined medical systems till about 1950s [1, 2].

The dielectric dispersion occurring in potentised homeopathic medicines subjected to variable frequency electric field was studied by using an instrumentation method developed by C R Mahata [3]. The experimental results for three potencies of Cuprum Metallicum (Cuprum met) in the frequency range of 100 kHz - 1 MHz was reported [3]. Dielectric dispersion studies were conducted in a broad range in a frequency range of 100 KHz to 50 MHz with potencies below and above the Avogadro limit by taking 6C and 30C potencies of *Graphite's* and *Cuprum Metallicum* in liquid form. Measurements were made with an Anomalous Dielectric Dispersion Detector (A3D) [4]. Anomalous dielectric dispersion in ordered molecular groups also studied. The homoeo-medicines cannot be anything except specifically ordered molecular groups, is theoretically proposed by Mahata [5, 6].

In the present study, the complex relative permittivity spectra of homeopathic medicine *Cuprum Metallicum* with different potencies (6C, 30C, 200C) have been measured using time domain reflectometry technique from 10MHz to 30GHz.

## II. EXPERIMENTAL

Homeopathic medicines *Cuprum Metallicum* with different potencies (6C, 30C, 200C) used for experimental purpose are taken from an *SBL PVT LTD*.

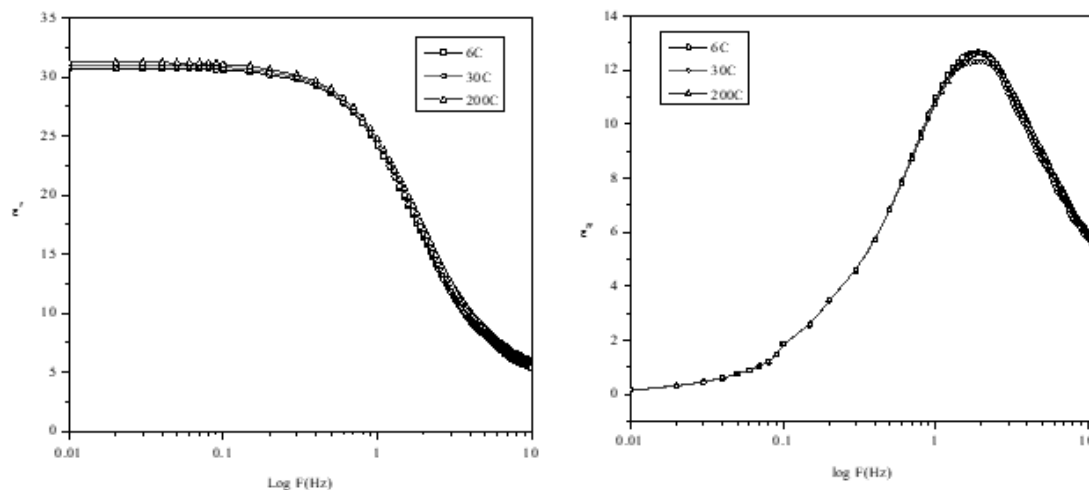
The dielectric spectra have been obtained by the time domain reflectometry (TDR) technique. The Tektronix model no. DSA8200 Digital Serial Analyzer sampling mainframe along with the sampling module 80E08 has been used for the measurement. The Fourier transformation of the pulses and data analysis were done earlier to determine complex permittivity spectra  $\epsilon^*(\omega)$  using non linear least squares fit method [17, 18].

## III. RESULTS AND DISCUSSION

Fig.1 shows frequency dependent complex permittivity spectra for *Cuprum Metallicum*. The complex permittivity spectra measured using TDR is fitted by the non-linear least squares fit method to the Havriliak - Negami expression [9, 10]-

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

where  $\epsilon_0$  is the static dielectric constant,  $\epsilon_{\infty}$  is the permittivity at high frequency,  $\tau$  is relaxation time and  $\alpha$  &  $\beta$  is the Cole-Cole and Davidson-Cole distribution parameter, respectively. Equation (1) includes the Debye ( $\alpha=0, \beta=1$ ) [11] Cole-Cole ( $0 \leq \alpha \leq 1$  and  $\beta=1$ ) [12] and Davidson - Cole ( $\alpha=0$  and  $0 \leq \beta \leq 1$ ) [13]. Fig.2 & Fig.3 shows the static dielectric constant and relaxation time of *Cuprum Metallicum* at various temperatures.



**Figure 1. Frequency dependent a) dielectric permittivity ( $\epsilon'$ ) and b) dielectric loss ( $\epsilon''$ ) for *Cuprum Metallicum* at different potencies.**

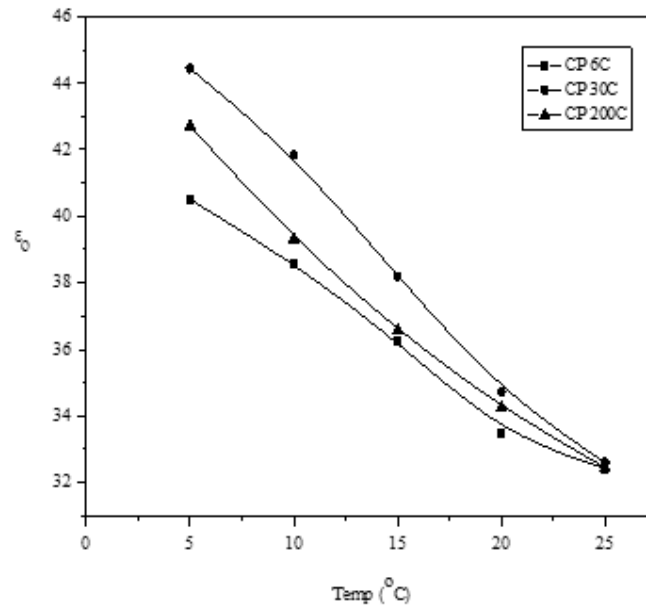


Figure 2. Static dielectric permittivity ( $\epsilon_0$ ) vs. potencies of Cuprum Metallicum at various temperatures.

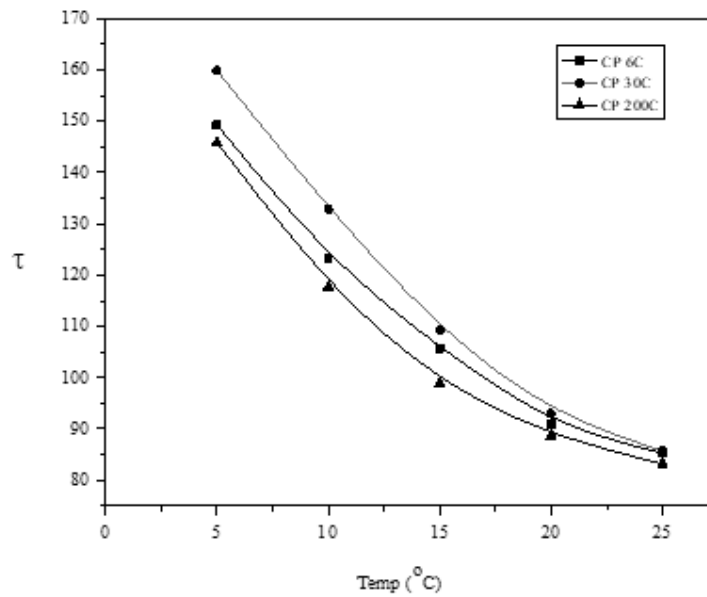


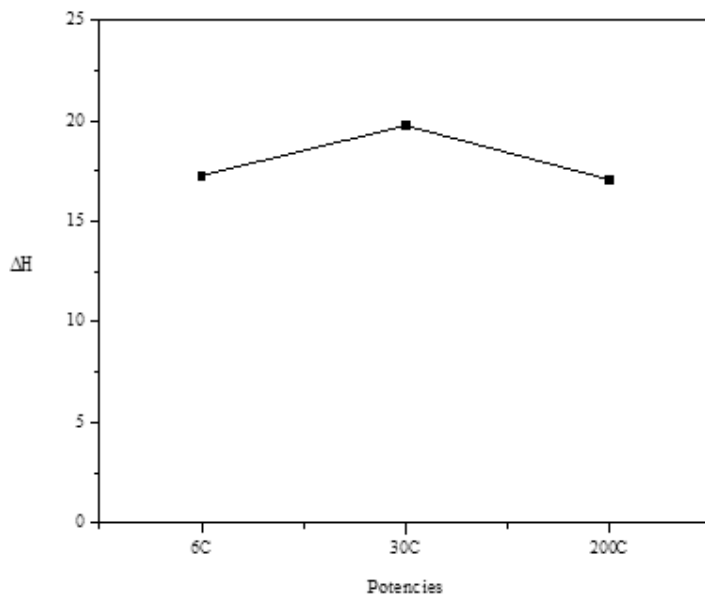
Figure 3. Relaxation times ( $\tau$  in ps) vs. potencies of Cuprum Metallicum at various temperatures.

### Thermodynamic properties

The thermodynamic parameters evaluated using Eyring equation is as follows [14]

$$\tau = (h/KT) \exp (\Delta H/RT) \exp (-\Delta S/R) \quad (2)$$

where  $\Delta S$  is the entropy of activation,  $\Delta H$  is the activation energy in kJ/mole.  $\tau$  is the relaxation time in ps and  $T$  is the temperature in K and  $h$  is the Planck's constant. Fig.4. shows plot of Thermodynamic energy of Cuprum Metallicum at different potencies. Activation energy ( $\Delta H$ ) for entire concentration is positive.



**Figure 5. Thermodynamic energy of Cuprum Metallicum at different potencies**

### IV. CONCLUSION

The complex permittivity spectra of Cuprum Metallicum at different temperature with different potencies have been studied using time domain reflectometry technique in the frequency range 10 MHz to 30 GHz. The experimental dielectric relaxation data contains valuable information.

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# Investigation of Solute -Solute interaction and Complex Formation in Binary Mixtures of Iso-Amyl Alcohol and Ethylenediamine at Microwave Frequency

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## ABSTRACT

The values of dielectric constant ( $\epsilon'$ ) and loss factor ( $\epsilon''$ ) have been experimentally determined for Iso- amyl alcohol, ethylenediamine and their binary mixture at 9.85 GHz microwave frequency. These values have been used to evaluate molar polarization ( $P_2$ ) and excess values of dielectric constant ( $\Delta\epsilon'$ ) excess dielectric loss ( $\Delta\epsilon''$ ) and used to investigate the complex formation in the mixture. Density ( $\rho$ ), viscosity ( $\eta$ ), square of refractive index ( $n_D^2$ ), activation energy ( $E_a$ ) also reported for pure liquids of Iso-Amyl Alcohol, Ethylenediamine and their binary mixtures. These values are used to investigate the solute -solute molecular interaction in binary system.

**Keywords:** Dielectric constant, Dielectric loss, Excess parameters

## I. INTRODUCTION

Experimental investigation of dielectric properties of organic compound is of great value in understanding the nature of complex formation between the molecules. The knowledge of dielectric properties and thermodynamic properties of organic compounds and their mixture at microwave frequencies helps in their characterization and applications. More investigation may lead to proper understanding of the behaviour of the liquid mixture. When a binary mixture is formed, the dielectric parameters and thermodynamic parameters do not vary linearly<sup>1-3</sup>. The deviation from linearity of these parameters is called excess parameters. These excess parameters are used to understand the nature of bonding between two constituents of the mixture.

The present paper aims at the estimation of dielectric behaviour of Iso-amyl alcohol (IAA) and ethylenediamine (EDA) binary mixture by studying the change in the dielectric constant ( $\epsilon'$ ) and dielectric loss ( $\epsilon''$ ) of IAA, EDA and their binary mixture at 25°C temperature.

## II. MATERIAL

Iso-amyl alcohol (IAA), A.R. grade and ethylenediamine (EDA) A.R. grade procured from M/s. S.D. Fine Chemicals and used without further purification. The two liquids according to their proportion by volume were mixed well and kept for six hours to ensure good thermal equilibrium.



### III. EXPERIMENTAL METHOD

The density ( $\rho$ ), viscosity ( $\eta$ ) of pure compound and their binary mixtures were measured using Pycknometer and Oswald's viscometer respectively. The refractive indices for sodium D-line were measured by using Abbe's refractometer.

The dielectric constant ( $\epsilon'$ ) and dielectric loss ( $\epsilon''$ ) were measured by using Surber's technique<sup>4</sup> of measuring reflection coefficient from air dielectric boundary of the liquid. Surber's technique is a special system, which permits rapid measurement of VSWR. Since there is a direct relationship between VSWR and reflection coefficient ( $\Gamma_r$ ) of a wave guide by measuring the ratio of relative amplitudes of reflected and incident signals, VSWR can be measured.

#### Dielectric Parameters:

Suber<sup>4,9</sup> has derived the following relations for dielectric parameters  $D, \epsilon', \epsilon''$ .

$$D = \tan \left[ 2 \tan^{-1} \frac{(\alpha_d \lambda_d)}{2\pi} \right] \quad [1]$$

$$\epsilon' = \left( \frac{\lambda_o}{\lambda_c} \right)^2 + \left( \frac{\lambda_o}{\lambda_d} \right)^2 \left[ 1 - \tan^2 \left( \frac{1}{2} \tan^{-1} D \right) \right] \quad [2]$$

$$\text{and } \epsilon'' = \frac{1}{\pi} \left( \frac{\lambda_o}{\lambda_d} \right)^2 \alpha_d \lambda_d \quad [3]$$

where  $\lambda_o$  is free space wavelength,  $\lambda_c$  is cut off wavelength for the wave guide,  $\alpha_d \lambda_d$  is the attenuation constant per unit length due to dielectric, ' $\lambda_d$ ' is the wavelength of electromagnetic waves in the wave guide filled with dielectric. Now the parameters to be measured are  $\lambda_d$  and  $\alpha_d \lambda_d$ . The dissipation factor  $D$  for the system may be computed analytically as follows.

Defining a factor  $M_n$  such that

$$M_n = \frac{|\Gamma_n|^2}{|\Gamma_\infty|^2} = \frac{I_n}{I_\infty} \quad [4]$$

where  $n = 1, 2, 3, \dots$   $|\Gamma_n|$  is the reflection coefficient by the liquid column of length  $l = n \left( \frac{\lambda_d}{2} \right)$  and  $|\Gamma_\infty|$  is the reflection coefficient for the liquid of infinite length.  $I_n$  and  $I_\infty$  represent the corresponding current values.

According to Surber<sup>4,9</sup> attenuation per wavelength is given by

$$\alpha_d \lambda_d = \frac{1}{n} l_n \left[ k_1 \left\{ 1 + (1 + k_2)^{1/2} \right\} \right] \quad [5]$$

$$\text{where } k_1 = \frac{(1 - MnY^2)}{Y(Mn - 1)} \quad [6]$$

$$k_2 = \frac{(Mn-1)(1-MnY^4)}{(1-MnY^2)^2} \quad [7]$$

and

$$Y = \frac{\left(1 - \frac{\lambda_d}{\lambda_g}\right)}{\left(1 + \frac{\lambda_d}{\lambda_g}\right)} \quad [8]$$

Thus measuring the values of  $\alpha_d \lambda_d$ ,  $\lambda_o$ ,  $\lambda_c$ , and  $\lambda_d$ , the values of dielectric parameters  $\epsilon'$ ,  $\epsilon''$  and  $D$  may be calculated by using above equations (1 to 8). The values of mole fraction ( $X$ ) of EDA, the wavelength in dielectric ( $\lambda_d$ ), output current ( $I_n$ ) for liquid length  $\left(n\lambda_d/2\right)$ , the output current ( $I_\infty$ ) for the liquid of infinite length and the attenuation per unit length ( $\alpha_d \lambda_d$ ), obtained experimentally.

The free energy of activation  $E_a$  of the viscous flow for the pure liquids and their binary mixtures is obtained by using the following equation <sup>10</sup>

$$\eta = \left(\frac{hN}{V}\right) \exp\left(\frac{E_a}{RT}\right) \quad [9]$$

where  $\eta$  is the viscosity and  $V$  is molar volume of the liquid and other symbols have their usual meaning.

The values of molar polarization of the mixtures were obtained by using the formula <sup>9</sup>

$$P_{12} = \left[\frac{(\epsilon'-1)}{(\epsilon'+2)}\right] \left[\frac{X_1 M_1 + X_2 M_2}{d}\right] \quad [10]$$

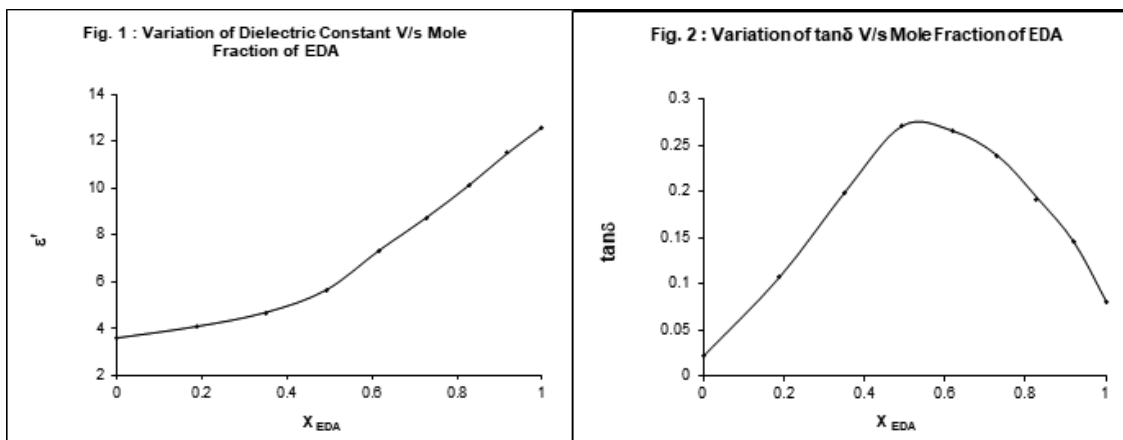
where  $M_1$  and  $M_2$  are the molecular weight,  $X_1$  and  $X_2$  are the mole fraction of the constituents of the mixture. The following Eyring and Glasstone <sup>11</sup> and assuming the following formula, the values of  $P_1$  and  $P_2$  are calculated.

$$P_{12} = X_1 P_1 + X_2 P_2 \quad [11]$$

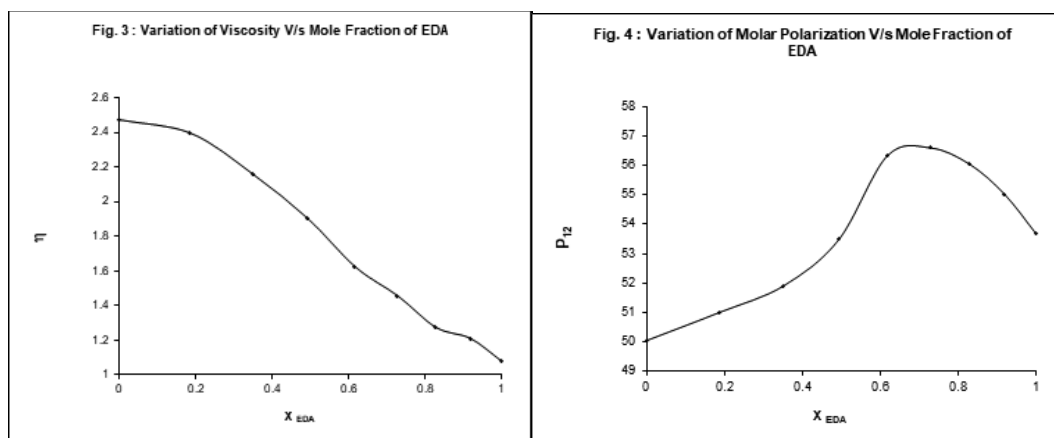
Where  $P_2$  is apparent polarization of each liquid in the mixture if  $P_1$  is the polarization of other component of the mixture in the pure liquid state.

#### IV. RESULT AND DISCUSSION

The values of dielectric constant ( $\epsilon'$ ) with mole fraction of EDA is depicted in Fig. (11.1). The non-linear variation of  $\epsilon'$  with mole fraction is considered to be due to the formation of complex in the mixture <sup>6</sup>.



The variation of  $\tan \delta$  V/s mole fraction of EDA shows that absorption in the mixture is maximum at 0.5 mole fraction of EDA, suggesting the large absorption at this concentration. An interaction causing association between IAA and EDA molecules may be responsible for such type of  $\tan \delta$  curve. Earlier Degaonkar et al.,<sup>7</sup> and Purohit et al.,<sup>8</sup> observed such marked change in  $\tan \delta$  curve. variation of viscosity ( $\eta$ ) with mole fraction of EDA. From graph, it is observed that the viscosity of binary mixture lie between viscosity of pure liquids.

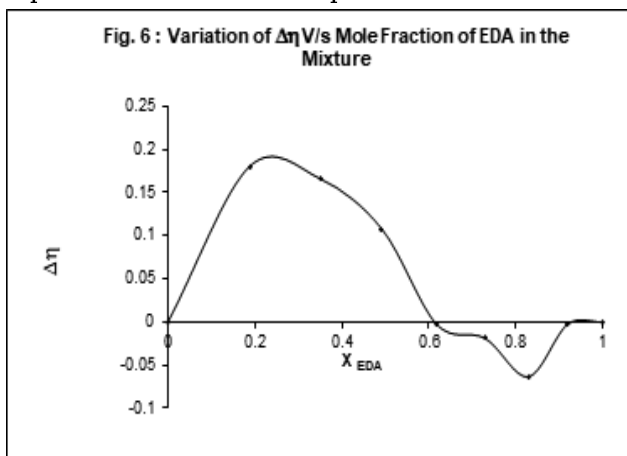
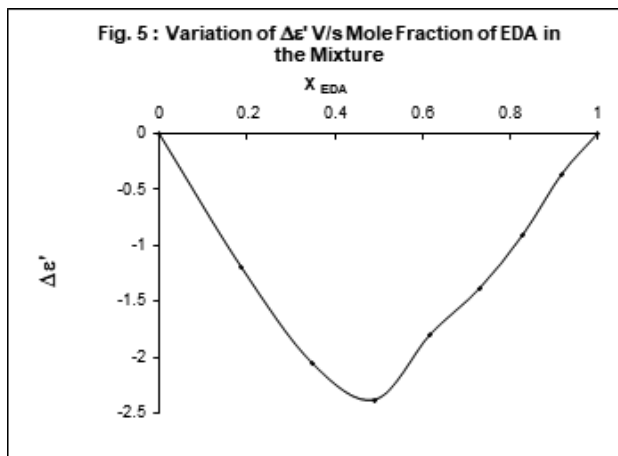


The values of molar polarization ( $P_{12}$ ) are plotted as a function of mole fraction of EDA for IAA, EDA and their binary mixture (Fig.4) when the molecules are polar, association of permanent molecular dipoles makes a great difference to the value of polarization. This is in fact is a function of number of free dipoles, and association diminishes the number of these free dipoles per unit volume. This explains how the determination of polarization give a quantitative measure of the polar association.

In the present investigation of IAA, EDA and their binary mixture, the amount of complex present is responsible for shape of polarization curve.

The excess parameters for binary liquid system is the measure of deviation from ideal behaviour of the mixture and found to be more sensitive towards molecular interactions in the liquid mixture. The values

of excess permittivity ( $\Delta\epsilon'$ ,  $\Delta\epsilon''$ ), excess viscosity ( $\Delta\eta$ ), excess square refractive index ( $\Delta n_D^2$ ) and excess activation energy ( $\Delta E_a$ ) are shown in table. The excess dielectric constant ( $\Delta\epsilon'$ ) is found to be negative over entire range of mole fraction of *EDA* in the mixture. The minima in  $\Delta\epsilon'$  versus mole fraction of *EDA*, is found to be at 0.5 mole fraction of *EDA*, at which we expect the formation of complex in the mixture.



The excess viscosity ( $\Delta\eta$ ) is found to be positive up to 0.6 mole fraction of *EDA*, with further increase of *EDA* in the mixture, the  $\Delta\eta$  values become negative, the negative deviation of  $\Delta\eta$  from linearity indicates that dispersive forces are primarily responsible for the interaction<sup>1</sup>. These excess parameters suggest interaction between alcohol amine mixture.

## V. CONCLUSION

1. Non-linear variation of dielectric constant with mole fraction of *EDA* suggest complex formation in the mixture.
2.  $\tan\delta$  curve suggest the absorption in the mixture is more than pure compounds.
3. Excess parameter study indicates solute – solute interactions in the mixture.

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**Table – 1** Values of mole fraction ( $X$ ) of EDA, density ( $\rho$ ), viscosity ( $\eta$ ), square of refractive index ( $n_D^2$ ), dielectric constant ( $\epsilon'$ ), loss factor ( $\epsilon''$ ), loss tangent ( $\tan\delta$ ), activation energy ( $E_a$ ) and molar polarization ( $P_{12}$ ) for binary liquid system of (EDA + IAA) at 25°C.

| $X$    | $\rho$ | $\eta$ (cp) | $n_D^2$ | $\epsilon'$ | $\epsilon''$ | $\tan\delta$ | $E_a$ Kcal/mole | $P_{12}$ |
|--------|--------|-------------|---------|-------------|--------------|--------------|-----------------|----------|
| 0.0000 | 0.8078 | 2.478       | 2.0022  | 3.571       | 0.0778       | 0.0218       | 3.588           | 50.06    |
| 0.1877 | 0.8211 | 2.400       | 2.0249  | 4.065       | 0.4330       | 0.1065       | 3.569           | 51.02    |
| 0.3503 | 0.8330 | 2.162       | 2.0420  | 4.666       | 0.9260       | 0.1985       | 3.507           | 51.71    |
| 0.4925 | 0.8431 | 1.908       | 2.0592  | 5.627       | 1.5210       | 0.2702       | 3.433           | 53.48    |
| 0.6180 | 0.8531 | 1.625       | 2.0765  | 7.338       | 1.9440       | 0.2649       | 3.337           | 56.34    |
| 0.7294 | 0.8621 | 1.456       | 2.0909  | 8.749       | 2.0831       | 0.2381       | 3.272           | 56.60    |
| 0.8291 | 0.8715 | 1.274       | 2.1054  | 10.132      | 1.9440       | 0.1918       | 3.192           | 56.05    |
| 0.9188 | 0.8815 | 1.211       | 2.1199  | 11.494      | 1.6638       | 0.1448       | 3.142           | 55.03    |
| 1.0000 | 0.8894 | 1.079       | 2.1316  | 12.602      | 1.0070       | 0.0799       | 3.126           | 53.69    |

**Table – 2** Values of excess parameters  $\Delta\epsilon'$ ,  $\Delta\epsilon''$ ,  $\Delta\eta$ ,  $\Delta n_D^2$  and  $\Delta E_a$  along with mole fraction ( $X$ ) of EDA for the binary liquid system of IAA+EDA at 25°C.

| $X$    | $\Delta\epsilon'$ | $\Delta\epsilon''$ | $\Delta\eta$ | $\Delta n_D^2$ | $\Delta E_a$ |
|--------|-------------------|--------------------|--------------|----------------|--------------|
| 0.1877 | -1.197            | 0.1887             | 0.1806       | -0.00158       | 0.0714       |
| 0.3503 | -2.060            | 0.5379             | 0.1663       | -0.00550       | 0.0876       |
| 0.4925 | -2.381            | 1.0060             | 0.1076       | -0.00672       | 0.0817       |
| 0.6180 | -1.799            | 1.3185             | -0.0026      | -0.00569       | 0.0468       |
| 0.7294 | -1.392            | 1.3583             | -0.0189      | -0.00567       | 0.0349       |
| 0.8291 | -0.907            | 1.1309             | -0.0635      | -0.00408       | 0.0037       |
| 0.9188 | -0.359            | 0.7712             | -0.0028      | -0.00158       | 0.0022       |

# Microwave Frequency Dielectric Dispersion of 1, 2-Ethenediol with Water using TDR

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## ABSTRACT

The Complex dielectric spectra  $\epsilon^*(\omega) = \epsilon' - j\epsilon''$  of binary mixture of 1, 2-Ethenediol with water were obtained in the microwave frequency range 10 MHz to 30 GHz using Time Domain Reflectometry (TDR) technique. The static dielectric constant ( $\epsilon_0$ ) and relaxation time ( $\tau$ ) have been obtained. On the basis of dielectric parameters intermolecular interaction are predicated.

**Keywords:** Time domain reflectometry, complex dielectric spectra, Relaxation time.

## I. INTRODUCTION

Microwave dielectric relaxation studies are useful in understanding the structure of alcohols. Dielectric studies involve measurements of dielectric permittivity and dielectric loss. The measurements can be used to find dielectric relaxation times and distribution parameters. The relaxation time depends upon the molecular size, shape, intramolecular and intermolecular forces, and can be used to investigate molecular and intramolecular motions and their relation to molecular structure.

1, 2-Ethenediol i.e. Ethylene glycol (EG) is organic liquid and has two -OH groups at the ends of their molecular structures. Dielectric relaxation studies on EG have revealed that the microwave frequency region dielectric dispersion is attributed to the reorientation of the molecules as whole and also ends -OH groups [1-3]. Due to the presence of ends -OH groups, the molecules of these liquids can enter into intra and intermolecular hydrogen bonding giving rise to several conformations in water mixture [2-3]. There are two kinds of water structures existing in solutions: "free" and "bound" take a central place among experimental and theoretical studies of different chemical and biological systems, i.e. molecules of water bounded to each other by H bonds from polymolecular clusters or more complex structure (free water). Similarly, molecules of solute can bind to neighboring water molecules also mostly through hydrogen bonding (bound water) [4]. The molecular interactions significantly influences the dielectric relaxation [5]. Further more, the environment of water solvent can be modified by the alcohol molecules because of the strong interactions between the hydroxyl groups of alcohols and water molecule. Zahn *et al* [6] have carried out the dielectric properties of water-ethylene glycol solutions.

In the present paper, dielectric relaxation studies of EG in water solution have been carried out using time domain reflectometry technique in the frequency range of 10 MHz to 30 GHz at 25°C Static dielectric

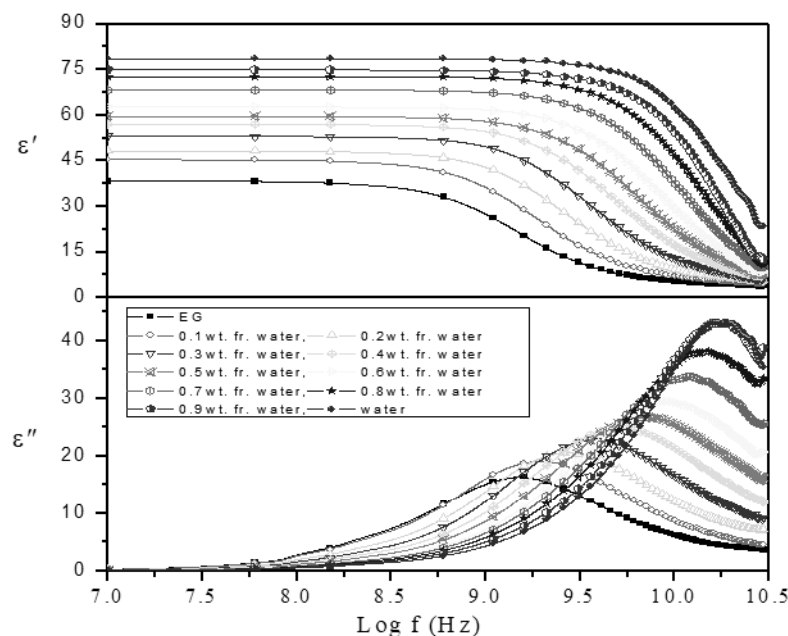
constant, relaxation time, Kirkwood correlation factors, of aqueous solutions of EG have been evaluated for their molecular conformations.

## II. EXPERIMENTAL METHOD AND DATA ANALYSIS

The dielectric spectra were obtained by the time domain reflectometry (TDR) technique. The Tektronix model no. DSA8200 Digital Serial Analyzer sampling mainframe along with the sampling module 80E08 has been used for the time domain reflectometry (TDR). A repetitive fast rising voltage pulse with 18ps incident rise time was fed through coaxial line system of impedance 50 ohm. Sampling oscilloscope monitors changes in step pulse after reflection from the end of line. Reflected pulse without sample  $R_1(t)$  and with sample  $R_x(t)$  were recorded in time window of 2ns and digitized in 2000 points. The time dependent data were processed to obtain complex reflection coefficient spectra  $\rho^*(\omega)$  over the frequency range from 10 MHz to 30 GHz as [2, 3].

$$\rho^*(\omega) = \left( \frac{c}{j\omega d} \right) \left[ \frac{p(\omega)}{q(\omega)} \right] \quad (1)$$

where  $p(\omega)$  &  $q(\omega)$  are Fourier transforms of  $[R_1(t) - R_x(t)]$  and  $[R_1(t) + R_x(t)]$  respectively,  $c$  is the speed of light,  $\omega$  is the angular frequency,  $d$  is the effective pin length and  $j = \sqrt{-1}$ . The complex permittivity spectra  $\epsilon^*(\omega)$  was obtained from reflection coefficient  $\rho^*(\omega)$  by applying calibration method as described earlier [4]. The dielectric permittivity  $\epsilon'$  and dielectric loss  $\epsilon''$  of EG with water at 25°C are shown in Figure. It is observed from the dielectric dispersion plot that the value of ( $\epsilon'$ ) decreases as the frequency increases, whereas, the dielectric loss ( $\epsilon''$ ) approaches maximum in the frequency range 1GHz to 2GHz.



**Figure1.** Complex permittivity spectra ( $\epsilon'$ ) and dielectric loss ( $\epsilon''$ ) for EG-Water at 25°C.

### III. RESULT AND DISCUSSION

To calculate static dielectric constant ( $\epsilon_0$ ), molecular reorientation relaxation time ( $\tau$ ) and distribution parameters ( $\alpha$  and  $\beta$ ), the complex permittivity  $\epsilon^*(\omega)$  data were fitted by the non-linear least squares method to the Havriliak-Negami expression [7]

$$\epsilon^*(\omega) = \epsilon_{\infty} + \frac{(\epsilon_0 - \epsilon_{\infty})}{[1 + (j\omega\tau)^{1-\alpha}]^{\beta}} \quad (2)$$

With  $\epsilon_0, \epsilon_{\infty}, \tau, \alpha$  and  $\beta$  are the fitting parameters. The equation includes the Cole-Cole ( $\beta=1$ ), Davison-Cole ( $\alpha=0$ ) and Debye ( $\alpha=0, \beta=1$ ) relaxation model. The various dielectric parameters obtained from Eq. (2) are reported in table 1. The static permittivity increases with increasing weight fraction of water in the EG-water mixtures. Resultant values agree well with the values of pure EG reported by Sengwa and Kaur [8]. Relaxation time ( $\tau$ ) decreases with water concentration in EGO-water mixture.

**Table 1.** Dielectric Relaxation parameters for EG-Water mixtures.

| 25°C    |                     |                          |             |          |
|---------|---------------------|--------------------------|-------------|----------|
| Wt.Fra. | $\epsilon_{\infty}$ | $\epsilon_0$<br>of Water | $\tau$ (ps) | $\beta$  |
| 0.0     | 2.62(1)             | 41.94(5)                 | 104.42(50)  | 0.880(2) |
| 0.1     | 3.06(1)             | 46.70(3)                 | 78.18(22)   | 0.930(1) |
| 0.2     | 2.67(2)             | 51.43(4)                 | 54.78(23)   | 0.900(1) |
| 0.3     | 2.85(1)             | 55.95(3)                 | 40.77(12)   | 0.930(1) |
| 0.4     | 2.43(2)             | 59.50(4)                 | 30.77(11)   | 0.940(1) |
| 0.5     | 1.06(2)             | 62.21(3)                 | 23.68(8)    | 0.930(1) |
| 0.6     | 1.38(2)             | 65.71(3)                 | 18.61(6)    | 0.930(1) |
| 0.7     | 1.91(3)             | 68.90(4)                 | 14.93(5)    | 0.980(1) |
| 0.8     | 2.04(3)             | 73.06(3)                 | 12.22(4)    | 0.980(1) |
| 0.9     | 2.88(4)             | 75.04(6)                 | 10.27(3)    | 0.950(1) |
| 1.0     | 1.98(2)             | 78.32(2)                 | 8.21(1)     | 1.000    |

### IV. KIRKWOOD CORRELATION FACTOR:

The Kirkwood correlation factor 'g' is parameter containing information regarding orientation of electric dipoles in polar liquids [9]. The value of 'g' for pure liquid is given by expression



$$g\mu^2 \frac{4\pi N\rho}{9kTM} = \frac{(\epsilon_0 - \epsilon_\infty)(2\epsilon_0 + \epsilon_\infty)}{\epsilon_0(\epsilon_\infty + 2)^2} \quad (3)$$

where 'μ' dipole moment is in gas phase, 'N' is Avogadro's number, 'M' is molecular weight, 'ρ' is the density of the liquid and 'kT' has usual meaning. We have taken  $\epsilon_\infty$  value from refractive index ( $\epsilon_\infty = n^2$ ) data at 25°C.

**Table 2:** Kirkwood correlation factor for EG water at 25°C.

| System | g    |
|--------|------|
| Water  | 2.82 |
| EG     | 2.62 |

For binary mixture, the static dielectric permittivity needs to be considered as the dipole orientation correlation factor ( $g^{eff}$ ). The modified form of Eq. (3) is used to study the orientation of the electric dipoles in the binary mixtures as follows [9, 10].

$$\frac{4\pi N}{9kT} \left[ \frac{\mu_W^2 \rho_W X_W}{M_W} + \frac{\mu_{EGO}^2 \rho_{EGO} (1 - X_W)}{M_{EGO}} \right] \times g^{eff} = \frac{(\epsilon_{0m} - \epsilon_{\infty m})(2\epsilon_{0m} + \epsilon_{\infty m})}{\epsilon_{0m}(\epsilon_{\infty m} + 2)^2} \quad (4)$$

where  $M_W$  and  $M_{EG}$  are molecular weight of water and EG respectively.  $\rho_W$  and  $\rho_{EG}$  are corresponding densities.  $X_W$  is volume fraction of water in EG.  $\epsilon_{0m}$  and  $\epsilon_{\infty m}$  are the static dielectric constant and dielectric constant at high frequency of the mixtures. The observed  $g^{eff}$  value is greater than unity in EG-water mixtures leads to the conclusion that the molecules associate to form multimer. The  $g^{eff}$  values greater than one indicates average parallel orientation of electric dipoles in a molecule.

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# Molecular and Dielectric Study of the Binary Liquid Mixture of 2,3-Dichloroaniline and Ethylene Glycol at FDR

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## ABSTRACT

A binary mixture system of 2,3 Dichloroaniline (2,3-DCA) and Ethylene glycol (EG) including those of pure liquids, over the entire composition range were measured at room temperatures at atmospheric pressure. The physical and chemical properties of viscosity, density and refractive index for the binary mixtures were determined. The temperature dependences of the density, viscosities and refractive index for the system were described. To investigate the internal interactions of the binary mixtures. calculations were employed. The trend of energetic and charge distribution of all ions and molecules involved in interactions between the 2,3-DCA and EG.

**Keywords:** 2,3-DCA and EG, Molecular Interactions and Physical-chemical properties

## I. INTRODUCTION

Recently several workers 1-3 have reported the utility of dielectric measurement while studying the molecular interaction in a binary mixture of liquids. The density and viscosity of binary mixture have studied 4. In this paper our aim is to provide the information regarding the possibilities of complex formation due to molecular association between two polar liquids namely 2,3-DCA and EG at room temperature. In this paper the dielectric properties and molecular behavior of 2,3-DCA with EG and their binary mixture are discussed.

## II. EXPERIMENTAL

2,3-Dichloroaniline (GC Grade) from Sigma-Aldrich, Germany and Ethylene glycol (AR Grade) were obtained from Spectrochem PVT. LTD. Mumbai, India. Without further purification the two liquids according to their proportions by volume were mixed well and kept 6 hours in well stoppered bottles to ensure good thermal equilibrium. 2,3-DCA was used as solute and EG as solvent.

## III. MEASUREMENTS

The densities, viscosities and refractive index of the pure components and their mixtures were measured by using DMA 35 portable vibrating density meter. Anton paar Autria (Europe) having accuracy of density 0.001

g/cm<sup>3</sup>, repeatability 0.0005 g/cm<sup>3</sup> and resolution 0.0001 g/cm<sup>3</sup> 5 and viscosity by LVDL V-pro II Brook field viscometer (USA) 6. Refractive indices for sodium D-line were measured by using Abbe's refractometer, having accuracy up to the third place of decimal 7.

#### IV. RESULTS AND DISCUSSION

The values of density ( $\rho$ ), viscosity ( $\eta$ ) and refractive index ( $n$ ) for viscous flow with increasing mole fraction ( $X$ ) of 2,3-DCA for the binary mixtures of 2,3-DCA+EG are reported in Table 1.

**Table 1.** Mole fraction ( $X$ ) of 2,3-DCA and EG density ( $\rho$ ), viscosity ( $\eta$ ) and refractive index ( $n$ ) for binary liquid mixture at room temperature.

| X       | $\rho$ g/cm <sup>3</sup> | $\eta$ cp | n     |
|---------|--------------------------|-----------|-------|
| 0.0000  | 0.9966                   | 1.35      | 1.403 |
| 0.09697 | 1.1370                   | 1.59      | 1.460 |
| 0.17185 | 1.1834                   | 1.84      | 1.484 |
| 0.27576 | 1.2024                   | 2.24      | 1.496 |
| 0.38000 | 1.2436                   | 2.44      | 1.506 |
| 0.42637 | 1.2680                   | 2.55      | 1.531 |
| 0.56672 | 1.2950                   | 2.98      | 1.551 |
| 0.72356 | 1.3631                   | 3.40      | 1.578 |
| 1.0000  | 1.4084                   | 3.84      | 1.590 |

The density of binary mixture of 2,3-DCA+EG are increasing as mole fraction of 2,3-DCA in the binary mixture is increasing. This is expected because density of pure 2, 3-DCA is more than that of pure EG. It can also be seen that viscosity ( $\eta$ ), refractive index ( $n$ ) is increasing with increase in mole fraction of 2, 3-DCA in the binary mixture. This increase in  $\eta$  and  $n$  is further supported by the increase in density of the binary mixture with increase in mole fraction of 2, 3-DCA. Increases in viscosity ( $\eta$ ) for the acid amine and EG mixture due to the formation of dissociated ions in the mixture. Which is endothermic and depends upon the acidic strength of EG. Since in the present paper the maximum viscosity for 2,3-DCA may be associated with the formation of dissociated ions in the mixture and due to the more acidic character of 2,3-DCA. The spectacular increases in viscosity ( $\eta$ ) may also be attributed to the mutual viscosity of the alcohols and amine molecules. Viscosity ( $\eta$ ) increases as mole fraction of 2, 3-DCA in the binary mixture increases. Increase in viscosity of binary mixture can be attributed to increase in effect of hydrogen bonding with decrease in mole fraction of EG. This is because pure 2,3-DCA is more viscous than pure EG. It is due to presence of strong hydrogen bonding in 2,3-DCA, more number of carbon atoms and long straight chain compound.

## V. CONCLUSION

The density, viscosity and refractive index values of the binary mixtures of 2,3-DCA with EG are reported all binary mixtures are miscible. The density, viscosity and refractive index values increased with the 2,3-DCA mole fraction. In contrast to monotonic increase of density, viscosity and refractive index with the mole fraction of 2,3-DCA and may be attributed to the entropic effects and weakening of hydrogen bonding interaction between ethanol molecules.

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# Study of Atmospheric Aerosol Using Optical Remote Sensing: A Review

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## ABSTRACT

This paper is review of the aerosol optical depth (AOD) of the air pollution, polluted particular matter in the atmosphere, the harmful effect of the air pollution on the human health. The AOD is measured from the retrieval of the data from different platforms, the advancement of the technology in the optical remote sensing and the AOD. The new algorithms are developed to examine and characterizing the AOD the number of satellites are working in space for imagine the aerosol in the atmosphere like Moderate Resolution Imaging Spectroradiometer (MODIS) and the Multiangle Imaging Spectroradiometer (MISR) instruments onboard NASA's Terra satellite in 1999 has provided global measurements of AOD, a measure of light extinction by aerosol in the atmospheric column, during their overpass time of 1030 local time (LT) this paper purpose is the how different kind of algorithms are used for the studying the types of aerosol and their depth by optical remote sensing.

**Keywords:** Atmospheric Aerosol, Remote sensing, AOD

## I. INTRODUCTION

Atmospheric aerosol is the general term for solid and liquid particles suspended in the atmosphere, mainly come from natural sources such as fine ash and dust lifted by the wind, salt particles, volcanic eruption and from human activities the burning of fossil and non-fossil fuels, transportation, and industrial dust. There are two types of atmospheric aerosol, that is Primary aerosol (Soil dust, sea spray, crustal materials, smoke and organic matter) and Secondary aerosol (sulphate, nitrates, ammonia, volatile organic compounds) components [1,2].

Atmospheric aerosol is a most part of Earth's atmosphere system and has most significant role on global climate change and air quality. Aerosol particles are believed to have a net cooling effect on the atmosphere due to light scattering in the visible and ultraviolet ranges. scientific knowledge on the interaction between atmospheric aerosols and solar Emissivity is very low compared to other atmospheric components mainly due to high spatiotemporal variability of atmospheric aerosols [3,4]. Atmospheric aerosols are of great importance in Earth's radiative budget due to their potential Increasing the scattering and absorption of shortwave (solar) radiation [5].

The common objectives of atmospheric aerosol:

- (a) The surface of earth atmospheric aerosol has direct impact on public health.
- (b) Roles in chemical and physical processes in the atmosphere and their potential effects on local and global climate [6].

Remote sensing is, broadly but logically speaking, the collection of information about an object without making physical contact with it. It is a derive information about state and condition of an object by interpreting the information contained in the electromagnetic signal coming from the object [7,8]. The term "Remote sensing" is most commonly used in connection with electromagnetic techniques of information acquisition [9].

In the remote sensing there are two types,

### **Active sensor**

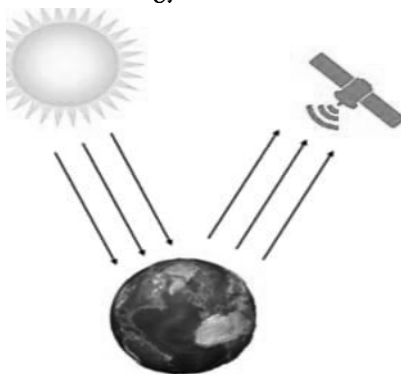
Provides their own electromagnetic energy that is transmitted from the sensors towards the terrain, interacts with the terrain producing a backscatter of energy & is recorded by the remote sensor's receiver.



**Active Remote Sensing**

### **Passive sensor**

Detects the nature any emitted microwave energy within its field of view.



**Passive Remote Sensing**

Optical remote sensing makes use of visible near-infrared and short-wave infrared sensors to form images of the earth surface by detecting the solar radiation reflected from targets on the ground different materials

reflect and absorb differently at different wavelengths. Thus, the targets can be differentiated by their spectral reflectance signature in the remotely sensed images. Optical remote sensing systems are classified into the various types depending on the number of spectral bands used in the imaging process.

#### **Needs for the measurement of aerosol-distribution**

- (a) Provide a reference climatology for measuring root trends natural and anthropogenic processes;
- (b) Remove aerosol effects from remotely sensed observations of Earth atmospheric system;
- (c) Understand the interaction between the lithosphere, hydrosphere, cryosphere, atmosphere and biosphere resulting from the transport, transformation and deposition of aerosols [10].

#### **Atmospheric Absorption**

The atmosphere act as a selective filter at different wavelength, such that certain spectral regions cannot be remotely observed.

The main cause for this absorption are

- 1) Atomic oxygen ( $O_2$ ), filters out ultraviolet rays less than 0.1 micro meters., as well as small portions in the infrared and microwave bands.
- 2) Ozone ( $O_3$ ), which removes most of the ultraviolet rays below 0.3 micro meters, some mirror band in the visible spectrum.
- 3) water vapor ( $H_2O$ ), a strong absorber around 6 micro meter and secondary absorber between 0.6 and 2 micro meters.
- 4) carbon dioxide ( $CO_2$ ), which absorbs in the thermal infrared (15 micro meter), has a significant effect in the infrared, between 2.5 and 4.5 micro meters [11].

#### **Atmospheric Scattering**

Scattering of electromagnetic radiation occurs due to reflection of incoming solar rays by gases, aerosols and water vapour present in the atmosphere. Aerosol are caused by both natural and human causes. They can be oceanic, due to water moment, or continental, such as dust in suspension or particle emitted by combustion. Origins and characteristics they vary greatly in their size, leading to different types of dispersions, as the process depends on the diameter of the dispersing particles.

There are three types of atmospheric dispersion,

- 1) **Rayleigh scattering**- These scattering affected by smaller wavelength diameter of the particles.
- 2) **Mie scattering**- These scattering affected by particle size and wavelength are same.
- 3) **Non selective scattering**- These scattering affected by particle size is greater than the wavelength [11].

#### **Atmospheric Emission**

These emission effects are in the thermal infrared. In order to accurately retrieve the surface temperature from the satellite images, it must be corrected [11].

## II. LITERATURE REVIEW

An aerosol is a two-phase colloidal system, consisting of particles (solid or liquid) and gases. In which he has been suspended an individual aerosol particle can be cold or warm depending on its size, refractive index etc. Aerosol optical thickness (AOT) is the most fundamental parameter for determining optical properties of aerosols which is the degree to which aerosols prevent the transmission of light in the atmosphere either through scattering or absorption[12].

Remote sensing data used for road delineation includes ground moving target indicators (GMTI) tracking, smart phone Global Positioning System (GPS) data, Street View images, synthetic aperture radar (SAR) imagery, light detection and ranging (LiDAR) data, high resolution imagery and hyperspectral imagery. Spaceborne high-resolution imaging is still the main technological approach to Earth Observation. Airborne High-resolution images have higher resolution and are less affected by the environment [13].

In fact, all particles for remote sensing applications it is necessary to treat simultaneously without suspending in the environment separation on aerosol and cloud particles. The general function is to receive Chemical composition, concentration and size distribution of particles using various remote sensing technique (e.g. optical observations from satellite). This is due to aerosols and cloud particles (and also atmospheric gases) do not exist in isolation but interact with each other Spatial and time [14].

Remote sensing techniques is ground based remote sensing and the satellite remote sensing, Satellite remote sensing plays an important role in aerosol detection as it can obtain aerosol information (e.g. AOD), but Single Scattering albedo (SSA) is a very difficult to found a aerosol from satellite measurement. Ground-based remote sensing is a very useful approach for detecting columnar aerosols as it provides multi-angle, multi-wavelength and polar measurements of solar and sky radiation [15].

The fine particular matter of diameter less than 2.25 $\mu$ m is very harmful for the human health which causes cancer of lungs pulmonary inflammation and cardiopulmonary mortality the aerosol is valuable for the design of air quality to strategies the forecasting. The estimation of aerosol optical depth(AOD) is important for measurement of harmful particles of matter to study their depth and properties characteristics of that matter. The development and measurement of aerosol optical depth provides unique synopsis of global surface 2.25 $\mu$ m concentration with coupled chemical targets of model on the relationship between aerosol optical depth and 2.25 $\mu$ m [16].

In 1970s researchers starts to use remote sensing data to retrieve the ocean aerosol optical thickness. the new satellite sensors use after 21<sup>st</sup> century. If the study of atmospheric environment and climate change then then the high temporal resolution of AOD are very important. AOD is a very basic characteristics of Atmospheric aerosol, They impact on climate change and human health. The method of retrieving AOD products using satellite remote sensing provides support of the investigation and monitoring of the climate effects of aerosols and regional air pollution. The proposed an AOD retrieval method based on HJ-1 A/B charge coupled device (CCD) visible light band and found that the AOD retrieved from the HJ-1 A/B CCD data presented the same spatial patterns and trends with the AOD products in Moderate Resolution Imaging Spectroradiometer (MODIS) [17].



Remote sensing provides the capable observation aerosol data the AOD is retrieval by satellitebased data the aerosol are play's important role in the earths balanced by scattering and absorbing solar and terrestrial radiation. the AOD is retrieval by the number of satellite techniques as multispectral thermal imager and ground truth the aerosol retrieval codes are modified and used for MIT single view[18].

A new method to recover AOT from moderate Resolution Imaging Spectroradiometer (MODIS) Satellite images, in which the strategy block partitioning mass communication were adopted, thereby maximizing load balance and reducing overhead time during inter-processor communication. AOT is an indicator of air quality an important geophysical parameter. Application to retrieve passive satellite remote sensing data land aerosol loading depends on prior knowledge of accurate land surface reflectance[19].

### III. DISCUSSION

This study explores the estimation of the AOD of the particle present in the atmosphere. The application of the AOD is for to strategies the air quality forecasting and the measurement of the aerosol this paper focus on the different kind of algorithms that are developed for the retrieval of AOD to this algorithms makes to find accuracy in AOD to mitigate the pollution and polluted air in atmosphere. The AOD is important for the study of the air pollution and harmful matter partials present in the atmosphere the negative effect to the human health the aerosol depth in atmosphere. the strategies on the harmful pollution have designed to slow down the negative effects on human health.

### IV. CONCLUSION

The AOD is measured by the optical remote sensing to study the properties and characteristics of the optical aerosol for pollution and air quality maintaining. the different kind of algorithms are developed for the AOD. Different kind of strategies are applied for the harmful particle in the atmosphere to mitigate the effect of pollution and harmful particle in the matter. The optical remote sensing is useful for the measuring the optical depth of aerosol.

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# Annealing Effects on Optical and Electrical Properties of a- (Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> Thin Films Deposited by Physical Thermal Evaporation

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## ABSTRACT

In the present study (Bi) doped Ge<sub>20</sub>Se<sub>80</sub> thin films are characterized for their optical and electrical properties. Bulk sample is prepared by melt quenching technique, while thin films are deposited via thermal evaporation. XRD study confirms the amorphous nature of both bulk and thin films samples. Optical parameters like refractive index, band gap and real and imaginary dielectric constant are calculated using transmission spectra in 400 to 1200 nm wavelength range. The dark conductivity ( $\sigma_d$ ) measurements of a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin films have been carried out over temperature range 298-353K. The effect of annealing is studied on optical and electrical properties of thin films.

**Keywords:** Annealing, Optical properties, Thin Films, Chalcogenide glasses,

## I. INTRODUCTION

Chalcogenide bulk glasses and thin films are known for their various applications. They are extensively studied for unique optical and electrical properties. These materials are suitable for infrared detectors and shows reversible phase change electrically and optically which make them useful candidate for memory storage. Chalcogenide glasses based on germanium selenide are promising materials for applications like waveguides and sensors [1, 2]. Chalcogenide glasses having high refractive index, wider band gap, linear and nonlinear properties make them useful for IR sensors, photo detector, holography and other applications [3-7]. The Ge<sub>20</sub>Se<sub>80</sub> glassy alloy has maximum glass forming tendency at x=20 for Ge<sub>x</sub>Se<sub>100-x</sub> and Ge<sub>20</sub>Se<sub>80</sub> possess a particular structure with chemical formula GeSe<sub>4</sub> [8]. Addition of third element into the binary alloy results in more stable cross-linked structures. Density of defect states change drastically in case of ternary alloys leading to increase in softening temperature, enhanced mechanical strength and glass forming region expansion [8,9]. Since Bi addition to a Ge-Se system enhance chemical stability, by replacing Se with Bi in a Ge-Se system leads to the modification of optical band gap and other electronic properties. Here Bi act as network modifier in Ge-Se system will lead to the more disordered network which further may led to alter the structural, optical and electrical properties [10]. In the present work, we have measured transmission spectra of a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin films. From measured experimental data, we have calculated various optical parameters. We also investigated dc conductivity and photoconductivity in these thin films. We have focused

our investigations to see effect of annealing on the optical and electrical properties of such a technically important material.

## II. EXPERIMENTAL

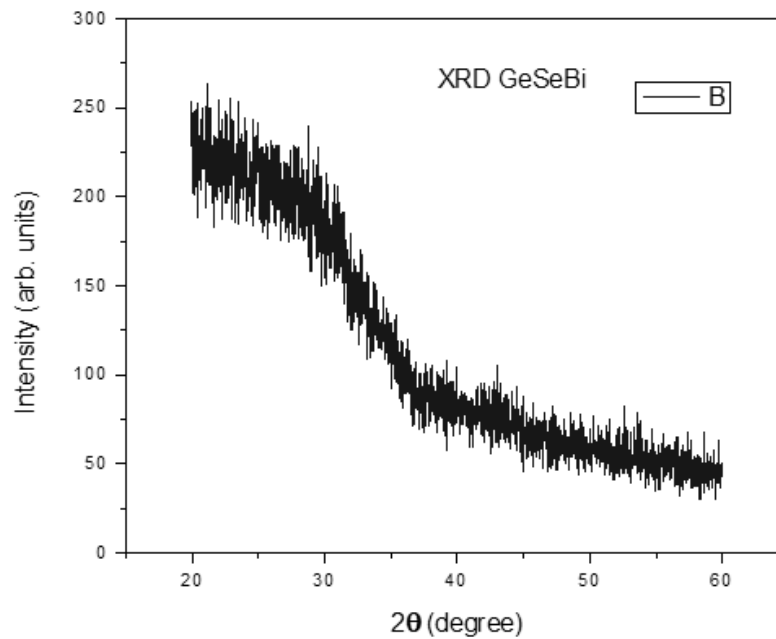
Glassy alloy of  $a-(\text{Ge}_{20}\text{Se}_{80})_{90}\text{Bi}_{10}$  has been prepared by melt quenching technique by taking elements according to their atomic weight percentage. The materials were sealed in quartz ampoules and heated up to 1100 °C in a rocking furnace at a heating rate of 2-3 °C per minute followed by quenching in ice cold water. Thin films were synthesized by thermal evaporation technique on well-degassed Corning 7059 glass substrate under vacuum  $2 \times 10^{-5}$  mbar. X-ray diffraction pattern (XRD) was examined at room temperature. The absence any sharp peak in XRD confirms the amorphous nature of thin films. Transmission spectra measured by computer-controlled spectrophotometer [Solar TII, MS 2004]. All the optical constants measurements reported in this paper are performed at room temperature (300 K). The sample is annealed at 130°C for 2 hour under vacuum ( $10^{-3}$  mbar).

The dark conductivity ( $\sigma_d$ ) measurements of  $a-(\text{Ge}_{20}\text{Se}_{80})_{90}\text{Bi}_{10}$  thin films have been carried out over the temperature range 298-353K. A vacuum of  $10^{-3}$  mbar were maintained in the sample holder during various measurements. Pre-deposited thick aluminum electrodes on well-degassed Corning 7059 glass substrates have been used for the electrical contacts with planar geometry of the film (length 2.0 cm; electrode gap  $2 \times 10^{-2}$  cm) is used for the electrical measurements. The photoconductivity measurements has been studied using metallic sample holder where heat filtered light (200 W tungsten lamp) shone through a transparent quartz window under vacuum of about  $10^{-3}$  mbar. The photocurrent ( $I_{ph}$ ) is obtained by subtracting the dark current from current in presence of light. Digital Luxmeter (TES-1332) is used for measurement of light intensity.

## III. RESULTS AND DISCUSSION

### 3.1 Structural study

XRD patterns of  $a-(\text{Ge}_{20}\text{Se}_{80})_{90}\text{Bi}_{10}$  thin films are shown in figure 1. It is clear from this figure that there is no sharp peak in XRD patterns of films suggests that  $a-(\text{Ge}_{20}\text{Se}_{80})_{90}\text{Bi}_{10}$  films amorphous in nature. The data were collected in a range of  $2\theta=20-60^\circ$  at a scanning rate of 10 °C per min at room temperature.



**Fig1. X-ray diffraction patterns of a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin film.**

### 3.2 Optical studies

Figure 2. Shows transmission spectra of thermally evaporated a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin film. The Swanepoel's envelope method has been employed to calculate the refractive index (n) and extinction coefficient (k) [11, 12]. This model assumes a thin film of uniform thickness deposited on a transparent substrate having a refractive index (s). In the transparent region ( $\alpha \approx 0$ ) the refractive index n, of a thin film is given by

$$n = \left[ M + (M^2 - s^2)^{1/2} \right]^{1/2} \quad (1)$$

where s is refractive index of the substrate and M is given by

$$M = \frac{2s}{T_m} - \frac{s^2 + 1}{2}$$

In the weak- and medium-absorption regions where ( $\alpha \geq 0$ ) the refractive index n is found to be given by

$$n = \left[ N + (N^2 - s^2)^{1/2} \right]^{1/2} \quad (2)$$

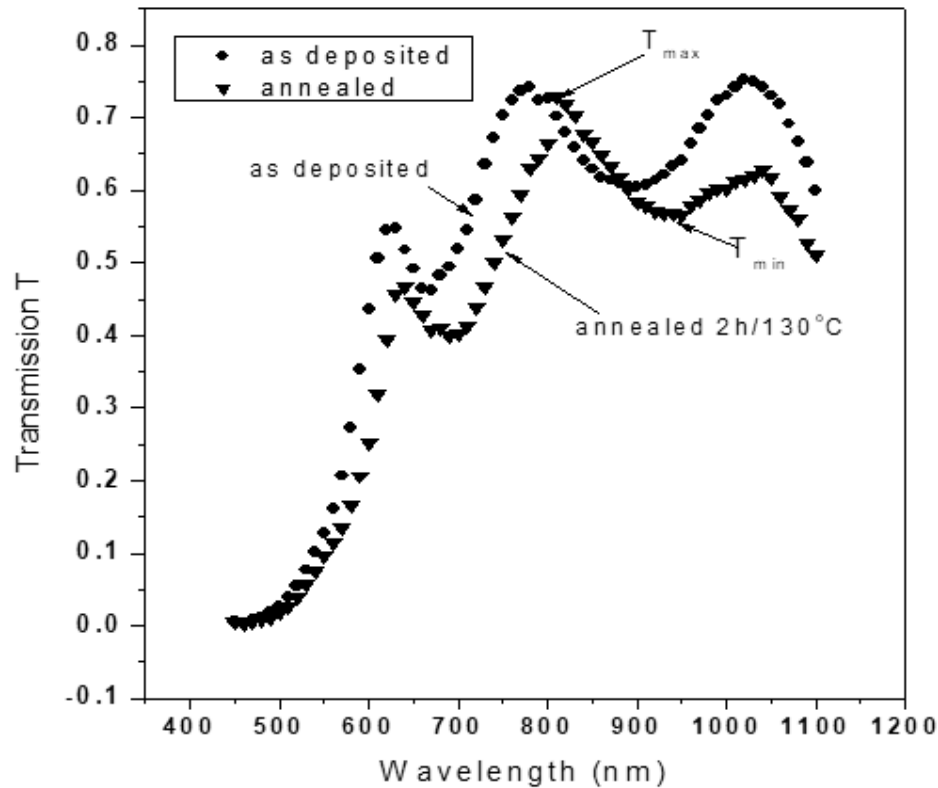
where

$$N = 2s \frac{T_{\max} - T_{\min}}{T_{\max} T_{\min}} + \frac{s^2 + 1}{2}$$

In the strong absorption region absorption coefficient ( $\alpha$ ) can be calculated by using

$$\alpha = d^{-1} \ln \left( \frac{16n^2s}{(n+1)^3(n+s^2)I_0} \right) \quad (3)$$

where  $d$  is the thickness of film,  $n(\lambda)$  and  $s$  are the refractive indices of the film and substrate respectively, and  $T_0$  is the measured transmission. In Amorphous semiconductors absorption is divided namely three regions, higher absorption region ( $\alpha \geq 10^4 \text{ cm}^{-1}$ ), exponential edge region ( $1 \leq \alpha \leq 10^4 \text{ cm}^{-1}$ ) and weak absorption region ( $\alpha \leq 1 \text{ cm}^{-1}$ )[13].

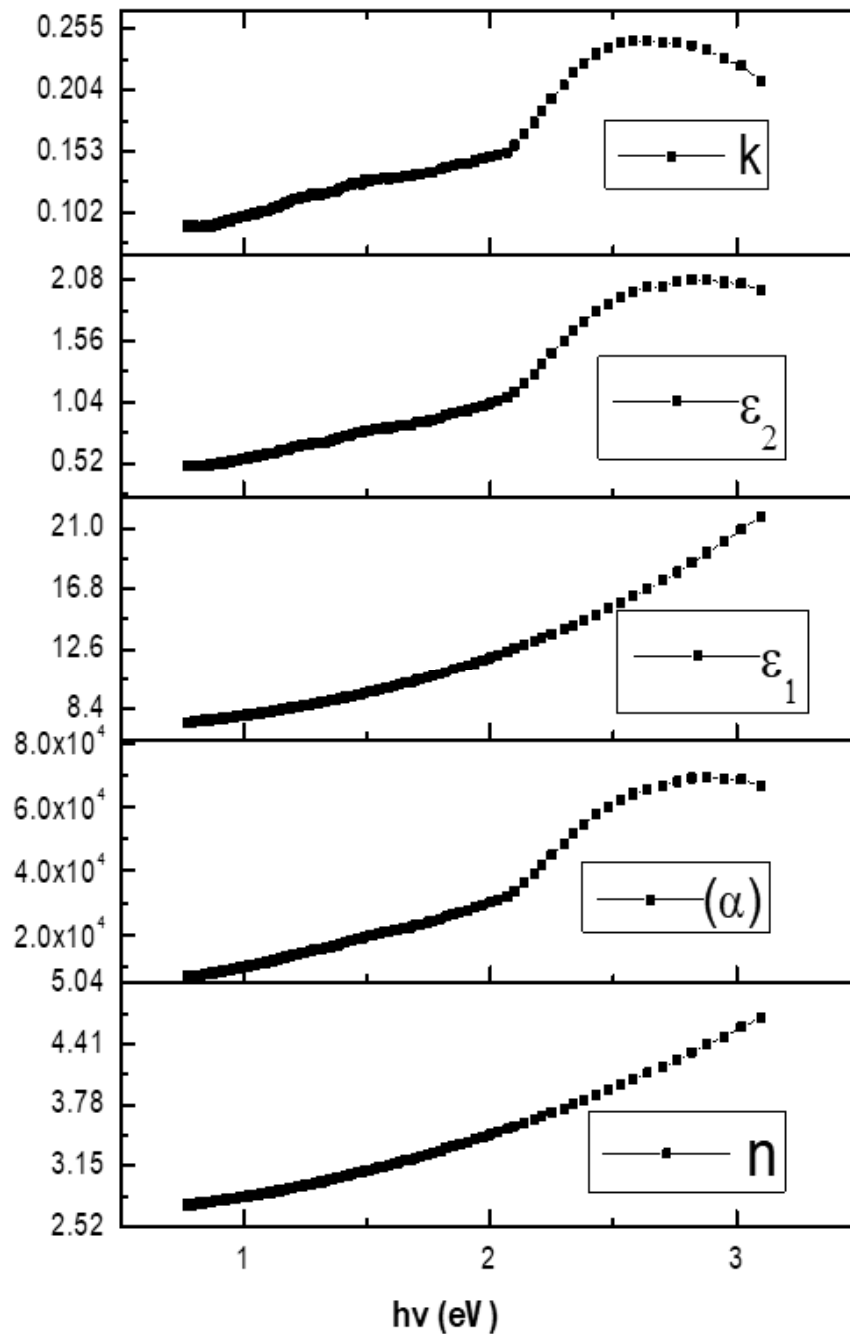


**Fig.2. Transmission spectrum vs wavelength of a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin film.**

The calculated value of absorption coefficient and refractive index along with other optical parameters are plotted as function of photon energies in Figure 3. The real ( $\epsilon_1$ ) and imaginary ( $\epsilon_2$ ) parts of the dielectric constant for a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> films has been calculated using the relation [14]

$$\epsilon_1 = n^2 - k^2 \quad \text{and} \quad \epsilon_2 = 2nk \quad (4)$$

The values of complex dielectric index (real and imaginary) ( $\epsilon_1$  and  $\epsilon_2$ ) plotted in Figure 3. Extinction coefficient  $k$ , is obtained from the already known  $\alpha$  values, using the basic equation, i.e.  $k = \alpha\lambda/4\pi$ . The values of extinction coefficient ( $k$ ) calculated using this equation and are plotted in Fig. 3.

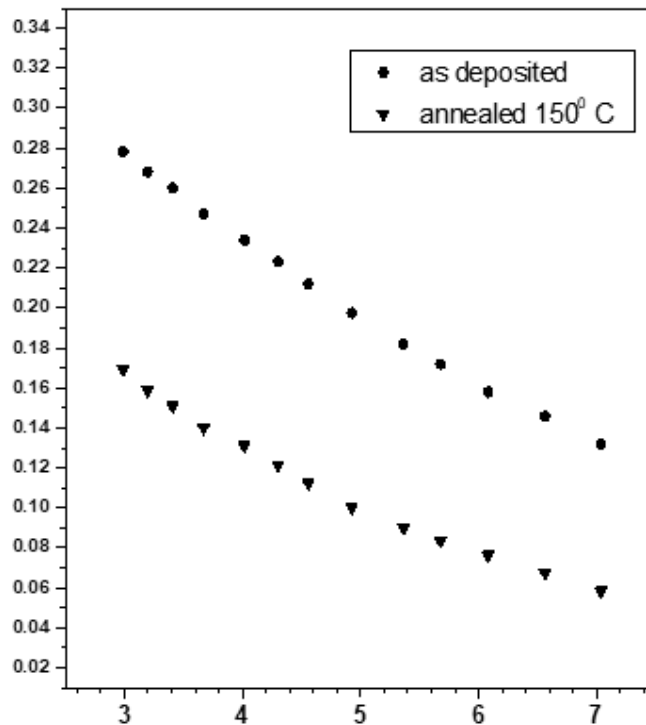


**Fig. 3** Refractive index ( $n$ ), absorption coefficient ( $\alpha$ ), real dielectric constant ( $\epsilon_1$ ), Imaginary dielectric constant ( $\epsilon_2$ ) and extinction coefficient ( $k$ ) of a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin film.

Wemple and DiDomenico parameters ( $E_0$  is the oscillator energy and  $E_d$  is the so-called dispersion energy) can be determined from experimental data by using the following relation [15, 16].

$$n^2(h\nu) = 1 + \frac{E_d E_0}{E_0^2 - (h\nu)^2} \quad (6)$$

Plot of  $(n^2 - 1)^{-1}$  vs.  $(h\nu)^2$  (Figure 4) allows us to determine the oscillator parameters, by linear fitting method. The values of  $E_0$  and  $E_d$  can directly be determined by the slope  $(E_0 E_d)^{-1}$  and intercept on vertical axis  $(E_0/E_d)$ . The calculated values of  $E_0$  and  $E_d$  are shown in the Table 1.



**Fig.4 Plot of  $(n^2 - 1)^{-1}$  vs.  $(h\nu)^2$  for a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin film.**

The value of static refractive index ( $n_0$ ) can be obtained using relation as described elsewhere [16]. The value of static refractive index ( $n_0$ ) is obtained relation (6) by assuming  $h\nu$  approaching zero reduce to relation (7).

$$n_0 = \left( 1 + \frac{E_d}{E_0} \right)^{1/2} \quad (7)$$

The absorption coefficient ( $\alpha$ ) is calculated from the relation

$$x = \exp(-\alpha.t) \quad (8)$$

where,  $x$  is absorbance as described elsewhere [15, 16]. The absorption coefficient of amorphous semiconductors in the strong-absorption region ( $\alpha \geq 10^4 \text{ cm}^{-1}$ ), the transition between extended states in both valence and conduction bands, is given by [17]

$$\alpha(h\nu) = B(h\nu - E_g^{opt})^n / (h\nu) \quad (9)$$



where  $E_g^{opt}$  is the optical band gap. The parameter B is the band tailing parameter and  $n = 1/2$  and 2 for direct and indirect band gap materials, respectively. The optical gap ( $E_g^{opt}$ ) obtained from the intersection of the plot  $(\alpha h\nu)^{1/2}$  vs  $h\nu$  is  $(1.49 \pm 0.01)$  eV (Table 1). The degree of disorder and density of defects states decreases by giving heat treatment to chalcogenide thin films, which increases the refractive index and band gap upon annealing. The other associated optical parameter also show changes upon heat treatment of thin films.

**Table.1.** The refractive index (n), the extinction coefficient (k), real part of dielectric constant ( $\epsilon_1$ ) imaginary part of dielectric constant ( $\epsilon_2$ ), oscillator energy ( $E_0$ ), oscillator strength ( $E_d$ ) and optical gap ( $E_g^{opt}$ ) of as deposited and annealed a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin films.

| Sample<br>(Ge <sub>20</sub> Se <sub>80</sub> ) <sub>90</sub> Bi <sub>10</sub> | n ( $\lambda=1000$<br>nm) | (k)   | ( $\epsilon_1$ ) | ( $\epsilon_2$ ) | $E_0$<br>(eV) | $E_d$ (eV) | $n_0$ | $E_g^{opt}$ (eV) |
|-------------------------------------------------------------------------------|---------------------------|-------|------------------|------------------|---------------|------------|-------|------------------|
| As deposited                                                                  | 2.92                      | 0.116 | 8.52             | 0.66             | 2.87          | 17.58      | 2.67  | 1.49             |
| Annealed                                                                      | 2.98                      | 0.118 | 8.78             | 0.70             | 2.91          | 18.43      | 2.73  | 1.54             |

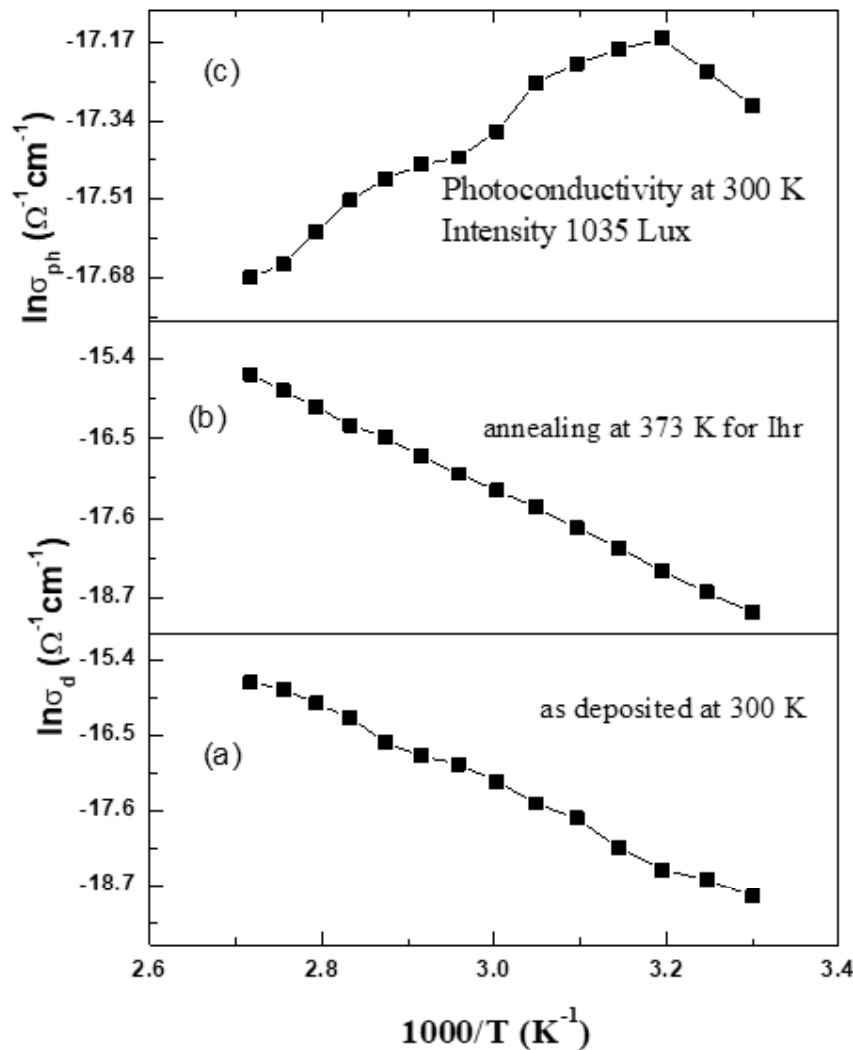
### 3.3 Electrical studies

The dark conductivity ( $\sigma_d$ ) measurements of a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin films have been carried out over the temperature range 298-353K. A vacuum of  $10^{-3}$  mbar is maintained in the sample holder during various measurements. The temperature dependence of ( $\sigma_d$ ) for thin film a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> plotted in Fig. 5(a)–(b). In most of chalcogenide glasses the plot of  $\ln\sigma_d$  versus  $1000/T$  are straight line indicating that dc conduction is single activation process. Such type of conduction mechanism can be expressed by Arrhenius relation given by

$$\sigma_d = \sigma_0 \exp\left(\frac{-\Delta E}{kT}\right) \quad (10)$$

where  $\sigma_0$  is pre exponent,  $\Delta E$  activation energy, k is Boltzmann's constant and T is the absolute temperature respectively.

The calculated values of  $\sigma_d$ ,  $\sigma_0$ , and  $\Delta E_d$  are given in table 2. It is observed that the value of dc activation energy ( $\Delta E_d$ ) decreases from 0.48 eV to 0.46 eV after annealing at temperature 373K. The value of  $\sigma_d$  decreases from  $6.40 \times 10^{-9} \Omega^{-1}\text{cm}^{-1}$  to  $6.12 \times 10^{-7} \Omega^{-1}\text{cm}^{-1}$  after annealing at temperature 373K. There is a slight decrease in  $\Delta E_d$  from 0.48 eV to 0.46 eV post annealing. The variation of steady state photoconductivity ( $\sigma_{ph}$ ) shown in Fig 5(c) with temperature at a particular intensity (1035 lux) with accuracy in measurement of  $I_{ph}$  is  $\pm 1\text{pA}$ . A maximum in the photoconductivity ( $\sigma_{ph}$ ) is observed in a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin films. At higher temperature the carrier concentration of thermal carriers exceeds that of photo carriers and  $\sigma_{ph}$  decreases with increase in temperature. The rate of recombination is governed mainly by the dark concentration of the carrier. The decrease in photoconductivity with increasing temperature is called “thermal quenching” [18]. With increasing temperature holes can hop more easily in the localized tail states, resulting in an increase in the recombination rate and hence decrease in photoconductivity.



**Fig. 5(a)-(c). The temperature dependent (a) dc dark conductivity as deposited 300 K, (b) annealed 373 K and (c) photoconductivity a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin film.**

The occurrence of this maximum in photoconductivity has been discussed in various theories [18, 19]. The value of  $\sigma_{ph}$  and  $\Delta E_{ph}$  are  $3.04 \times 10^{-8} \Omega^{-1} \text{cm}^{-1}$  and 0.12 eV respectively at room temperature (300K). It is clear from the Fig 5(c) that the photoconductivity is an activated process. The activation energy ( $\Delta E_{ph}$ ) for photoconduction is much smaller than dark conduction. The photosensitivity the ratio of light to dark current ( $\sigma_{ph}/\sigma_d$ ) is shown in Table 2. It is observed the photosensitivity increases after annealing from 4.75 to 4.96.

Table.2. The dc conductivity ( $\sigma_d$ ), pre-exponential factor ( $\sigma_0$ ), dark activation energy ( $\Delta E_d$ ), photoconductivity ( $\sigma_{ph}$ ), the activation energy of photoconduction ( $\Delta E_{ph}$ ), photosensitivity ( $\sigma_{ph}/\sigma_d$ ) of a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin films.

| Sample                                                              | $\sigma_d$ ( $\Omega^{-1}\text{cm}^{-1}$ ) |                       | $\sigma_0$ |          | $\Delta E_d$ (eV) |          | $\sigma_{ph}$ ( $\Omega^{-1}\text{cm}^{-1}$ ) | $\Delta E_{ph}$ | $\sigma_{ph}/\sigma_d(300\text{K})$ |          |
|---------------------------------------------------------------------|--------------------------------------------|-----------------------|------------|----------|-------------------|----------|-----------------------------------------------|-----------------|-------------------------------------|----------|
|                                                                     | as                                         | annealed              | as         | annealed | as                | annealed |                                               |                 | as                                  | annealed |
| (Ge <sub>20</sub> Se <sub>80</sub> ) <sub>90</sub> Bi <sub>10</sub> | 6.40<br>$\times 10^{-9}$                   | 6.12 $\times 10^{-9}$ | 0.47       | 0.72     | 0.48              | 0.46     | 3.04 $\times 10^{-8}$                         | 0.12            | 4.75                                | 4.96     |

#### IV. CONCLUSIONS

The effect of annealing on the optical and electrical properties of a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin film have been studied. It is found that values of the refractive index (n), the extinction coefficient (k), real part of dielectric constant ( $\epsilon_1$ ), imaginary part of dielectric constant ( $\epsilon_2$ ), oscillator energy ( $E_0$ ), oscillator strength ( $E_d$ ) and optical gap ( $E_g^{opt}$ ) of a-(Ge<sub>20</sub>Se<sub>80</sub>)<sub>90</sub>Bi<sub>10</sub> thin films after annealing which can be attributed due to structural rearrangements and change in the density of defects states. The temperature dependence dark and photoconductivity results indicates changed in the carrier concentration before and after annealing is leading to changes in various electrical parameters. DC activation energy ( $\Delta E_d$ ) decreases from 0.48 eV to 0.46 eV after annealing at temperature while on the other hand photosensitivity increases after annealing.

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# Comparison of Radar Backscattering Models IEM, Oh & Dubois for Synthetic Aperture Radar (SAR) Data

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## ABSTRACT

Synthetic aperture radar (SAR) observations have been used in numerous studies to estimate soil moisture and surface roughness, because of their important roles in many aspects. The objective of this paper is to compare the most used radar backscattering models: Oh et al., Dubois et al., and the Integral Equation Model (IEM) using a wide dataset of SAR (Synthetic Aperture Radar) data. These forward models reproduce the radar backscattering coefficients ( $\sigma^0$ ) from soil surface characteristics (dielectric constant, roughness) and SAR sensor parameters (radar wavelength, incidence angle, polarization). This comparison shows that the IEM is the most adequate to estimate soil moisture & roughness from SAR data.

**Keywords:** Oh Model, Dubois Model, Integral Equation Model (IEM); Synthetic Aperture Radar (SAR), Soil moisture, Backscattering Coefficients, Surface Roughness.

## I. INTRODUCTION

Soil moisture and surface roughness play important roles in various applications such as agronomy, hydrology, agriculture, risk prediction, etc. The radar signal, which depends on several radar parameters (incidence angle, frequency, polarization), is also correlated with soil surface roughness and moisture content. Synthetic Aperture Radar (SAR) data was used widely and successfully used for monitoring the spatial and temporal evolution of soil moisture and roughness. The estimation of soil moisture & roughness is done by inverting the measured SAR backscatter through SAR backscattering models (both empirical and physical).

A number of radar backscattering models have been reported in the literature. The most frequently used empirical models are those developed by Oh et al. [1–4], Dubois et al. [5], and the most popular physical models are the Integral equation model (IEM) [6]. These models are supposed to reproduce the radar backscattering coefficient and allow the estimation of soil surface parameters (moisture content and roughness) from SAR images. Several studies reported important discrepancies between backscattering model simulations and SAR observations [11–13].

Most studies have been carried out to evaluate and compare the robustness of the backscattering models such as Oh, Dubois, and IEM. Zribi et al. [13] evaluated the Oh model and IEM using L-, C- and X-band SAR data and in situ measurements. Results show that the IEM provides accurate simulations (RMSE about 2.0 dB) only over smooth surfaces. In addition, for rough surfaces and medium incidence angles, Oh model simulations retrieve backscattering values very close to the measured ones, while showing poor correlation with measured backscattering coefficients over smooth areas. Baghdadi and Zribi evaluated the backscattering models IEM, Oh, and Dubois by using large C-band SAR data and in situ measurements. Results showed that these models frequently tend to over-estimate or under-estimate the radar signal and the errors in model simulation depend on height, surface roughness, rms, soil moisture, mv, and/or incidence angle. This study aims to evaluate the most popular backscattering SAR models (Oh, Dubois, and IEM) by using a wide range of SAR data. Most of the methods for soil moisture mapping are based on backscatter models for soil moisture estimations. The objective of our study is to evaluate the most common backscatter models using a wide dataset of SAR data acquired from numerous agricultural sites. Thus, this study should be of great importance to the scientific community since it helps to understand the backscatter model's performance for a wide range of soil surface conditions, acquired for several study areas throughout the world by numerous SAR sensors.

## II. SYNTHETIC APERTURE RADAR (SAR)

Backscattering signals measured using SAR are affected by land surface characteristics i.e. dielectric constant, the soil surface roughness of the soil, and the physical and geometrical properties of vegetation, size, shape, orientation, etc. [15] The main characteristics of the currently operating spaceborne SAR sensors along with some past and future sensors are summarised in Table 1. [16] SAR remote sensing has the following characteristics and advantages [18][15]: (a) estimating SM change using repeat observations, (b) correcting the effects of surface roughness based on a multi-incidence angle (c) a combination of high spatial-spatial resolution observations from active microwave sensors and coarse observations from passive microwave sensors, (d) measuring SM for bare soil quantitatively using dual polarization L-band or three- polarization.

**Table 1.** Characteristics of major spaceborne SAR systems.

| Platform | Sensor | Polarization | Band(s) | Highest Spatial Resolution(m) | Swath Width (km) | Mission                                 |
|----------|--------|--------------|---------|-------------------------------|------------------|-----------------------------------------|
| SEASAT   | SAR    | HH           | L       | 25                            | 100              | June-Oct 1978                           |
| SIR-A    | SAR    | HH           | L       | 40                            | 50               | Nov 12-15th 1981                        |
| SIR-B    | SAR    | HH           | L       | 25                            | 30               | Oct 5-13th 1984                         |
| Almaz-1  | SAR    | HH           | S       | 13                            | 172              | Mar 31st 1991-Oct 17 <sup>th</sup> 1992 |

|                               |                |                             |         |     |         |                                                                                 |
|-------------------------------|----------------|-----------------------------|---------|-----|---------|---------------------------------------------------------------------------------|
| ERS-1                         | AMI            | VV                          | C       | 30  | 100     | July 17 <sup>th</sup> , 1991-<br>Mar 10 <sup>th</sup> , 2000                    |
| JERS-1                        | SAR            | HH                          | L       | 18  | 75      | Feb 11 <sup>th</sup> , 1992-<br>Oct 12 <sup>th</sup> , 1998                     |
| SIR-C/X-SAR                   | SIR-C<br>X-SAR | VV,HH,HV,<br>VH, HH         | L, C, X | 30  | 10-200  | April 1994<br>Oct 1994                                                          |
| ERS-2                         | AMI            | VV                          | C       | 30  | 100     | April 21 <sup>st</sup> 1995-                                                    |
| RADARSAT-1                    | SAR            | HH                          | C       | 10  | 100-170 | Nov 28 <sup>th</sup> , 1995-                                                    |
| SRTM                          | C-SAR<br>X-SAR | VV, HH<br>HH                | C, X    | 30  | 50      | Feb 11 <sup>th</sup> – 22 <sup>nd</sup><br>2000                                 |
| ENVISAT                       | ASAR           | VV,HH,HH/V<br>V             | C       | 30  | 100-400 | Mar 1 <sup>st</sup> 2002-                                                       |
| ALOS                          | PALSAR         | HV/HH,VH/V<br>V<br>Quad-pol | L       | 10  | 70      | Jan 24 <sup>th</sup> 2006-                                                      |
| TerraSAR-X                    | X-SAR          | Quad-pol                    | X       | 1   | 10-100  | June 15 <sup>th</sup> 2007-                                                     |
| RADARSAT-2                    | SAR            | Quad-pol                    | C       | 3   | 10-500  | Dec 14 <sup>th</sup> 2007-                                                      |
| COSMO/<br>SkyMed Series       | SAR-2000       | Quad-pol<br>HH, HV, VH,     | X       | 1   | 10-200  | June 8 <sup>th</sup> & Dec 8 <sup>th</sup> , 2007-<br>21 <sup>st</sup> Jan 2008 |
| TecSAR                        | SAR            | VV                          | X       | 1   | 40-100  |                                                                                 |
| SAR-Lupe                      | SAR            | -                           | X       | <1  | -       | Dec 2006 & Jul<br>2008-                                                         |
| Kondor-5                      | SAR            | HH,VV                       | S       | 1   | -       | 2009                                                                            |
| TanDEM-X                      | SAR            | Quad-pol                    | X       | 1   | 10-150  | 2009                                                                            |
| RISAT                         | SAR            | Quad-pol                    | C       | 3   | 30-240  | 2009                                                                            |
| HJ-1C                         | SAR            | HH, VV                      | S       | 20  | -       | 2009                                                                            |
| ARKON-2                       | SAR            | -                           | X, L, P | 2   | -       | 2011                                                                            |
| MapSAR                        | SAR            | Quad-pol                    | L       | 3   | 20-55   | 2011                                                                            |
| KompSAT-5                     | SAR            | HH, HV, VH,<br>VV           | X       | 20  | 100     | 2011                                                                            |
| SAOCOM-1                      | SAR            | Quad-pol                    | L       | 7   | 50-400  | 2011                                                                            |
| RADARSAT                      | SAR            | Quad-pol                    | C       | 3   | 20-500  | 2012 – 2014                                                                     |
| Constellation<br>Mission SMAP | SAR            | HH, HV, VV                  | L       | 3km | 30-1000 | 2012                                                                            |
| Sentinel-1                    | SAR            | Quad-pol                    | C       | 5   | 400     | 2013                                                                            |
| Sentinel-1A                   | SAR            |                             | C       |     |         | 2014                                                                            |
| Sentinel-1B                   | SAR            |                             | C       |     |         | 2016                                                                            |

|                                       |     |          |   |     |      |      |
|---------------------------------------|-----|----------|---|-----|------|------|
| DESDynl                               | SAR | Quad-pol | L | 25  | >340 | 2015 |
| RADARSAT-Constellation (3 Satellites) | SAR | Quad-pol | C | 1-3 | 350  | 2018 |

### III. IN-SITU MEASUREMENTS

Most of the techniques have been used for measurements of soil moisture and surface roughness using active microwave-based models.

#### 3.1 Soil Moisture Measurements

The soil moisture is described as the level of saturation in the upper soil layer relative to the soil field capacity and is regulated by the precipitation and potential evaporation and is highly variable in space and time. Most of the studies have compared the estimation of soil moisture using active microwave sensors like (Shoshany et al., 2000; Kelly et al., 2003; Baghdadi et al., 2006; Rahman et al., 2008; Zribi et al., 2011; Das and Paul, 2015). Shoshany et al. (2000) have estimated Gravimetric SM converted into volumetric SM (%).

Gravimetric residual moisture method and volumetric moisture content have been widely used for SM measurements. Gravimetric SM (mg) values were obtained from laboratory analysis and converted into volumetric soil moisture ( $V_{sm}$ ): [20]

$$V_{sm} = mg * sbd \quad (1)$$

Where, sbd multiplying bulk density.

Further, Mohan et al. (2015) have estimated gravimetric soil moisture ( $G_{SM}$ ) as:

$$G_{SM} = \frac{M_{water}}{M_{soil}} = \left[ \frac{W_{wet} - W_{dry}}{W_{dry}} \right] \quad (2)$$

Using simple formula volumetric soil moisture can be calculated as:

$$\frac{Wet\ weight - Dry\ weight}{height} \quad (3)$$

#### 3.2 Roughness Measurement:

After the soil moisture, the surface roughness is another important factor that affects the backscattering SAR signature, because it determines how the incidence wave interacts with the surface. There are several ways to describe the natural surface roughness, and two frequently used methods are: fractal geometry theory and statistical description [21]. The fractal geometry theory describes the complicated surface roughness structure, especially for irregular and fragmented soil structures [22]. The surface roughness model helps to describe the surface height variations with respect to the ground surface level.

### IV. BACKSCATTERING COEFFICIENTS

The backscattering coefficient of soil represents the relationship between soil properties and the scatterometer responses [23]. Some of the factors that are known to govern backscattering behavior are: i) dielectric constant of the vegetation material which is strongly influenced by moisture content; ii) the shape



distribution; iii) orientation distribution. iv) size distribution of the scatterers and roughness and dielectric constant of the underlying soil surface [24]. From the backscattering coefficient, we can directly calculate the soil dielectric constant [25]. It shows a linear relationship with SM as [20].

$$\sigma^o = A + B.W \quad (4)$$

Where A is the  $\sigma^o$  of a completely dry soil surface and B is the sensitivity of  $\sigma^o$  to change with the surface SM content.

### Description of scattering models:

The most common approaches used to develop models for soil moisture retrieval are developing direct theoretical or physical models by simulating the backscattering coefficients in terms of soil attributes such as the dielectric constant and the surface roughness for an area with known characteristics. The dielectric constant of the soil surface and hence the soil moisture content can be estimated from mathematical inversion of these models.[26]

#### 1.The Semi-Empirical Oh model

Oh, et al. developed from 1992 to 2004 several versions of a semi-empirical backscattering model. Based on theoretical models, scatterometer measurements, and airborne SAR observations, the Oh model is built over a wide variety of bare soil surfaces. The Oh model relates the co-polarized ratio  $p$  ( $=\sigma_{HH}^0/\sigma_{VV}^0$ ) and the cross-polarized ratio  $q$  ( $=\sigma_{HV}^0/\sigma_{VH}^0$ ) to incident angle ( $\theta$ ), wave number ( $k$ ), the standard deviation of surface height ( $H_{rms}$ ), correlation length ( $L$ ), soil moisture ( $m_v$ ), dielectric constant ( $\epsilon_r$ ),  $\Gamma_0$  is the Fresnel reflectivity. The initial version of the Oh model is defined as:

$$p = \frac{\sigma_{HH}^0}{\sigma_{VV}^0} = \left[ 1 - \left( \frac{\theta}{90^\circ} \right)^{\frac{1}{3\Gamma_0}} e^{-k r_{rms}} \right]^2 \quad (5)$$

$$q = \frac{\sigma_{HV}^0}{\sigma_{VH}^0} = 0.23 \sqrt{\Gamma_0} (1 - e^{-k r_{rms}}) \quad (6)$$

Where,

$$\Gamma_0 = \left| \frac{1 - \sqrt{\epsilon_r}}{1 + \sqrt{\epsilon_r}} \right|^2 \quad (7)$$

Oh et al. [14] proposed a new expression for  $q$  to incorporate the effect of the incidence angle:

$$q = 0.25 \sqrt{\Gamma_0} (0.1 + \sin \theta^{0.9}) (1 - e^{-|1.4 - 1.6\Gamma_0| k r_{rms}}) \quad (8)$$

The expressions for  $p$  and  $q$  were again modified in 2002, and an expression was proposed for the cross-polarized backscatter coefficient (Oh et al. 2002):

$$p = 1 - \left( \frac{\theta}{90^\circ} \right)^{0.35 m_v - 0.65} e^{-0.4(k r_{rms})^{1.4}} \quad (9)$$

$$q = 0.1 \left( \frac{r_{ms}}{L} + \sin 1.3\theta \right)^{1.2} (1 - e^{-0.9(k r_{rms})^{0.8}}) \quad (10)$$

$$\sigma_{HV}^0 = 0.11 m_v^{0.7} \cos^{2.2} \theta (1 - e^{-0.32(k r_{rms})^{1.8}}) \quad (11)$$

Given that the measurement of the correlation length is not exact and that the ratio  $q$  is insensitive to the roughness parameters, Oh (2004) proposed a new formulation for  $q$  that ignores the correlation length:

$$q = 0.095 (0.13 + \sin 1.5\theta)^{1.4} (1 - e^{-1.3(k r_{rms})^{0.9}}) \quad (12)$$

Oh's models were compared with the experimental database using the ratios p and c. The ratio of c is defined from the semi-empirical formulations of p and q.

## 2. The semi-empirical Dubois model:

Dubois et al. (1995) suggested a semi-empirical approach for modelling radar backscatter coefficient for co-polarised backscatter only, using scatterometer data collected at six frequencies between 2.5 GHz and 11GHz [25]. The expressions involve the angle of incidence, the dielectric constant, the rms surface height and the wavelength:

$$\sigma_{HH}^{\circ} = 10^{-2.75} \left( \frac{\cos^{1.5} \theta}{\sin^3 \theta} \right) 10^{0.028 \epsilon_r \tan \theta} (k \text{ rms } \sin \theta)^{1.4} \lambda^{0.7} \quad (13)$$

$$\sigma_{VV}^{\circ} = 10^{-2.75} \left( \frac{\cos^3 \theta}{\sin^3 \theta} \right) 10^{0.046 \epsilon_r \tan \theta} (k \text{ rms } \sin \theta)^{1.1} \lambda^{0.7} \quad (14)$$

## 3. The Integral Equation Model (IEM):

The IEM is a physically based radioactive transfer backscattering model application to a wide range of roughness values (Fung et al. 1992). The parameters required to compute the backscattering coefficient from the IEM model are correlation length, rms surface height, dielectric constant, polarisation and incidence angle and surface parameters. Over bare soils in agricultural areas, the backscatter coefficients of the surface contribution are expressed as:

$$\begin{aligned} \sigma_{pp}^{\circ} = & \frac{k^2}{2} |f_{pp}|^2 e^{-4 \text{rms}^2 k^2 \cos^2 \theta} \sum_{n=1}^{+\infty} \frac{(4 \text{rms}^2 k^2 \cos^2 \theta)^n}{n!} W^{(n)}(2k \sin \theta, 0) \\ & + \frac{k^2}{2} \text{Re}(f_{pp}^* F_{pp}) e^{-3 \text{rms}^2 k^2 \cos^2 \theta} \sum_{n=1}^{+\infty} \frac{(4 \text{rms}^2 k^2 \cos^2 \theta)^n}{n!} W^{(n)}(2k \sin \theta, 0) \\ & + \frac{k^2}{8} |f_{pp}|^2 e^{-2 \text{rms}^2 k^2 \cos^2 \theta} \sum_{n=1}^{+\infty} \frac{(\text{rms}^2 k^2 \cos^2 \theta)^n}{n!} W^{(n)}(2k \sin \theta, 0) \end{aligned} \quad (15)$$

Where p is H and V polarisation, k is the radar wave number ( $k=2\pi/\lambda$ ), rms is the standard deviation of surface height,  $\theta$  is the radar angle of incidence,  $W^{(n)}$  is the Fourier Transform of the nth power of the surface correlation function, fpp is a function of the incidence angle and the Fresnel reflection coefficient and Fpp is a function of the incidence angle,  $\epsilon_r$  is the dielectric constant of the soil,  $\mu_r$  is the relative permittivity.

Where,

$$f_{hh} = \frac{-2R_h}{\cos \theta}$$

$$f_{vv} = \frac{2R_v}{\cos \theta}$$

$$f_{hh} = 2 \frac{\sin^2 \theta}{\cos \theta} \left[ 4R_h - \left( 1 - \frac{1}{\epsilon_r} \right) (1 + R_h)^2 \right]$$

$$f_{hh} = 2 \frac{\sin^2 \theta}{\cos \theta} \left[ \left( 1 - \frac{\epsilon_r \cos^2 \theta}{\mu_r \epsilon_r - \sin^2 \theta} \right) (1 - R_h)^2 - \left( 1 - \frac{1}{\epsilon_r} \right) (1 + R_v)^2 \right]$$

$$R_h = \frac{\mu_r \cos \theta - \sqrt{\mu_r \epsilon_r - \sin^2 \theta}}{\mu_r \cos \theta + \sqrt{\mu_r \epsilon_r - \sin^2 \theta}} : \text{ Fresnel reflection coefficient at horizontal polarization}$$

$$R_v = \frac{\epsilon_r \cos \theta - \sqrt{\mu_r \epsilon_r - \sin^2 \theta}}{\epsilon_r \cos \theta + \sqrt{\mu_r \epsilon_r - \sin^2 \theta}} : \text{ Fresnel reflection coefficient at vertical polarization}$$

$$W^n(a, b) = \text{Fourier transform of the nth power}$$

$$W^n(a, b) = \frac{1}{2\pi} \iint \rho^n(x, y) e^{-i(ax+by)} dx dy \quad (16)$$

The distribution of  $\rho(x, y)$  is exponential for low surface roughness values and Gaussian for high surface roughness values. The correlation functions for one-dimensional roughness profiles are defined as follows:

$$\rho(x) = e^{-(x/L)^\tau} \quad (17)$$

where  $L$  is the correlation length.

The backscattering IEM has a large validity domain. Baghdadi et al. (2004) and Zribi (1998) showed that, for bare soil in agricultural areas, IEM performs better with a fractal autocorrelation function. This is the function used in the present study. For retrieving surface roughness and soil moisture from SAR data, authors often use the original version of the IEM model.

## V. CONCLUSION

The semi-empirical models of Oh and Dubois as well as the IEM physical backscattering model were evaluated using SAR data. The objectives of this paper are to compare the three models Oh, Dubois and IEM models. Comparison between the radar data by the three most commonly used surface radar backscattering models (Oh, Dubois and IEM) concludes that IEM performs better from overview of literatures.

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# Molecular Interaction between Carbohydrates and Amino Acid Using Dielectric Spectroscopy

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## ABSTRACT

The present work aims at the inter molecular interaction of aqueous D-Glucose with L-Leucine ternary system using time domain reflectometry technique (TDR) within the frequency range 0.01GHz to 30GHz in the temperature region from 278.15K to 298.15K. The frequency dependent dielectric permittivity has been calculated by using Havriliak-Negami equation. For aqueous D-Glucose and L-Leucine ternary system the concentration range covers in molar concentration  $0.514 \leq c/M \leq 2.710$  and  $0.004 \leq c/M \leq 0.020$  respectively. Cole-Davidson model is used for the well description of complex dielectric permittivity spectra  $\epsilon^*(\nu)$ . Dielectric parameters such as relaxation time  $\tau_0$ , static dielectric constant  $\epsilon_0$ , high frequency limiting dielectric constant  $\epsilon_\infty$  and the orientation correlation between neighbouring molecules due to hydrogen bonding interaction determined by Kirkwood correlation factor  $g$  were calculated.

**Keywords:** D-Glucose, L-Leucine, Dielectric parameters, Time domain reflectometry.

## I. INTRODUCTION

Dielectric relaxation spectroscopy (DRS) is a very useful technique for studying molecular interactions and understanding the dynamical behavior of nearly all organic, polymeric and biological macromolecules. (Since with the advent of modern technologies scientists are using electromagnetic waves for getting information through interaction with matter). Dielectric spectroscopy is a tool in which a pulse of high frequency electromagnetic radiation incident upon a sample is reflected back and gives information in the form of electrical signals, which on further analysis gives structural information about the sample under study through dielectric parameters such as complex permittivity, static dielectric constant, relaxation amplitude or strength, relaxation time, dipole moment and so on [1].

Carbohydrates are bio-molecules formed by aldehyde or ketone compounds with multiple hydroxyl groups that account for the majority of organic matter on Earth due to their important role in all forms of life. TDR was used to investigate the temperature dependent complex permittivity spectra of monosaccharides (D-fructose and D-xylose) and disaccharides (D-maltose monohydrate) in aqueous solution. Within the frequency range of 10 MHz to 50 GHz we demonstrated how dielectric parameters such as dielectric constant

( $\epsilon_0$ ), relaxation time ( $\tau_0$ ) are sensitive to variations in mixture constituents of aqueous sugar solutions. This information could be useful in the pharmaceutical and food processing industries for formulation [2].

Amino acids are biologically important organic compounds composed of amine ( $-\text{NH}_2$ ) and carboxylic acid ( $-\text{COOH}$ ) functional groups, as well as a nitrogen atom. Each amino acid has its own side chain. The essential components of an amino acid are carbon, hydrogen, oxygen, and nitrogen [3].

The amino acids, which are the building blocks of proteins, have sparked widespread interest in multidisciplinary research-leucine (Leu) and L-isoleucine (I-Leu) are amino acids that are required for life in relation to humans. They participate in vital biological processes such as haemoglobin formation and maple syrup detection in new born screening programmes, urine disease is detected among the Characterization of Leucine and L-isoleucine is a popular area of research in Metabolomics and peptide sequencing spectrometry (mass spectrometry) [4].

The interactions of some L—amino acids with D-glucose in dilute aqueous solutions were studied using titration calorimetry and UV absorption spectroscopy. The findings revealed that L—amino acids get the ability to form intermolecular bonds.

Moreover no one studied intermolecular interaction of L-Leucine in aqueous solution of D-Glucose by using dielectric relaxation spectroscopy.

In this work we have studied dielectric relaxation and thermodynamics properties of L-leucine in aqueous solutions of D-glucose with different molar concentration over frequency range 10MHz to 30GHz within temperature range 278.15K to 298.15K.

## II. EXPERIMENTAL

### 2.1. MATERIALS

D-Glucose was purchased from Fisher Scientific chemical company and L-leucine was purchased from sigma Aldrich. Double distilled and deionized water was used for making the solution. The chemicals were weighed in an electronic digital balance (Mettler Toledo ME- 204) with a least count of 0.0001 gm.

## III. RESULTS AND DISCUSSION

The Havriliak-

$$\epsilon^*(w) = \epsilon_\infty + \left[ \frac{(\epsilon_0 - \epsilon_\infty)}{[1 + (jw\tau_0)^{1-\alpha}]^\beta} \right] \quad (1)$$

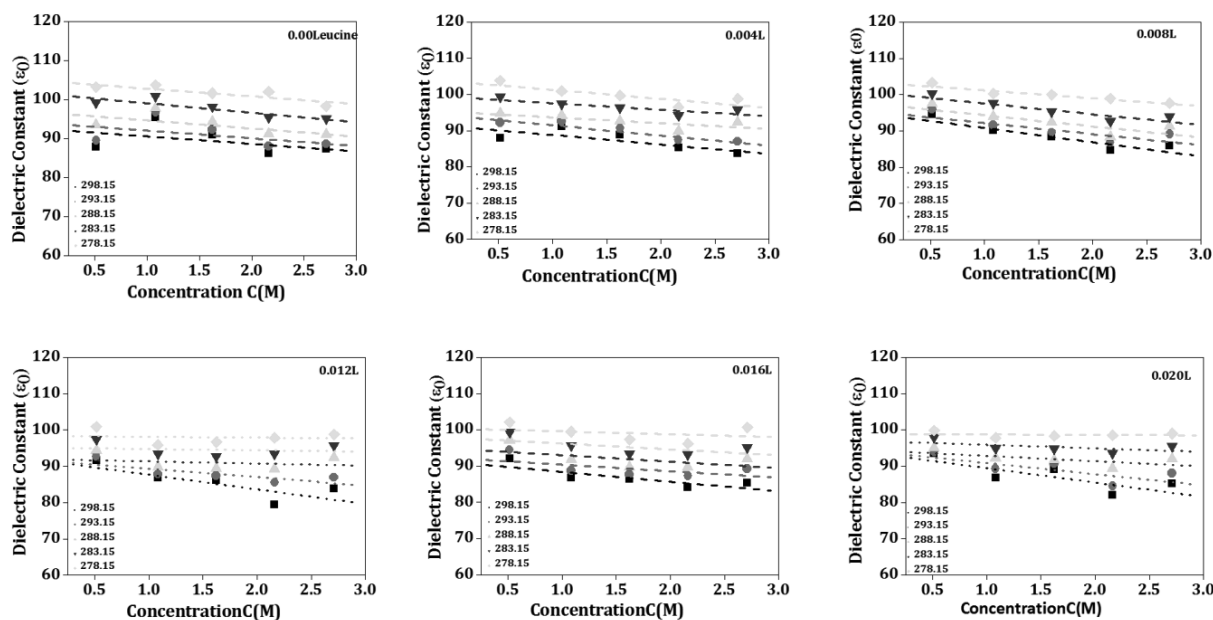
Where the static permittivity  $\epsilon_0$ ,  $\epsilon_\infty$  is the high frequency permittivity,  $\tau_0$  is the relaxation time, and  $\alpha$  and  $\beta$  are the empirical parameters for the relaxation distribution times with values ranging from 0 to 1.

As the concentrations of L-Leucine in aqueous D-Glucose increase, the dielectric constant values decrease while the relaxation time increases. The decrease in the static dielectric constant with increasing concentration in aqueous solution is due to the formation of hydration layer, which causes water molecules to be influenced by D-Glucose and L-Leucine molecules. As a result, the decrease in static dielectric constant indicates that a large amount of L-Leucine and D-Glucose in solution has been completely associated.

Relaxation time has increased in water solution may be due to L-Leucine and D-Glucose molecules forming a structure around the water molecule, making rotation of the water molecules. The variation in relaxation time reveals information about the hydrophilic nature of the solute particle. The dielectric constant, as well as the relaxation time increases as the temperature drops. This is to be expected because density increases as temperature decreases [5].

#### Static dielectric constant:

The static dielectric constants of aqueous D-Glucose solutions at different concentrations of L-Leucine and temperatures has been studied. The dielectric dispersion and absorption curves span a wider frequency range[6].



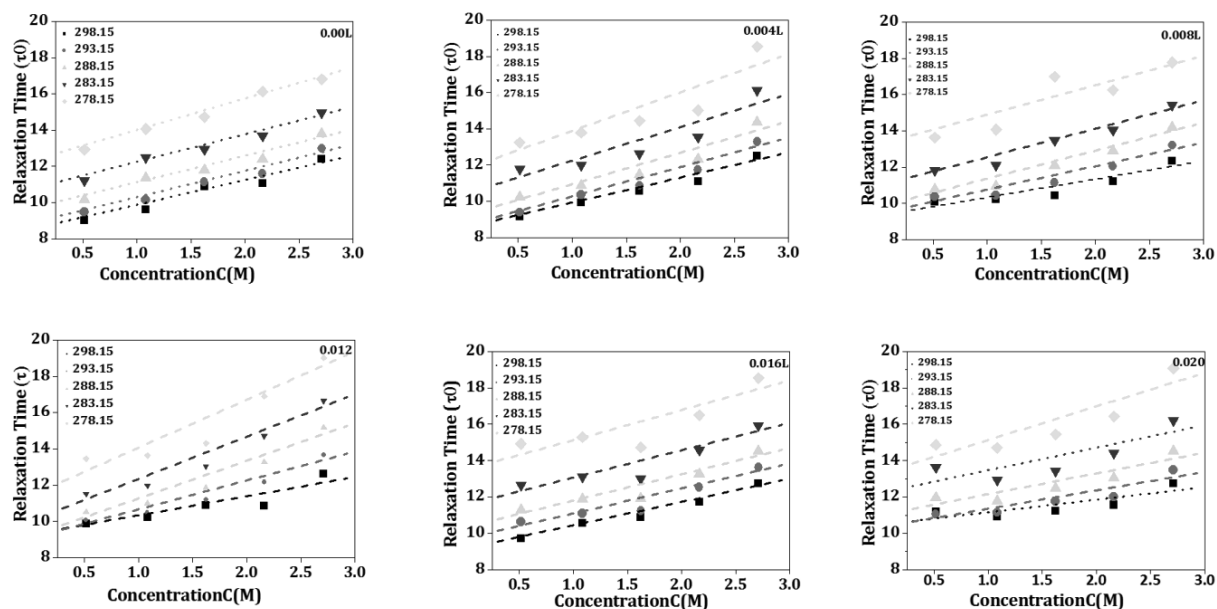
**Figure 1:** dielectric constant for aqueous D-glucose in presence of L-Leucine

As shown in Fig.1 the dielectric constant increases with decrease in temperature. This may be due to the formation of dipole-dipole antiparallel alignment for all concentrations of L-Leucine. This observation could be explained by the fact that the net decrease in the number of free water molecules with concentration is larger at higher concentrations than for lower molar concentrations [7].

#### Relaxation time:

The relaxation time is proportional to molecular size and is highly dependent on the nature of the functional group. Furthermore, changing its values provides information about the solute's hydrophilic character. Particles, as well as the apparent the reorientation of a dipole. TDR experiments show that relaxation time increases linearly with decreasing temperature as shown in fig.2. and the addition of L-Leucine in aqueous D-Glucose shows slight interaction.



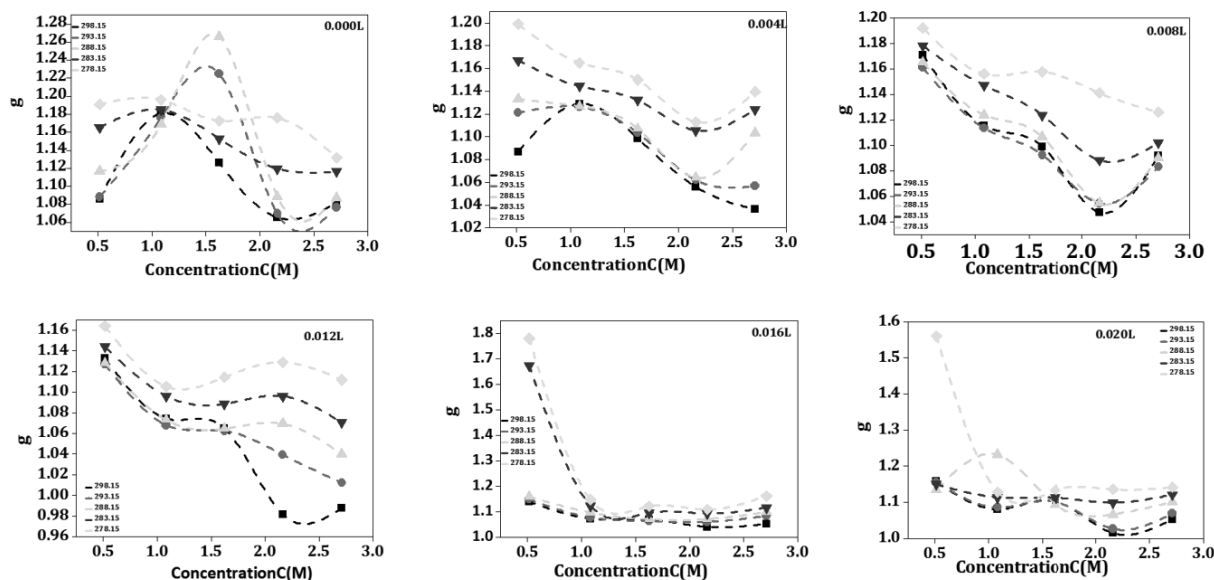


**Figure 2:** dielectric relaxation time for aqueous D-glucose in presence of L-Leucine

The linear increase in relaxation time with concentration demonstrates molecular interaction [8]. The relaxation time for different concentration of L-Leucine in aqueous D-Glucose does not deviate significantly from ideal behaviour, suggesting stronger molecular interaction than the others, indicating that molecules have a non-cooperative domain [9].

$$g\mu^2 = \frac{9K_B T M}{4\pi N \rho} \left[ \frac{(\epsilon_S - \epsilon_{\infty})(2\epsilon_S + \epsilon_{\infty})}{\epsilon_S(\epsilon_{\infty} + 2)^2} \right] \quad (2)$$

The Kirkwood-Frohlich equation provides useful information about the orientation of an electric dipole. The Kirkwood correlation factor 'g' is calculated from the dielectric constant and provides information on the collective orientation correlation of molecules. The extent of hydrogen bonding is measured by the deviation of 'g' from unity [10].



**Figure 3:** variation in correlation factor 'g' for aqueous D-glucose in presence of L-Leucine.

The molecular interaction of L-Leucine with aqueous D-Glucose mixture can be described by the Kirkwood correlation factor ( $g$ ), which can be calculated using the modified Kirkwood equation. To calculate ' $g$ ' we used values of dipole moment ( $\mu=2.34$  D) of aqueous D-Glucose and L-Leucine. Fig.3. shows the plot of  $g$  at various concentration of L-Leucine in aqueous D-Glucose. Observed values of  $g$  at lower L-Leucine concentrations are more than one, which suggests that there is a strong possibility of parallel alignment of dipoles. As the concentration of solute increases, molecules become close to each other as a result, the possibility of antiparallel alignment of dipoles emerges [11].

#### IV. CONCLUSION

From the overall study of dielectric parameters, we may conclude that the dielectric constant and relaxation time of aqueous D-Glucose at various concentrations of L-Leucine decrease with increasing temperature. This may be due to an increase in dipole-dipole antiparallel alignment. Obtained values of relaxation time confirm that the environment is not cooperative. The Kirkwood correlation factor gives information about the orientation of electric dipoles in molecules.

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# Study of Molecular Interaction in Aqueous Valine-Aceclofenac Mixture Using Dielectric Relaxation Spectroscopy (DRS)

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## ABSTRACT

The present work reports structural and dynamical properties of aqueous amino acid Valine [C<sub>5</sub>H<sub>11</sub>NO<sub>2</sub>] in the presence of Non steroidal anti-inflamatory drug (NSAID) Aceclofenac (ACF) [C<sub>16</sub>H<sub>13</sub>Cl<sub>2</sub>NO<sub>4</sub>] using time domain reflectometry (TDR) in the frequency region of 0.01 GHz to 30 GHz over the temperature range of 298.15 K-278.15 K. For aqueous Valine and ACF induced aqueous Valine the concentration range covers in molar concentrations are  $0.00 \leq c/M \leq 0.10$  and  $0.00 \leq c/M \leq 0.01$  respectively. Cole-Davidson model is used for the well description of the complex dielectric permittivity spectra  $\epsilon^*(\nu)$ . Dielectric parameters such as the static dielectric constant  $\epsilon_0$ , the high frequency limiting dielectric constant  $\epsilon_\infty$ , relaxation time  $\tau_0$ , dipole moment  $\mu$ , Kirkwood correlation factor  $g$  were obtained and expressed in terms of molecular interaction and hydrogen bonding.

**Keywords:** Time Domain Reflectometry, Dielectric Relaxation, Valine, Aceclofenac, Dipole moment.

## I. INTRODUCTION

Dielectric relaxation spectroscopy (DRS) is a very useful technique for studying molecular interactions and understanding the dynamical behavior of nearly all organic, polymeric and biological macromolecules. (since with the advent of modern technologies scientists are using electromagnetic waves for getting information through interaction with matter). Dielectric spectroscopy gives structural information about the sample under study through dielectric parameters such as complex permittivity, static dielectric constant, relaxation amplitude or strength, relaxation time, dipole moment and so on. The method has a wide frequency range (from  $10^{-5}$  to  $10^{11}$  Hz) and can therefore be used to study a wide range of processes, from slow and hindered macromolecular vibrations to constrained charge transfer processes (like proton conductivity in nearly dry systems) to relatively quick reorientations of small molecules or side chain groups [1].

Water is remarkable liquid in many aspects. Because of its unusual physical and chemical characteristics, including the latent heat of vaporization, high specific heat and maximum density at 4°C, extensive work is being done to determine its precise structure. The ability of the water molecules to participate in any number of hydrogen bonds by employing their two hydrogen atoms and the two lone pairs on their oxygen is what determines the structural characteristics of liquid water. The local polarization's spontaneous fluctuation,

which results from partial charge separation during cluster formation, may be the cause of the high value of the dielectric constant [2].

Amino acids play various essential roles in living systems. In aqueous solutions, the interactions between the solvent and the various constituent groups of a protein, such as the amino acid side chains and the backbone peptide group, play an important role in the structure and function of proteins. Amino acids are extremely small biomolecules that serve as the primary building blocks of proteins and enzymes [3].

Aceclofenac is a non-steroidal anti-inflammatory drug (NSAID) indicated for various painful indications and proved as effective as other NSAIDs and chemically known as 2-[2-[2-[(2,6-dichlorophenyl) amino]phenyl]acetyl] oxyacetic acid [4]. Other applications includes treatment of osteo arthritis, rheumatoid arthritis, tendinitis, ankylosing spondylitis and joint inflammation and reduces pain intensity and duration of morning stiffness and other inflammatory conditions [5,6]. Aceclofenac is such a carboxylic acid derivative and one of the important non-steroidal anti-inflammatory drug (NSAID) molecules, which also possess analgesic properties [7]. It has free carboxylic acid in its structure, which is found in many pharmaceutical compounds and plays an important role in drug design. Because of the simultaneous presence of carbonyl (C=O) and hydroxyl (O-H) groups, carboxylic acids can act as both hydrogen bond acceptor and donor. As a result, carboxylic acids, which are quite polar in nature [8], can form dimers that correspond to the well-known homo-synthons in supramolecular chemistry [9]. Aceclofenac exhibits very slight solubility in water, and as a consequence, it exhibits low bioavailability after oral administration [10-12]. As, amino acid is a basic building block of protein and amongst 20 different amino acids Valine is a branched chain, hydrophobic, an essential amino acid and usually found in interior of proteins.

After careful literature survey, it was found that no work on the interaction of concentration dependence of aceclofenac with aqueous valine using time domain reflectometry in the GHz frequency, and at 298.15 K, 288.15 K, and 278.15 K temperatures has been reported so far. Amino acids are important biomolecules that interact with drugs inside the body. In biological systems, solvent-mediated interactions are the primary determinants for regulating the structure, dynamics, and thermodynamics of biomolecules, ultimately dictating their biological function and that of the cell. Because biomolecules are embedded in a highly polar medium, electrostatics is a critical component of molecular solvation effects. Although pure aceclofenac has a

The aim of this work is to study the dielectric relaxation of Valine-ACF-Water solution using the time domain reflectometry technique. The solutions were prepared at room temperature for different molar concentrations of valine viz. 0, 0.02, 0.04, 0.06, 0.08, 0.1 and aceclofenac viz. 0, 0.002, 0.004, 0.006, 0.008 and 0.01. We have measured the dielectric relaxation spectra for these solutions at 298.15 K, 288.15 K and 278.15 K using time domain reflectometry in the frequency range of 0.01 GHz-30 GHz. The purpose of the present research work is to investigate the impact of temperature and concentration on the structure and dynamics of water molecules in presence of valine and ACF macromolecules as well as the intermolecular interactions between aqueous Valine and ACF molecules, in terms of various dielectric and thermodynamic parameters. We interpreted the obtained dielectric data by comparing with those of earlier dielectric studies.

## II. EXPERIMENTAL

### 2.1 materials

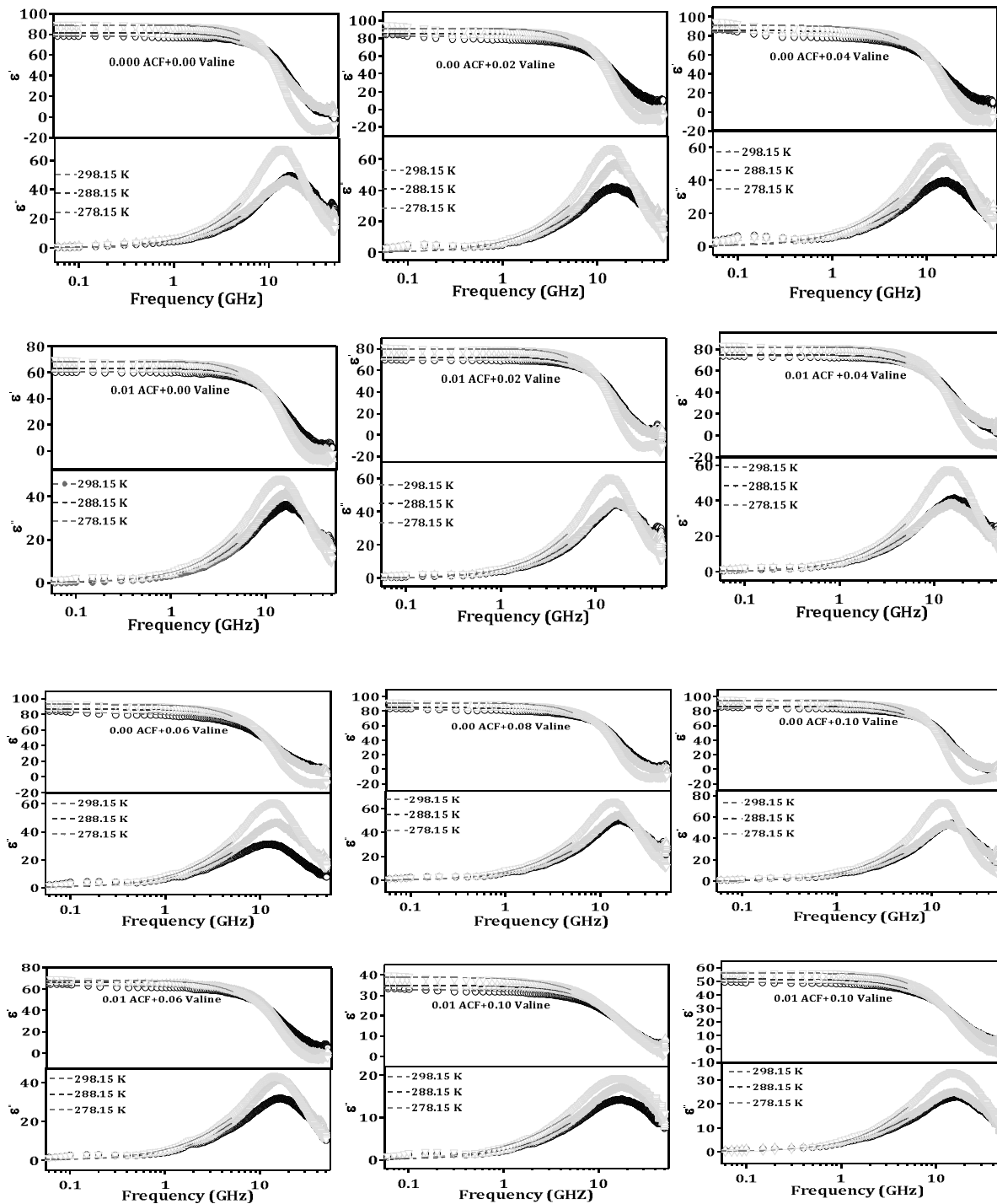
Valine was purchased from sigma Aldrich and Aceclofenac was purchased from Hi Media Laboratories Pvt. Ltd. Mumbai, India and used without purification. Double distilled and deionized water was used for making the solution. The chemicals were weighed in an electronic digital balance (Mettler Toledo ME- 204) with a least count of 0.0001 gm. The solutions of 15 ml were prepared at room temperature for different concentrations of Valine and ACF and the dielectric measurement were carried out by using TDR.

### 2.2 Dielectric Measurements

The Tektronix Digital Serial Analyzer model no. DSA8300 sampling mainframe along with the sampling module 80E10B has been used for TDR. A sampling module provides 12 ps incident and 15 ps reflected rise time pulse was fed through a coaxial line system having  $50\Omega$  impedance. Sampling oscilloscope monitors show change in step pulse after reflection from the end of line. The reflected pulse without sample  $R_1(t)$  and with sample  $R_2(t)$  were recorded in the time window of 5 ns and digitized in 2000 points. The Fourier transform of the pulse and data analysis was performed to determine complex permittivity spectra  $\epsilon^*(\omega)$  using least square fit method [14-16]. A temperature controller system was used to maintain the constant temperature. The sample cell is surrounded by a heat insulating container and the temperature at the cell is checked by using electronic thermometer. The temperature of sample cell was maintained at desired value within the accuracy of  $\pm 1^\circ\text{C}$ .

## III. RESULTS AND DISCUSSION

Dielectric dispersion and absorption curves obtained for the aqueous Valine at 0.00, 0.02, 0.04, 0.06, 0.08 and 0.1 M concentration in presence of poor water soluble aceclofenac (ACF) with the concentrations 0.002, 0.004, 0.006, 0.008 and 0.01 M used at temperatures 298.15 K, 288.15 K and 278.15 K is shown in fig. 1 where only spectra at low and high concentrations and at all temperatures along with the spectra for water were depicted. The spectra show that there is a gradual decrease in dielectric permittivity for all the used concentrations and temperature and the loss peaks shift towards lower frequency side. This suggests molecular association between solute and solvent molecules.



**Figure 1:** Permittivity spectra contains dielectric permittivity ( $\epsilon'$ ) and loss ( $\epsilon''$ ) as a function of frequency for water and aqueous Valine in presence of ACF at different concentration and temperature. (Symbols-Observed data and Dotted lines-Fitted data)

Temperature and Concentration dependent dielectric parameter of Valine was established by studying the variation of dielectric constant, dielectric loss, relaxation time, Kirkwood correlation factor and dipole moment as well as thermodynamic parameters such as free energy of activation, entropy of activation and enthalpy of activation [17].

$(\epsilon')$  and loss  $(\epsilon'')$  for Valine-ACF-Water system obtained for various concentrations in the temperature range of 298.15 K - as a function of frequency is shown in fig. 1. The values of complex permittivity  $\epsilon^* = \epsilon' - j\epsilon''$  Valine-ACF-Water system have been analyzed and used for the evaluation of dielectric parameters at various temperatures and concentrations [18]. The process can be described by S. Havriliak -

$$\epsilon^*(\omega) = \epsilon_\infty + \left[ \frac{(\epsilon_0 - \epsilon_\infty)}{[1 + (j\omega\tau_0)^{1-\alpha}]^\beta} \right] \quad (1)$$

Where  $\epsilon_0$  is the static permittivity,  $\epsilon_\infty$  the high frequency limiting static permittivity,  $\tau_0$  is the average relaxation time,  $\omega$  is the angular frequency  $\alpha$  and  $\beta$  are the distribution parameters.  $\alpha$  ( $0 < \alpha < 1$ ) indicates the broadness of the symmetric relaxation curve when the dielectric data are described by the Cole-Cole equation. The relaxation curve with ( $0 < \beta < 1$ ),  $\alpha = 1$  corresponds to Debye-type of relaxation and a smaller value of  $\alpha$  gives the broader symmetric relaxation curve, whereas the relaxation curve with  $\beta = 1$  corresponds to a non-Debye type of relaxation in which the asymmetric relaxation ( $0 < \beta < 1$ ),  $\alpha = 0$  is associated with the cooperative mechanics of dielectric relaxation. It has been found that the dielectric data for the studied systems obey the Cole-Davidson dispersion model. As the frequency range of dielectric study in present work is from 1 GHz to 30 GHz, the value of  $\epsilon_\infty$  is just a fitting parameter. In the fitting procedure,  $\epsilon_\infty$  is not fitted and assumed to be 3.0. This is done because the data are not sensitive to  $\epsilon_\infty$  in the high frequency range.

The data collected reveals that the static dielectric constant for aqueous PVP was found more than that of pure water and it increases with increase in concentration of valine except at higher concentrations of ACF. This suggests that increasing valine concentrations decreases the number of water molecules per valine molecule that form hydrogen bonding at hydroxyl and methyl side group and thus form hydration layer around valine molecule. This association between water and valine increases the value of static dielectric constant only at lower ACF concentration but for further increase in concentration of ACF cause decrease the value of static dielectric constant. As higher values of dielectric constant has more significance for drugs stability in pharmacy which is directly related to solubility and stability of the products [20]. The addition of ACF to aqueous valine gives surprising results that decreases the values of static dielectric constant towards higher PVP concentration. The trend and magnitude of the values of static dielectric constants towards higher concentration of ACF show little variations in the values of dielectric constant over the measured concentration range. This suggests that the presence of ACF with higher concentration in aqueous valine make the system less stable. This may be due to formation of hydration layer around valine and the interaction between valine and ACF gets reduced or may be due to the formation of complexes as a result static dielectric constant decreases.

The increase in the values of static dielectric constant for aqueous valine in absence or at lowest ACF concentration clearly indicates that dipole-dipole parallel alignment must present between ACF and water molecules. As valine concentration increases, the values of the quantities  $g\mu^2$  [table] which signify the



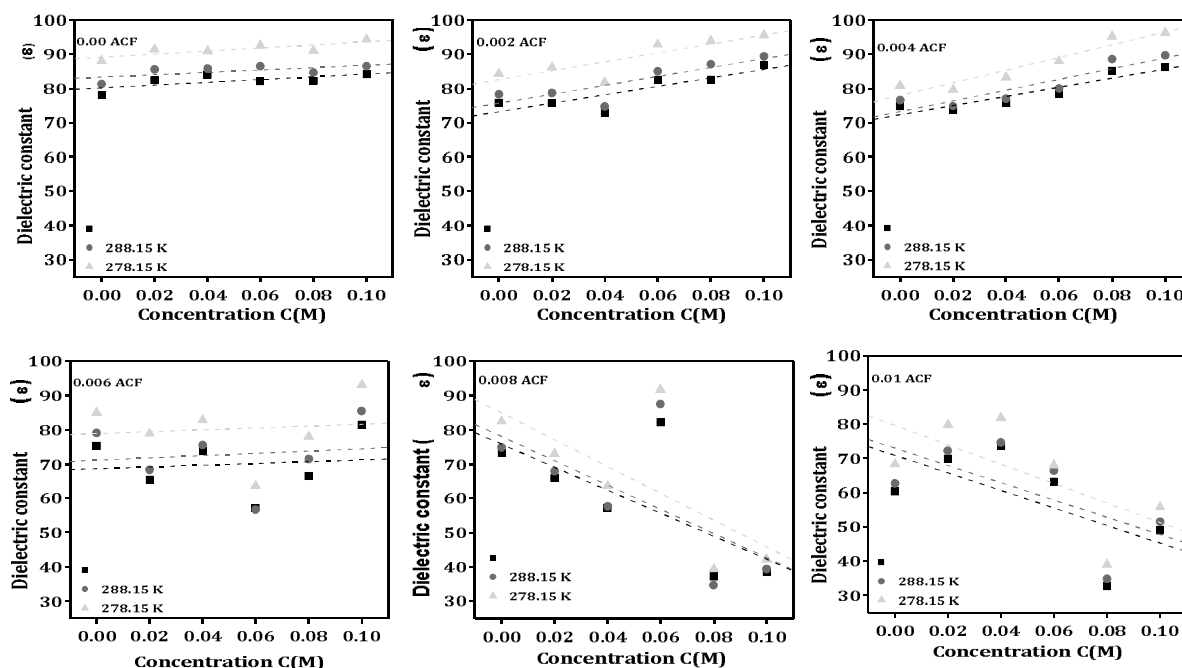
variation in dipole moment and Kirkwood correlation factor  $g$  that describes orientational correlation between solute and solvent molecules decreases. This suggests reduced parallel correlation between the dipoles of aqueous valine and ACF molecules as every ACF molecule is entirely surrounded by a water molecule. At lower ACF concentrations, interactions between valine molecules and ACF molecules gets screened, which lowers the values of the static dielectric constant. The formation of a hydration shell around valine may be the cause of this decrease in the dielectric constant and also suggests the loss of free water molecules. Valine will have an impact on the hydrogen bonding network throughout this procedure [21]. Also, such formation of shielding or hydration layer around valine molecules that reduces the interaction between valine and ACF molecules and so reduces the correlation.

To see the effect of temperature on the structural behavior of aqueous valine the study has been extended towards lower temperature. From the observed data, it has been noticed that by lowering the temperature from 298.15 K to 278.15 K static dielectric constant seems to be increasing for all the used concentrations. This rise in the values of static dielectric constant towards lower temperature over all the valine concentrations may be due to the formation of induced dipoles via hydration layer with the neighbouring or surrounding molecules as the molecules gained lower thermal energy and therefore amplitude of the random thermal motion is restricted [22]. This gives perfect alignment (parallel or antiparallel) with the applied field so that dipoles are more closely aligned with each other; as a result the orientation polarization gets increased and so the static dielectric constant.

This suggests that the system is more stable towards lower temperature and lower valine concentrations and will be more suitable for drug design and other pharmaceutical applications.

The alignment of dipoles can be well explained using dipole moment and correlation factor  $g$  calculated and discussed in the next section.

The variation in static dielectric constant for aqueous valine in the presence of varying concentrations of aceclofenac (ACF) is shown in the fig 2. It has been observed that the overall trend for the static dielectric constant measured at 0.002, 0.004, 0.006, 0.008 and 0.01 M concentrations of aceclofenac at different temperatures was found to be decreasing with increasing aceclofenac concentrations. The presence of aceclofenac in aqueous valine resulted in further decrease in the values of static dielectric constant and the variation was observed to be larger at 0.01 (M) concentration of aceclofenac. This variation in the values of static dielectric constant may be due to the molecular interaction between the methyl group ( $\text{CH}_3$ ) of the screened valine by the water molecules and the H from the O-H group of ACF through weak dipole-dipole interaction as a result hydrogen bonding network affected due to the presence of aceclofenac which resulted in lowering the values of static dielectric constant with increasing ACF concentration. But for the highest used concentration of ACF there found very rapid decrease in the values of static dielectric constant because at highest concentration all the possible hydrogen bonding sites are saturated and no site is available for bonding to be taking place; as a result there is no further change in the structural conformation which decrease the static dielectric constant over the used concentrations and temperature [23].

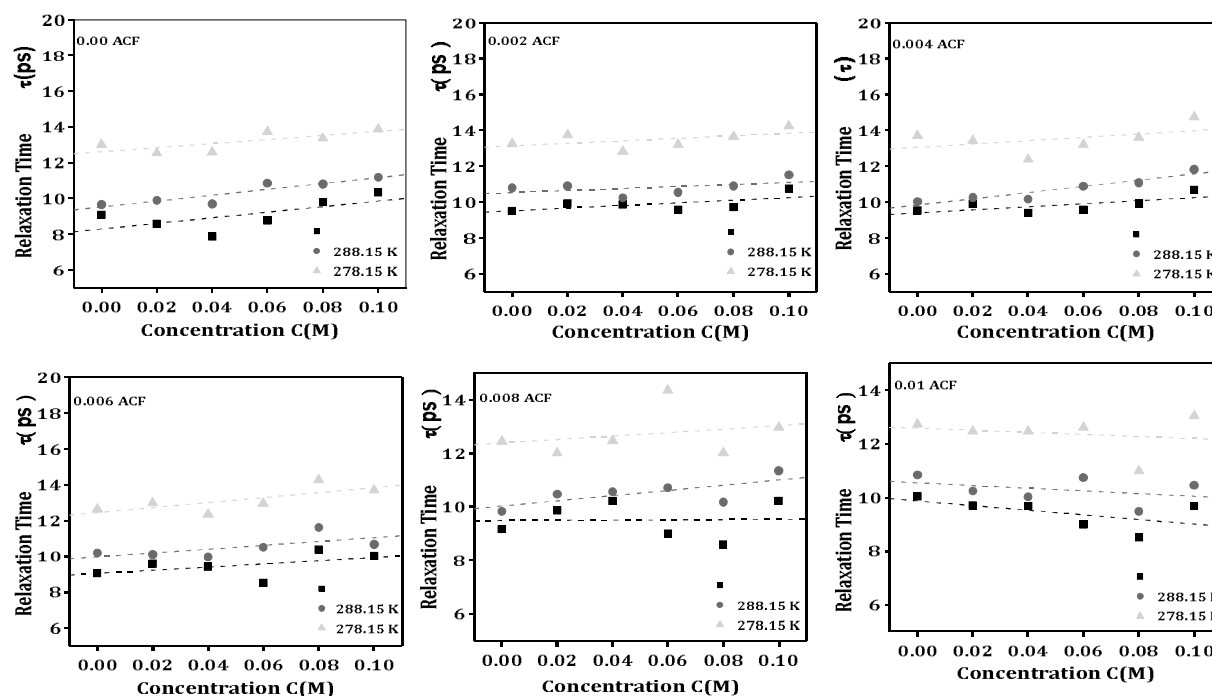


**Figure 2:** Temperature and concentration dependent static dielectric constant of aqueous valine in presence of different concentrations of aceclofenac.

Variation in static dielectric constant with different molar concentrations of ACF 0.002, 0.004, 0.006, 0.008 and 0.01 M in aqueous valine at different temperatures is shown in the fig 2. It has been observed that for all the used concentrations of aqueous valine the values of static dielectric constant increases for all the measured temperatures with increasing ACF except at higher ACF concentration while it was increasing towards lower temperatures over all the used concentrations of ACFs.

Increase in the values of static dielectric constant by lowering the temperature from 298.15 K to 278.15 K, may be due to increased dipole-dipole interaction (parallel or antiparallel) between valine-aceclofenac molecules via hydration shell and is associated with the cooperative relaxation of bulk-like water.

The relaxation dynamics for the rotational motion of water molecules in the solute environment are given by dielectric relaxation time measured for aqueous valine (fig. 3) and in the presence of aceclofenac. The relaxation time for aqueous valine increased linearly with valine concentration over all the measured temperatures, indicating a more heterogeneous / non-cooperative environment for water molecules that offers a large steric hindrance to the rotational motion of water molecules in the solvent rich (valine) and in the low temperature region.



**Figure 3:** Dielectric relaxation time measured for aqueous PVP in the presence of Ibuprofen at different concentration and temperature.

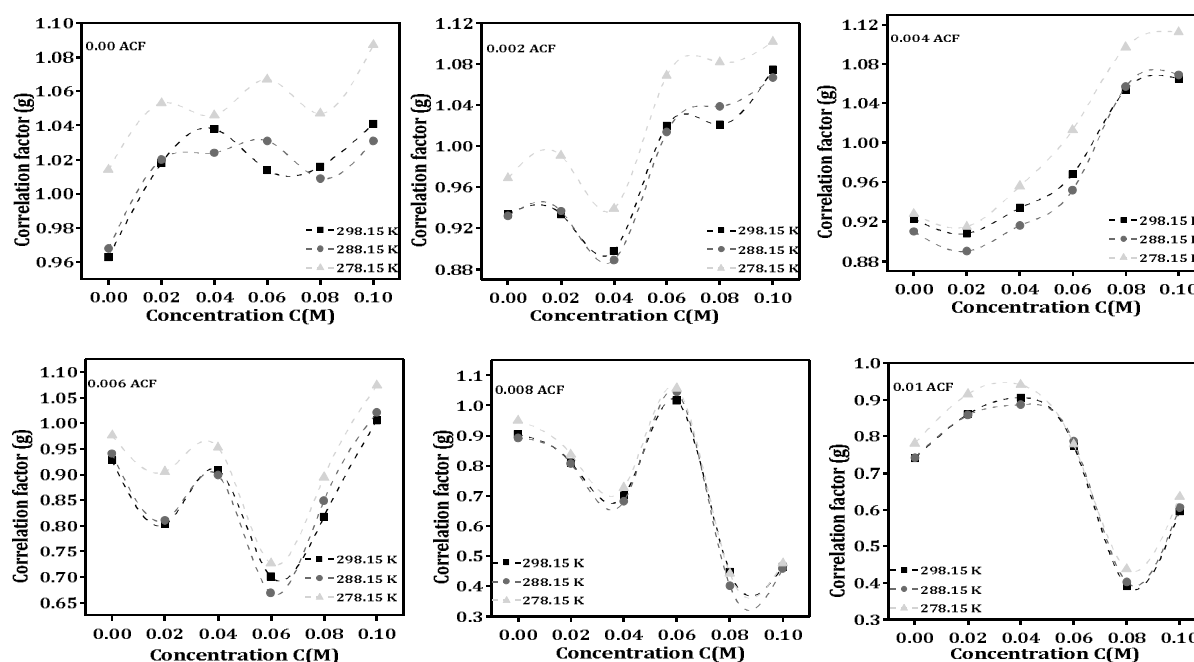
Relaxation time for the aqueous valine in presence of aceclofenac (ACF) at various valine concentrations is shown in the fig 3. For all the used ACF concentrations, it has been observed that relaxation time increases towards low temperature and with valine concentration except at higher concentrations of ACF. This could be due to the formation of a hydration shell surrounding valine, which interacts with ACF via the hydration shell, or to a dipole-dipole induced interaction between valine and ACF via water molecules. As a result, rotational motion of water molecules gets restricted that results in increasing the values of relaxation time [24]. Towards lower temperature dipole-dipole parallel alignments in the valine-ACF-water system gets increased that affected rotational motion of water molecules due to the increased molecular hindrance and so the relaxation time increases towards low temperature.

The information regarding orientation of electric dipoles in polar liquid is described by Kirkwood correlation factor ' $g$ '. The degree of intermolecular hydrogen bonding is measured by the deviation of the values of ' $g$ ' from unity. If ' $g$ ' is greater than 1 it means that molecules tend to direct themselves with parallel dipole moments; when  $g$  is smaller than 1 then molecules prefer an ordering with antiparallel dipole moments. ' $g$ ' = 1 may be due to the cancellation of the effects of both kinds of parallel and anti-parallel multimers for associating molecules [25-27]. Due to insufficient data available for the dipole moment at the measured temperature we used dipole moment for water  $\mu = 2.37$  D as calculated previously [28] to calculate the correlation factor ' $g$ ' from the measured  $g\mu^2$  calculated using Kirkwood-Frohlich equation [29-31].

$$g\mu^2 = \frac{9K_B T M}{4\pi N \rho} \left[ \frac{(\epsilon_s - \epsilon_\infty)(2\epsilon_s + \epsilon_\infty)}{\epsilon_s(\epsilon_\infty + 2)^2} \right] \quad (2)$$

Where  $K_B$  is the Boltzmann constant,  $T$  is absolute temperature,  $M$  is the molecular weight,  $N$  is Avogadro's number and  $\rho$  is the density.

Since ' $g$ ' is a measure of orientational correlation between a molecule and its nearest neighbors, the departure of ' $g$ ' from unity could be an indication of molecular association due to short-range ordering interactions. In our case of aqueous valine and ACF induced valine, correlation factors are increases towards higher PVP concentrations (due to the parallel orientation of the dipoles) [32] suggesting increased correlation between solute dipole via hydration shell. The variation in the values of ' $g$ ' with increasing ACF concentration in valine at different temperatures is shown in fig 4. From the observed data, it has been concluded that the correlation (Parallel orientation) between water and the surrounding molecules decreases by the presence of aceclofenac at higher concentrations of ACF. This could be due to the reduced parallel correlation between solutes and solvent. This may also be due to the fact that with increasing concentrations of both valine and ACF; number of water molecules attached to both the solutes under different conformations will be reduced [33]. These results suggest that as the concentration of ACF molecules is increased, parallel orientation of molecular dipole reduces, thereby reducing effective dipole moment. The ' $g$ ' values are found to be lower at higher concentration of ACF. In addition, it was also observed that temperature also plays important role in changing the effective dipole moment. The ' $g$ ' value was found to be increasing towards lower temperature which confirms the increased parallel dipole-dipole interaction due to the increased interaction between ACF, valine and water through hydration shell.



**Figure 4:** variation in correlation factor ' $g$ ' for aqueous valine and ACF induced valine.

The variation ' $g$ ' for the aqueous valine and ACF induced valine at different concentration and temperature is shown in fig 4 and the values of ' $g\mu^2$ ' and ' $g$ ' are reported in table 1.

**Table 1.** The values of ' $g\mu^2$ ' and ' $g$ ' for the solution of Valine+ACF+water.

| Valine(M)/T(K) | 298.15 | 288.15 | 278.15 | 298.15 | 288.15 | 278.15 |
|----------------|--------|--------|--------|--------|--------|--------|
|                | gμ2    |        |        | g      |        |        |
| ACF 0.00 (M)   |        |        |        |        |        |        |
| 0              | 5.414  | 5.44   | 5.697  | 0.963  | 0.968  | 1.014  |
| 0.02           | 5.722  | 5.731  | 5.917  | 1.018  | 1.02   | 1.053  |
| 0.04           | 5.834  | 5.752  | 5.879  | 1.038  | 1.024  | 1.046  |
| 0.06           | 5.699  | 5.794  | 5.994  | 1.014  | 1.031  | 1.067  |
| 0.08           | 5.709  | 5.671  | 5.885  | 1.016  | 1.009  | 1.047  |
| 0.1            | 5.851  | 5.796  | 6.107  | 1.041  | 1.031  | 1.087  |
| ACF 0.002 (M)  |        |        |        |        |        |        |
| 0              | 5.247  | 5.238  | 5.445  | 0.934  | 0.932  | 0.969  |
| 0.02           | 5.243  | 5.265  | 5.563  | 0.934  | 0.937  | 0.991  |
| 0.04           | 5.045  | 4.989  | 5.279  | 0.898  | 0.889  | 0.939  |
| 0.06           | 5.73   | 5.698  | 6.009  | 1.02   | 1.014  | 1.069  |
| 0.08           | 5.734  | 5.838  | 6.078  | 1.021  | 1.039  | 1.082  |
| 0.1            | 6.04   | 5.994  | 6.19   | 1.075  | 1.067  | 1.102  |
| ACF 0.004 (M)  |        |        |        |        |        |        |
| 0              | 5.189  | 5.115  | 5.213  | 0.923  | 0.91   | 0.928  |
| 0.02           | 5.101  | 5.001  | 5.14   | 0.908  | 0.89   | 0.915  |
| 0.04           | 5.242  | 5.149  | 5.375  | 0.934  | 0.916  | 0.956  |
| 0.06           | 5.439  | 5.348  | 5.691  | 0.968  | 0.952  | 1.013  |
| 0.08           | 5.922  | 5.941  | 6.163  | 1.054  | 1.057  | 1.097  |
| 0.1            | 5.982  | 6.009  | 6.241  | 1.065  | 1.069  | 1.112  |
| ACF 0.006 (M)  |        |        |        |        |        |        |
| 0              | 5.213  | 5.288  | 5.492  | 0.928  | 0.941  | 0.977  |
| 0.02           | 4.514  | 4.558  | 5.091  | 0.803  | 0.811  | 0.906  |
| 0.04           | 5.108  | 5.051  | 5.353  | 0.909  | 0.899  | 0.953  |
| 0.06           | 3.938  | 3.763  | 4.086  | 0.701  | 0.669  | 0.727  |
| 0.08           | 4.596  | 4.774  | 5.031  | 0.818  | 0.849  | 0.895  |
| 0.1            | 5.653  | 5.732  | 6.034  | 1.006  | 1.021  | 1.074  |
| ACF 0.008 (M)  |        |        |        |        |        |        |
| 0              | 5.074  | 5.007  | 5.326  | 0.903  | 0.891  | 0.948  |
| 0.02           | 4.553  | 4.533  | 4.705  | 0.81   | 0.807  | 0.837  |
| 0.04           | 3.938  | 3.834  | 4.084  | 0.701  | 0.682  | 0.727  |

|                     |       |       |       |       |       |       |
|---------------------|-------|-------|-------|-------|-------|-------|
| 0.06                | 5.707 | 5.866 | 5.935 | 1.016 | 1.045 | 1.056 |
| 0.08                | 2.52  | 2.254 | 2.484 | 0.448 | 0.401 | 0.442 |
| 0.1                 | 2.61  | 2.581 | 2.676 | 0.465 | 0.459 | 0.476 |
| <b>ACF 0.01 (M)</b> |       |       |       |       |       |       |
| 0                   | 4.16  | 4.172 | 4.387 | 0.741 | 0.742 | 0.781 |
| 0.02                | 4.833 | 4.821 | 5.149 | 0.861 | 0.858 | 0.916 |
| 0.04                | 5.089 | 4.983 | 5.285 | 0.906 | 0.887 | 0.941 |
| 0.06                | 4.357 | 4.421 | 4.375 | 0.775 | 0.787 | 0.778 |
| 0.08                | 2.194 | 2.262 | 2.461 | 0.391 | 0.402 | 0.438 |
| 0.1                 | 3.348 | 3.408 | 3.57  | 0.596 | 0.606 | 0.635 |

#### IV. CONCLUSIONS

From the overall study we may conclude that the static dielectric constant for aqueous valine increases with increasing valine concentration may be due to the formation of hydration shell around valine at all concentrations of ACF except at higher concentrations. During this process hydrogen bonding network will be affected by the presence of valine. Due to formation of hydration shell relaxation time for aqueous valine was found to be increasing with valine concentration over all the measured temperature that indicate more heterogeneous /non-cooperative environment for water molecules or we may say large steric hindrance to the rotational motion of water molecules in the solvent rich and low temperature region. From 298.15 K to 278.15 K static dielectric constant seems to be increasing for all the used concentrations may be due to the formation of induced dipoles via hydration layer with the neighbouring or surrounding molecules as the molecules gained lower thermal energy and therefore amplitude of the random thermal motion is restricted. This gives perfect alignment (parallel or antiparallel) with the applied field so that dipoles are more closely aligned with each other; as a result the orientation polarization gets increased and so the static dielectric constant.

The presence of aceclofenac in aqueous valine resulted in further decrease in the values of static dielectric constant and the variation was observed to be larger at higher ACF concentration. It is because of the molecular interaction between the methyl group ( $\text{CH}_3$ ) of the screened valine by the water molecules and the H from the O-H group of ACF through weak dipole-dipole interaction as a result hydrogen bonding network affected due to the presence of aceclofenac which resulted in lowering the values of static dielectric constant. At highest concentration all the possible hydrogen bonding sites are saturated and no site is available for bonding to be taking place; as a result there is no further change in the structural conformation which decrease the static dielectric constant over the used concentrations and temperature.

Increasing values of dielectric relaxation time with increasing valine concentration reveals non cooperative environment for the molecular or rotational motion for water molecules. This may be due to association

between water molecules that form hydration shell around valine that interacts with ACF through hydration shell or dipole-dipole induced interaction between valine and ACF through water. As a result rotational motion of water molecules gets restricted and observes only increased values of relaxation time.

For aqueous valine and ACF induced valine, correlation factors are lower than 1 (due to the anti-parallel orientation of the dipoles) and increases further towards higher valine concentrations suggesting increased correlation between solute dipole via hydration shell except at higher concentrations of ACF. This may also be due to the fact that with increasing concentrations of both valine and aceclofenac; number of water molecules attached to both the solutes under different conformations will be reduced. At higher ACF the  $g$  values are very much less than unity is the clear indication of highly aligned antiparallel conformation. The  $g$  value was found to be increasing towards lower temperature which confirms the formation of weak interaction between ACF, valine and water through hydration shell.

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## Synthesis, Characterisation of Ni-beta Zeolite

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### ABSTRACT

The coal fly ash is produced on large scale in India by the thermal power stations. In this paper, the modified zeolite beta synthesized using fly ash is used for studying the dielectric properties. The zeolite is modified by ion exchange process so as to form Ni-beta type zeolite. The samples were tested for dielectric constant ( $\epsilon'$ ), dielectric loss ( $\epsilon''$ ), electrical conductivity ( $\sigma_{ac}$ ). The dielectric properties depend upon the percentage of loading metal cations. This zeolite beta reported in this work helps to work as a material for dielectric applications.

**Keywords:** Coal fly ash, Zeolite beta, dielectric properties

### I. INTRODUCTION

Zeolites are crystalline aluminosilicates and they have many applications in industry which are well known. Synthesis of zeolites using coal burnt fly ash is a nice alternative to use this solid waste. As coal fly ash contains a large amount of silica and alumina, which is helpful in zeolite synthesis. Zeolites are synthesized by hydrothermal treatment in an alkaline solution [1]. Fly ash is a fine grained powder, which is mainly composed of spherical glassy particles, produced during the combustion of pulverized coal. Many researchers have been synthesized zeolite beta from solid waste [2]. Nowadays, a novel application of zeolite in electronics is necessary [3]. This paper reports the dielectric properties of zeolite Ni-beta synthesized from coal fly ash.

#### 1. Materials & Methods:

The starting material fly ash was obtained from Parali thermal power station, Maharashtra (India). The fly ash zeolite beta synthesized using fly ash based on previous study [4] is used. The zeolite beta thus formed is ion exchanged with 1 M solution of  $\text{NH}_4\text{NO}_3$  at  $80^\circ\text{C}$  for 12 h. This process was repeated thrice so as to get proper ion exchange. The product was filtered, air dried at  $60^\circ\text{C}$  for 24 hr and then calcined at  $450^\circ\text{C}$  so that the  $\text{NH}_4$ -beta is decomposed into H- beta i.e. protonic form then the zeolite which when ion exchanged with 0.1M, 0.2M and 0.3M solution of nickel nitrate  $[\text{Ni}(\text{NO}_3)_2 \cdot n\text{H}_2\text{O}]$ , so as to obtain the  $\text{Na}_{(1-x)}\text{Ni}_x$  beta zeolite where  $x = 0.1, 0.2, 0.3\text{M}$ .

### 1.1.Characterisation:

The physical properties of coal fly ash and synthesized products were measured as follows. The chemical composition fly ash was determined by using a X-ray Fluorescence Spectroscopy. The chemical composition was analyzed using X-ray fluorescence analysis equipment (Phillips PW - 2404).The sample phases were characterized by X-ray diffraction (XRD) using a (Philips PW 3710) diffractometer with Cu- K $\alpha$  radiation (1.5496Å).

### 2.2. Dielectric Measurement:

The samples of Na-beta and Ni- beta zeolite were compressed to form pellet of 10 mm diameter and 1 mm thickness. The pellets were heated to 300<sup>0</sup>C to obtain a hard solid sintered material. The pellets were polished with silver paste for good electrical contact. The electrical conductivity was measured in the frequency range 20Hz–1MHz at room temperature 25<sup>0</sup>C using LCR-meter (HP-4284A).

## 2. Results and discussion:

### 2.1.XRF

**Table1.** Chemical composition of fly ash

| Oxides                         | % wt   | Mol/100 g of fly ash |
|--------------------------------|--------|----------------------|
| SiO <sub>2</sub>               | 70.23% | 1.169                |
| Al <sub>2</sub> O <sub>3</sub> | 23.27% | 0.228                |
| Fe <sub>2</sub> O <sub>3</sub> | 4.38%  | 0.027                |
| MgO                            | 1.26%  | 0.031                |
| Na <sub>2</sub> O              | 0.42   | 0.0067               |
| LOI                            | 0.44%  | -                    |

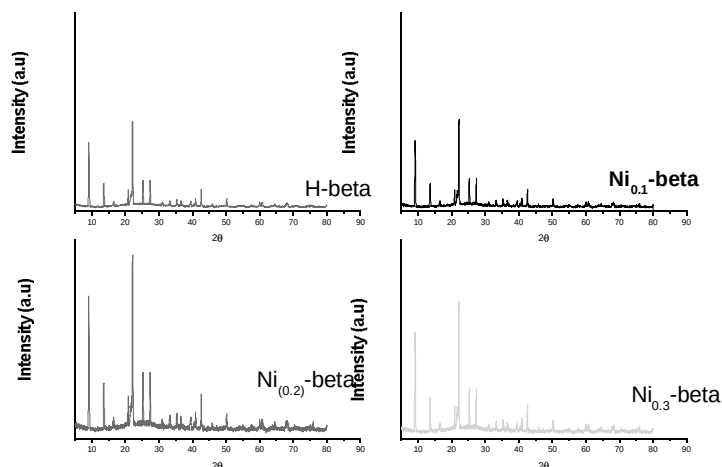
The elemental composition analysis by XRF in Table 1 indicated that coal fly ash contained large quantities of silica and alumina which are the two main components in zeolite. The chemical analysis of the fly ash used as the starting material in this work showed it to be a high-silica ash with the mole ratio of SiO<sub>2</sub>: Al<sub>2</sub>O<sub>3</sub> = 5.127: 1.

### 2.2. XRD

The X-ray diffraction pattern of fly ash based zeolite H– beta and its exchanged form Ni-beta is shown in fig.1. The d values are compared with the standard [5] . The powder X-ray diffraction(PXRD) pattern showed characteristic peaks of beta-type zeolite (Figure 1), indicating formation of microporous zeolite beta crystals.. The peaks at  $2\theta = 43.23^\circ$  is representative peak of a NiO [6]. As can be seen in Figure 1,

the intensity of peaks corresponding to H-beta zeolite decreased, whereas, the intensity of peaks corresponding to nickel increased on increasing the nickel doping on H-beta zeolite.

**Figure 1.** X-ray diffraction patterns of H-beta/Ni-beta zeolite.



The XRD for Ni-beta were found to be similar to that of original H-beta sample, indicating that there is no structural changes occur after ion exchange with nickel nitrate [7].

### 2.3. Dielectric Measurement:

The variation of dielectric constant ( $\epsilon'$ ), dielectric loss ( $\epsilon''$ ), ac conductivity ( $\sigma$ ) with  $\log f$  for H -beta and Ni-beta zeolites are shown in figure 2, 3, and 4. In Figure 2, the permittivity ( $\epsilon'$ ) of zeolite H-beta was found to decrease with an increase in frequency. This characteristic gives the increase of the permittivity at low frequency. The low dielectric constant of zeolites ( $\epsilon'$ ) suggests, however, that such processes in the zeolite channels should involve concerted action rather than strong charge separation.

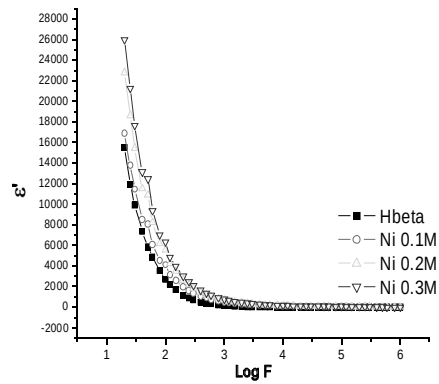


Figure 2. Variation of dielectric constant ( $\epsilon'$ ) with  $\log f$

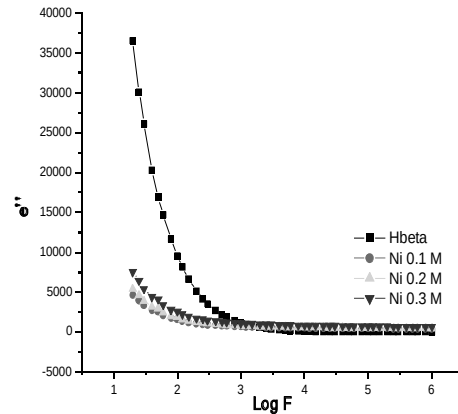


Fig.3 Variation of dielectric loss ( $\epsilon''$ ) with  $\log F$

In fig.3 the variation of dielectric loss ( $\epsilon''$ ) with frequency at room temperature is shown. This dielectric loss is frequency dependent and also influenced by water content of the zeolite [8]. The loss is in lowest frequency region and has been frequently observed in zeolites is supposed to be due to a dc ionic conductivity loss and grain boundary effect [9-10].

In fig. 4 the variation of ac conductivity ( $\sigma$ ) with frequency at room temperature is shown. The conductivity increases with increase in frequency. The conductivity of zeolite H-beta is less than Ni -beta, as the conductivity depends on the cation size and the channels within the zeolites structure.

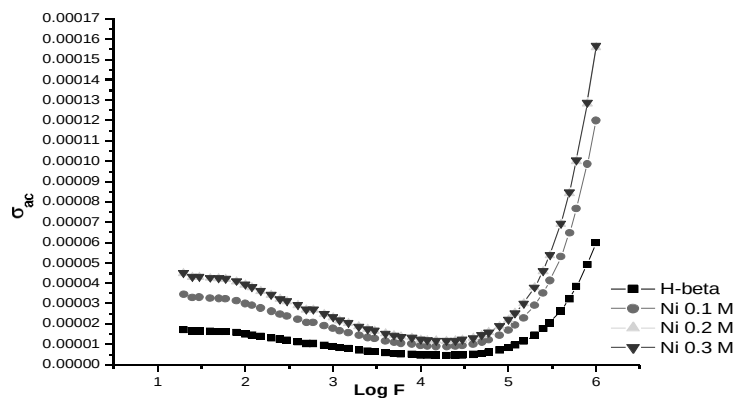


Fig.4 Variation of ac conductivity ( $\sigma_{ac}$ ) with  $\log F$

### 3. Conclusion:

Zeolite beta is successfully synthesized from solid waste material fly ash and it shows no structural change after modification with cobalt. The zeolite beta and Ni-beta shows good response for dielectric applications.

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## To Analyze Intermolecular Interactions among Hydrogen Bonded Liquids by using TDR and FTIR Spectroscopy

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### ABSTRACT

In the present investigation dielectric measurements have been carried out by making the use of TDR technique in the frequency span of 10 MHz-50 GHz at temperatures 0°C, 5°C, 10°C, 15°C, 20°C and 25°C respectively at 11 volume fractions of 1-PENT in ETOH. Excess properties like excess permittivity and excess inverse relaxation time have been explored using the calculated values of dielectric constant and relaxation time which have been reported in our earlier study, “Dielectric relaxation study of 1-Pentanol-Ethanol binary mixtures at 10 MHz-50 GHz frequency range using TDR technique”. The values of Bruggemann factor ( $F_B$ ) are calculated at all different aforesaid temperatures and compositions by making the use of least square fit method. Apart from all of these measurements FTIR measurements also been performed to scrutinize the intermolecular interactions in the binary mixture of liquids utilized for the present study.

**Keywords:** Time Domain Reflectometry (TDR); 1-Pentanol; Ethanol; Excess properties; Functional groups; FTIR.

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### I. INTRODUCTION

TDR is the authentic and dynamic approach for the study of structure of intermolecular interactions both in pure form and binary mixture of liquids, which allows the researchers in just one quantification for the broadband of frequencies [1, 2]. Dielectric measurements is a crucial tool for estimating intermolecular interactions which are due to dipole-dipole interactions which leads to succeeding molecular structural reposition in a binary mixture, and due to the existence of hydrogen bonds in the binary mixture the dielectric properties of the participating constituent liquids alters significantly [3-4]. Alcohols have allured much attentiveness amongst most of the researchers for the dielectric study due to its polarity, as

this polarity character individualize it from other no polar organic compounds this rationality polar character leads to association of alcohol molecules through the rather attraction of positive charge of hydrogen atom of one hydroxyl group with a correspondingly negative charge of oxygen atom of another hydroxyl group. Alcohols can be utilized in many ways, in chemical industries as solvents for oils, resins and antifreeze for explosive and in this way alcohol's participation is noteworthy in chemistry and biology, not only that it can also be employed to realize the associative behavior with multitude of internal structures that relies on carbon chain length and position of O-H group [5, 6]

An extensive analysis have been done to study dielectric properties of 1-alkanols with acrylate group [7]. Recently our research group have given the qualitative data regarding the study of dielectric properties by making the use of medicinal compounds [8-9]. The workers studied the dielectric properties extensively [10]. The study revealed the increase in dipole moments and formation of dimers in the binary mixture [11]. The study has been carried out to study the dielectric properties of amines [12]. The study yields an info in to the structural changes [13].

Fourier transform infrared spectroscopy (FTIR) is the dominant approach for the characterization of samples which are in solid, liquid and gas phase [14]. It is only the IR active molecules which absorbs the IR light if there is change in dipole moment during the course of vibrations [15], and ethanol and 1-pentanol are polar and IR active as both of them possess permanent dipole moment and hence yields absorbance spectra. Sivgurunathan et.al

have studied the comparison between FTIR spectra of O-H and C=O regions between 1-alkanols and alkyl methacrylate [16]. Conduction of study affirmed the ontic of NH<sub>2</sub>, CH and C=O stretches in formamide, and dimethyl amino ethanol, both in pure form and in binary mixture [17].

The literature survey have shown that there is not too much work have been done yet for the dielectric study of 1-PENT-ETOH binary system and there is no FTIR study have been performed for the aforesaid system, so the main goal of present investigation is to study intermolecular interactions via excess permittivity ( $\epsilon^E$ ), Bruggemann factor and dipolar rotations through excess inverse relaxation time and also with the aid of FTIR spectroscopy to study the existence of intermolecular hydrogen bonding in polar groups both in pure form and binary mixture of participating liquids.

## 2. Experimental details

**2.1 Chemicals:-** The chemicals utilized for the present investigation was obtained from EMD Millipore Corporation Germany grade having 99% purity so was used without further purification.

### 2.2 Methodology- Dielectric study

Samples were prepared by mixing the volume fractions of 1-Pentanol in ethanol in the range of 0% to 100%, and measurements were taken by placing the sample in electronically temperature controlled bath with an accuracy of  $\pm 0.1^\circ\text{C}$  at temperatures  $0^\circ\text{C}$ - $25^\circ\text{C}$ . The Tektronix DSA8300 sampling main frame oscilloscope sampling with the dual-channel sampling module 80E10B has been used for time domain reflectometry. The sampling module is well equipped with 12 ps incident and 15 ps reflected rise time pulse. The coaxial cable which has been utilized to feed pulse has 50 ohm impedance, inner diameter



of 0.28 mm and outer diameter of 1.19 mm. Sampling oscilloscope monitor changes in pulse after reflection from the end of line. Reflected pulse without sample  $R_1(t)$  and with sample  $R_x(t)$  was recorded in time window of 5 ns and digitized in 2000 points. The addition [ $q(t) = R_1(t) + R_x(t)$ ] and subtraction [ $p(t) = R_1(t) - R_x(t)$ ] of these pulses is done in oscilloscope memory. These subtracted and added pulses are transferred to PC for further analysis. The Fourier transformations of the pulse and data analysis were done to determine complex permittivity spectra  $\epsilon^*(\omega)$  using non-linear least square fit method which have been reported in our earlier study [18].

### 2.3 FTIR measurements:-

To study the FTIR spectra for 1-PENT and ETOH both in pure form and the binary mixture of the same Bruker spectrometer have been utilized in the frequency span of 500-4000  $\text{cm}^{-1}$  at room temperature.

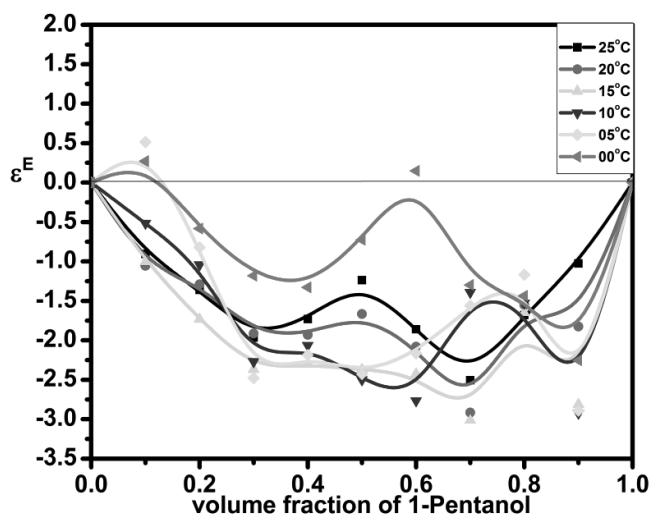
## 3 Results and discussion

### Excess permittivity

The values of excess permittivity have been figured out using the equation [19]

$$(\epsilon_0)^E = (\epsilon_0)_m - [(\epsilon_0)_E X_E + (\epsilon_0)_A (1 - X_E)] \quad (1)$$

Where  $X_E$  represents the volume fraction of an ethanol. Subscripts m, E and A represent Mixture, ethanol and solute 1-pentanol respectively.



**Figure 1. Excess permittivity  $(\epsilon_0)^E$  vs. volume fraction of Ethanol at various temperatures**

The crucial data regarding the interactions among the polar-polar binary liquid mixtures can be figured out by utilizing excess permittivity  $(\epsilon^E)$  [20], which can be summarized as follows.

- (i)  $(\epsilon)^E=0$  means no interactions among participating liquids
- (ii)  $(\epsilon)^E<0$  designates interaction in such way as to lead reduction in effective dipole moments.
- (iii)  $(\epsilon)^E>0$  interactions contribute to increase in dipole moments.

An alterations in the values of Excess properties are as shown in fig (1). the positive values of excess dielectric constant corroborates the formation of monomers contrarily the negative values formation of multimers designating the interaction of molecules in such a way that the effective dipoles gets reduced. The figure reflects all the values of excess permittivity negative at all temperatures and for all concentrations of 1-PENT in ETOH ,this can be attributed to the breaking of hydrogen bonds among solute and solvent molecules with subsequent emergence of multimeric structures ,which stipulates reduction in dipole moments due to alignment of adjacent dipoles in opposite directions.

These results are in conformity with those obtained. by researchers [21] except at 0.70 mole fraction

#### Excess inverse relaxation time:-

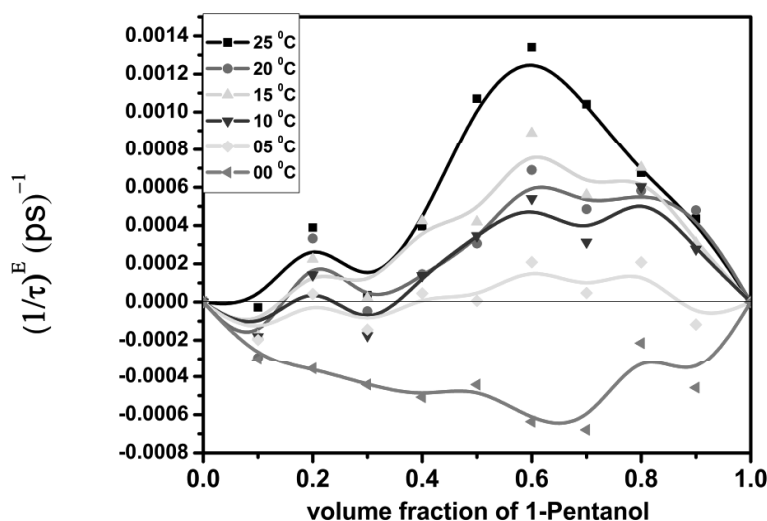
The excess inverse relaxation time was found out using the relation

$$\left(\frac{1}{\tau}\right)^E = \left(\frac{1}{\tau}\right)_m - \left[\left(\frac{1}{\tau}\right)_A X_A + \left(\frac{1}{\tau}\right)_B X_B\right] \quad (2)$$

Where  $\left(\frac{1}{\tau}\right)^E$  is the excess inverse relaxation time which represents the average broadening of dielectric spectra [22].

The significant data regarding the rotation of dipoles by using this property is as follows [23]

- (i)  $(1/\tau)^E=0$  designates no solute-solvent interaction
- (ii)  $(1/\tau)^E<0$  solute-solvent interactions in such way that dipoles rotates slowly under the effect of field of hindrance.
- (iii)  $(1/\tau)^E>0$  gives speedy rotation of dipole.



**Figure 2.Excess inverse Relaxation time  $(1/\tau)^E$  vs volume fraction of 1-Pentanol at various temperatures**

The fig. (2) depicts the calculated values of excess inverse relaxation time for all the concentrations of 1-PENT in ETOH at temperatures 0 °C- 25°C. The fig reflects all the values positive at temperatures 5°C-

-25°C for all concentrations with conspicuous maxima at 60% of  $\left(\frac{1}{\tau}\right)^E$  1-PENT at 25°C, these positive values stipulates the solute –solvent interactions via hydrogen bonding in such a manner which leads to faster rotation of dipoles. The fig also shows the negative trend for  $\left(\frac{1}{\tau}\right)^E$  values at temperature 0 °C which can be attributed to creation of field of hindrance which leads to slow rotation of dipole moments. These results are different from the results obtained for the same system [24].

### Bruggeman factor ( $F_B$ )

The Bruggeman factor ( $F_B$ ) is an additional parameter which gives an informative approach towards intermolecular interactions and which is dependent on dielectric permittivities of solute, solvent, and their binary mixture can be expressed as [25]

$$f_B = \left[ \frac{(\epsilon_{0m} - \epsilon_{02})}{(\epsilon_{01} - \epsilon_{02})} \right] \left( \frac{\epsilon_{01}}{\epsilon_{0m}} \right)^{\frac{1}{3}} = 1 - v \quad (3)$$

Where  $\epsilon_{0m}, \epsilon_{01}, \epsilon_{02}$  are the static dielectric constants corresponding to mixture solute and solvent respectively.  $V$  is the volume fraction of solvent (ethanol). From above equation linear relation is expected from plot  $F_B$  versus volume fraction of ethanol. But in binary liquids, there is a nonlinear relationship. The nonlinearity of Bruggeman factor vs. volume fraction of solvent can be expressed by [26].

$$f_B = \left[ \frac{(\epsilon_{0m} - \epsilon_{02})}{(\epsilon_{01} - \epsilon_{02})} \right] \left( \frac{\epsilon_{01}}{\epsilon_{0m}} \right)^{\frac{1}{3}} = 1 - [a - (a - 1)V]V \quad (4)$$

In this equation volume fraction ( $V$ ) is changed by a factor ' $a - (a - 1)V$ ' of the mixture which can be ascribed to the solutes molecular structural readjustment within the mixture [27] and molecular ideal behavior can be resolved by random constant ' $a$ ' where  $a=1$  points out Ideal mixture with no additional interaction between two liquids and reduces to Bruggeman equation. ' $a$ ' has been found out by least square fit method.

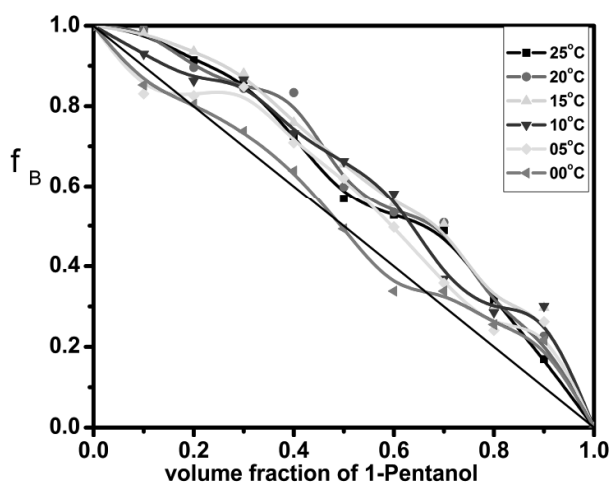


Figure 3. Nonlinearity of Bruggemann factor at various temperatures

The experimental values of 'a' are found to be 0.45, 0.28, 0.22, 0.37, 0.57, and 0.92, at temperatures 25 °C, 20 °C, 15 °C, 10 °C, 5 °C, and 0 °C respectively. The nonlinearity of plot  $F_B$  vs. volume fraction of 1-pentanol provides an evidence of intermolecular interactions through the hydrogen bonding among the hydroxyl groups of both the liquids and all obtained values of 'a' are less than unity designates reduction in effective volume of solvent than its actual volume [28].

#### FTIR analysis:-

FTIR is the significant approach which yields a precise data regarding the identification of functional groups at precise frequency and intermolecular Hydrogen bonding. The FTIR measurements were made for pure alcohols and their binary mixtures, and it is observed that the FTIR spectra shown in figure 4(a) and 4(b) for 1-Pentanol and ethanol in pure form is in conformity with spectra reported in literature for the same [29].

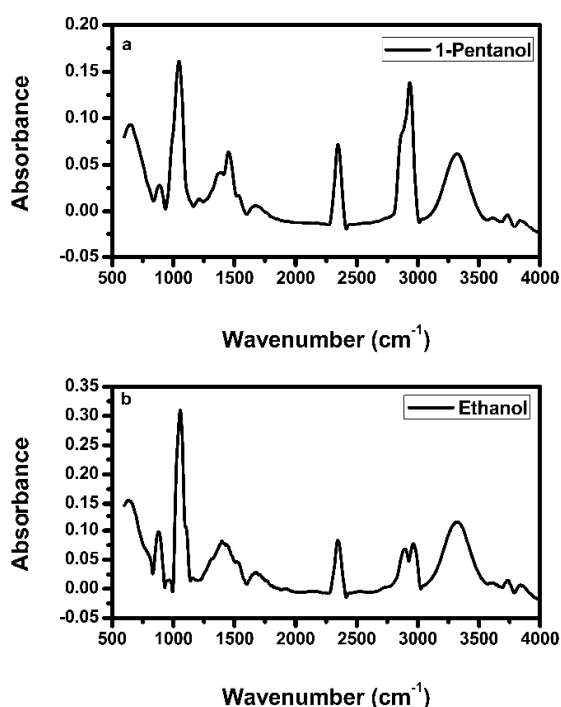
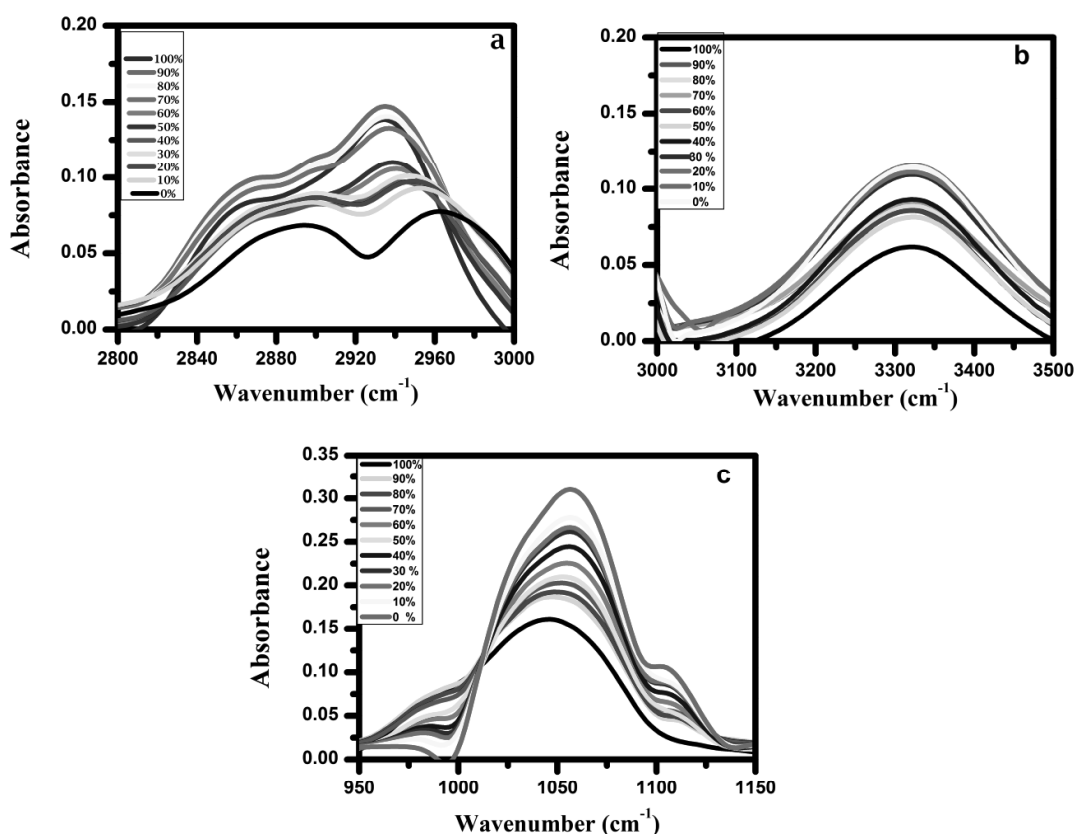


Figure 4. FTIR Spectra in pure form (a)1-Pentanol (b) Ethanol

The absorbance bands at particular frequencies appeared for 1-PENT and ETOH and their binaries can be attributed to OH, C-H and, C-O bands which are in well agreement with literature values for the pure form of liquids. [30-31].



**Figure 5-FTIR absorbance peaks for the identification of functional groups [a]CH [b] OH [c] CO**

The fig.5 (a) shows sharp bands for asymmetric stretch at 2928.59 and 2972 cm<sup>-1</sup> and that for symmetric stretch at 2865.25, and 2881.58 cm<sup>-1</sup> respectively for 1-PENT and ETOH, the upsurge in band frequencies can be ascribed to weak intermolecular interactions in the binaries [32]. The bands for 1-PENT are more intense than ETOH as it consists of more C-H groups in comparison with ETOH. Fig. 5(b) exhibits broad bands at 3322.48 and 3325.58 cm<sup>-1</sup> for 1-PENT and ETOH and there is a shifting of band frequencies for all concentrations of 1-PENT in ETOH which stipulates the self associative character of 1-PENT [33]. The electro negativity difference between C and O assigns a polarity character to C-O bonds which in turn assign the large dipole moment, and due to change in dipole moment during

bond vibrations the peaks are more intense for primary alcohols and their mixture. The C-O stretch for 1-PENT and ETOH which is shown in fig. 5(c) is at 1049 and 1044 and 1044 cm<sup>-1</sup> and there is a decline in C-O stretch frequency from 40% of 1-Pentanol to ethanol in pure form. This shift in frequency is the

sign of disruption of dipole-dipole interactions among the similar species followed by dipole-dipole interactions among unlike species. The table (1) reflects all the wave numbers assigned to the functional groups of liquids utilized before mixing and after mixing.

**Table 1-FTIR data for functional group wave numbers.**

| Volume fraction of 1-Pentanol | Functional groups wave numbers (cm <sup>-1</sup> ) |         |         |
|-------------------------------|----------------------------------------------------|---------|---------|
|                               | CH                                                 | OH      | C-O     |
| 0.0                           | 2928.59                                            | 3325.58 | 1044.00 |
| 0.1                           | 2970.22                                            | 3323.44 | 1045.73 |
| 0.2                           | 2971.02                                            | 3322.29 | 1046.38 |
| 0.3                           | 2970.29                                            | 3325.35 | 1046.69 |
| 0.4                           | 2964.50                                            | 3325.65 | 1047.25 |
| 0.5                           | 2959.90                                            | 3327.31 | 1047.83 |
| 0.6                           | 2959.91                                            | 3324.83 | 1048.10 |
| 0.7                           | 2957.98                                            | 3325.79 | 1049.95 |
| 0.8                           | 2957.52                                            | 3324.91 | 1051.09 |
| 0.9                           | 2957.19                                            | 3325.74 | 1052.02 |
| 10                            | 2972                                               | 3322.48 | 1049.00 |

#### 4. Conclusion:

The positive value of excess permittivity indicates the formation of monomers while the negative value points out the formation of multimetric structures in the binary mixture.

The trend of positive excess inverse relaxation time values suggest the slow rotation of dipoles on one hand, negative trend of this values leads to the slow rotation of the same. nonlinear plot of ( $F_B$ ) versus volume fraction of solute in solvent reflects the existence of intermolecular interactions in the mixture and the values of 'a' are found out at all the temperatures ,all are found to deviate from the ideality  $a=1$ . The wave number shifting for Absorbance peaks of functional groups CH ,OH ,and C-O have been studied for the binary mixture of 1-pentanol in ethanol for all concentrations at room temperature which stipulates there is weak molecular interactions according to the shifting of peaks wave numbers to higher side ,and the spectra's and the wave numbers of peaks reported for the systems in pure form are in well conformity with that reported in literature.

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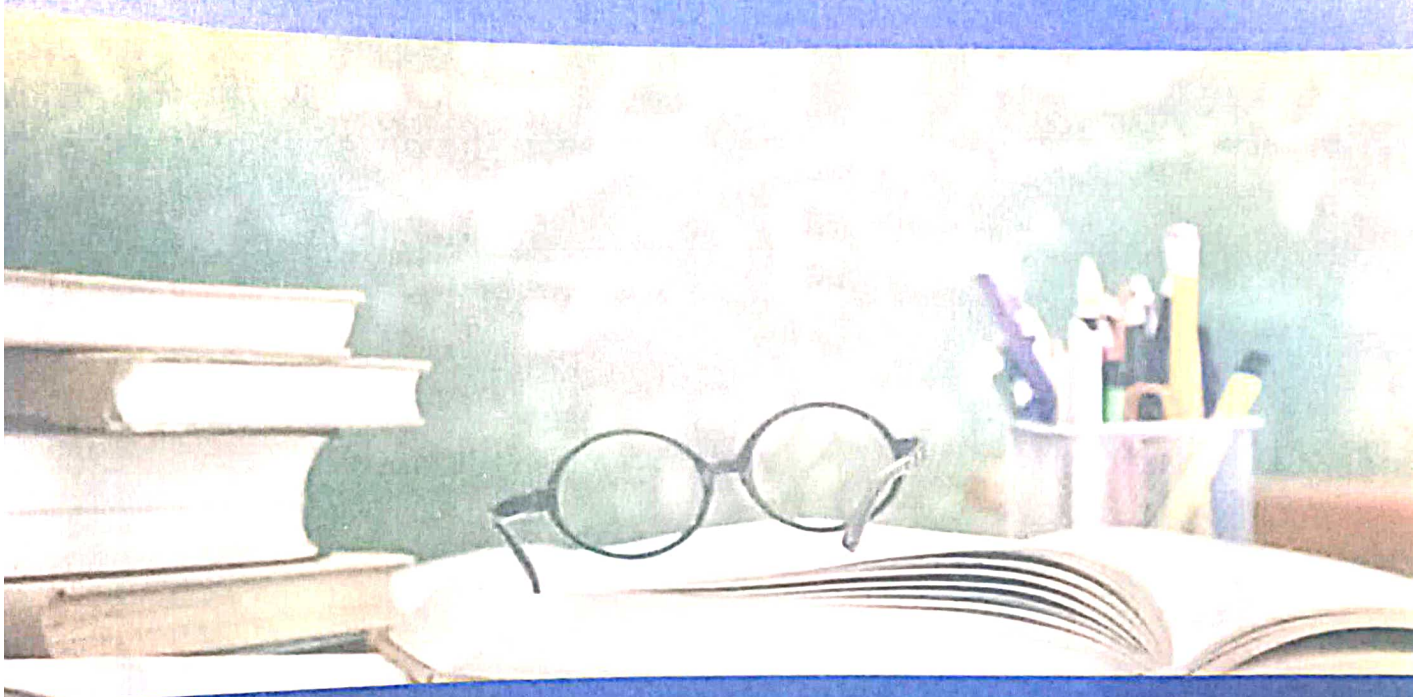
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## **Gustad Multiculturalism in Rohinton Mysterles Such a Long Journey**

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The present paper deals with aspect of multiculturalism reflected in rohinton mysteries such a long journey. The present paper Deals with various aspect of multiculturalism as Hybridity, identity, diaspora etc. the writer try to revealed his attempt to present multiculturalism in India free caste, creed , religion etc. The term multiculturalism what's first used in 1957 in Switzerland with reference to mingling of Various cultures in that country. It refers to respect for other different culture. It tolerate we of life of people belong to different caste, creed, religion etc. It is a outcome of social political and religious movement. The 20<sup>th</sup> century saw immigrants from all the parts of the world including India also rohinton mystery in such a long journey presented Canada in paradoxical way. Canada heads multicultural society especially society with mixing of English and French culture. Immigrant Indian writers faced difficulty to reveal their thoughts. They stranded between two major flow off two cultures cultures. The novel focuses on the life of gustad Noble and his family lives in Kodadad. Gustad belongs to parsi community who strictly maintained it's religious and an Cultural identity. How they maintained Separate identity. Though there is particular description writer emphasizes on universal experience. Readers in Canada can identify themselves with the characters though these characters how different socio cultural identity Though these characters have different religious beliefs , different habits and language,. Their beats same heart in all of them.

Though born and brought up in Parsi community he respects belief and traditions of other religion as Hindu, Christian and Islam. He had friends from different religion and cultural background. He has a Muslim friend Ghulam Muhammad and a Christian friend Malcolm. Under the influence of his friends gustad begins to change his habit of eating.



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## 10. Colonial Perspectives in Robinson Crusoe

**Dr. Shehjad Sidhiquii Mohd. Vikaroddin**

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### Abstract

The study focuses on postcolonial identity in Daniel Defoe's Robinson Crusoe. It aims to reveal the problematic of postcolonial identity, including colonialist ideology in the work. This study applies postcolonial criticism, and in conducting the research, the researchers apply descriptive qualitative method. The study results in the language in which colonialist thinking is expressed based on the colonizers' assumption of their own superiority, which they contrast with the alleged inferiority of native peoples, the original inhabitants of the lands they invaded.

**Keywords:** Postcolonial Identity, Colonialist Ideology, Superiority, Inferiority.

### Introduction

Despite many critics draw examples from the literary works of African Americans as well as from literature of other former population (Tyson, 1999), the tendency of postcolonial criticism to focus on global issues, on comparisons and contrasts among various peoples, means that it is up to the individual members of specific populations to develop their own body of criticism on the history, traditions, and interpretations of their own literature (Tyson, 1999). Henceforth, Nordlund's states that the third world postcolonial writers prioritize social and cultural selfhood issues (Nordlund, 2010).

To enhance, Nordlund states that Defoe's polarized treatment of selfishness and unselfishness in Robinson Crusoe is a fictional response to two interconnected problems with personal autonomy: the extrinsic problem is dependent on other people, and the intrinsic. This Study applies postcolonial criticism. As a primary concern of theoretical framework, postcolonial criticism seeks to understand the operations politically, socially, culturally, and psychologically of colonialist and anti-colonialist ideologies. A good deal of postcolonial criticism analyzes the ideological forces that, on the one hand, pressed the colonized to internalize the colonizers' values and in contrast, promoted the resistance of colonized peoples against their oppression, a resistance that is as old as colonialism itself. Since colonialist and





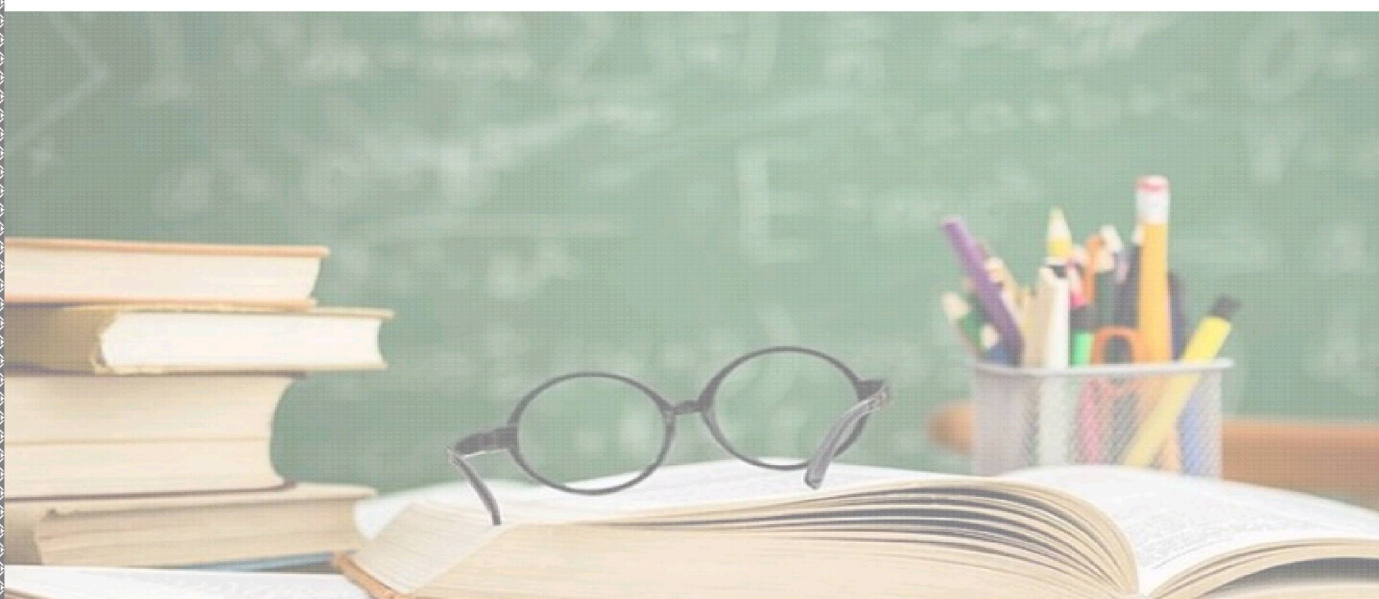
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## Identity Crisis in Arun Joshi's 'The Foreigner'

**Dr. Shehjad Siddiqui Mohd Vikaroddin**

Asst. Professor, Department of English,  
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Arun Joshi became a famous Indian novelist with the publication of his first novel *The Foreigner*. The novel deals with the protagonist Sindhi Oberoi's journey from his detachment to involvement. Arun Joshi depicts the inner conflict between him and detachment. He depicts the loneliness and rootlessness of the protagonist Sindhi. His life is an account of his search for his roots. He is a bond foreigner with no Nation, for he is born in Kenya of a skeptical Indian father and an English mother. When he was of 4 years old his parents died in an air crash. After the death of their parents, he becomes lonely. His uncle provided him with emotional support but he also so died and once again he became lonely in this world.

"Whenever he is teacher says every foreign student is valuable for them. He would ask the question which country to I belong whether Kenya England or India?"<sup>1</sup>(*The Foreigner*.p.17) . He thinks himself approved young man living in latter 20th century, who had become the cat from everything except himself. He explains his son as a foreigner further but he never feels foreigner under the protection of his uncle in Nairobi

"I hadn't failed like that when my uncle was leaving it wasn't that I loved my uncle very much but anything a matter of fact we really exchange letters but the thought that he moved about in that house on the outskirts of Nairobi gives me a feeling of an anchor."<sup>2</sup>(*The Foreigner*. p 17) in search of his roots Sindhi keeps on changing places. He moves from Nairobi to London to Boston and then finally to Delhi. He joins London University to study engineering but the University lecturers not able to help him for find out his roots so he become fed up with them. He wants to find out





meaning of his life therefore he says I wanted to find to know meaning of life. And my classroom didn't tell me I think about it.

Sindhi leaves for Boston to take PhD in engineering. Here he took experience of rootlessness and loneliness. The crisis of Identity in the foreign took at the psychological level he get treatment of foreigner by American students at international student Association "It was intended to bring a foreigner in contact with Americans but all it achieved with animosity, everybody ended with hitting Americans all the more .I don't know why it happened."3 (The Foreigner.p16)

Sindi also feels pain of aligned. He says born and Indian I had been spat upon, had I been a European, I would have done spitting. What difference does it make? he feels greatly miserable when people used to ask about his parents. For he repeatedly told about the accident of his parents sindhi's living with his uncle in Kenya and further study in England and America took him away from his roots crisis of Identity wrist in his soul he feels foreigner in Kenya in England in Boston and in Delhi.

There is something strange about you know something distant I would give that when people are with you they don't feel like they are human beings maybe design Indian characteristics but I have a feeling you would be a foreigner anywhere.

. " In New Delhi also he feels foreigner shell are Tales in frankly you are still a foreigner you don't belong here"4 (The Foreigner.p.21). When Babu in America accused him of his ignorance of Hindu family in that he was a perfect example of an Indian who pretend to be a foreigner and behaved as one *Even Sindhi hesitates scene calling himself a Hindu. Sindhi in difference to the world eroj in him*5(Arun Joshi's Fiction p.80.) *the feeling of loneliness* She is so detached that he thinks nothing real to him all else is an illusion life is a journey from word to death through the dark parts of illusion at last date is the extreme point where everything that belongs to the World must end only in the novel in our one of him pads giant parties loan beauty things over his own loneliness.

Between her and me the Chasma of the living world prevail I had a feeling that I was watching her from the age of the world just dead Kingdom begin During a ball dance at



the reception center of the international students Association in Boston Sindhi fields. "it is A Remarkable how you can be in a crowded room like that and still feels lonely like you were sitting in your own Tom."6 (A History of Indian English literature.p230) It is from Scotland that's in the goods to Boston to study engineering at MIT it is here that he comes in contact with June bleach whom Babu Khemka also loves letter on his arrival in poster even his love for June Blit is colored with hatred and anger he is a fed up with the randomness of existence and does not accept the offer of a job at the MIT he feels of nowhere so he could not be stable at any country and he wants to go back to Nigeria or India which also is decided by the flip of a coin Hate for Nigeria I said coin show details New Delhi.

It is this we change is the course of his life and he comes first to New Delhi the land from where is for fathers had settled in Kenya he never feels at home during his stay either in the UK or us at Boston the episode with June believe it is also marked by her feeling of Emptiness all the time after Babu reach Boston June is a closed him because in the does not find himself cut out for marriage June separation from him with makes him realize that she had become a part of him his professor found him last and that Sindhi was offered a teaching assignment on the faculty he did not accept if and shift to the New York for an assignment where he developed with his team in his inner crisis in define the fast Haunting him like a Ghost

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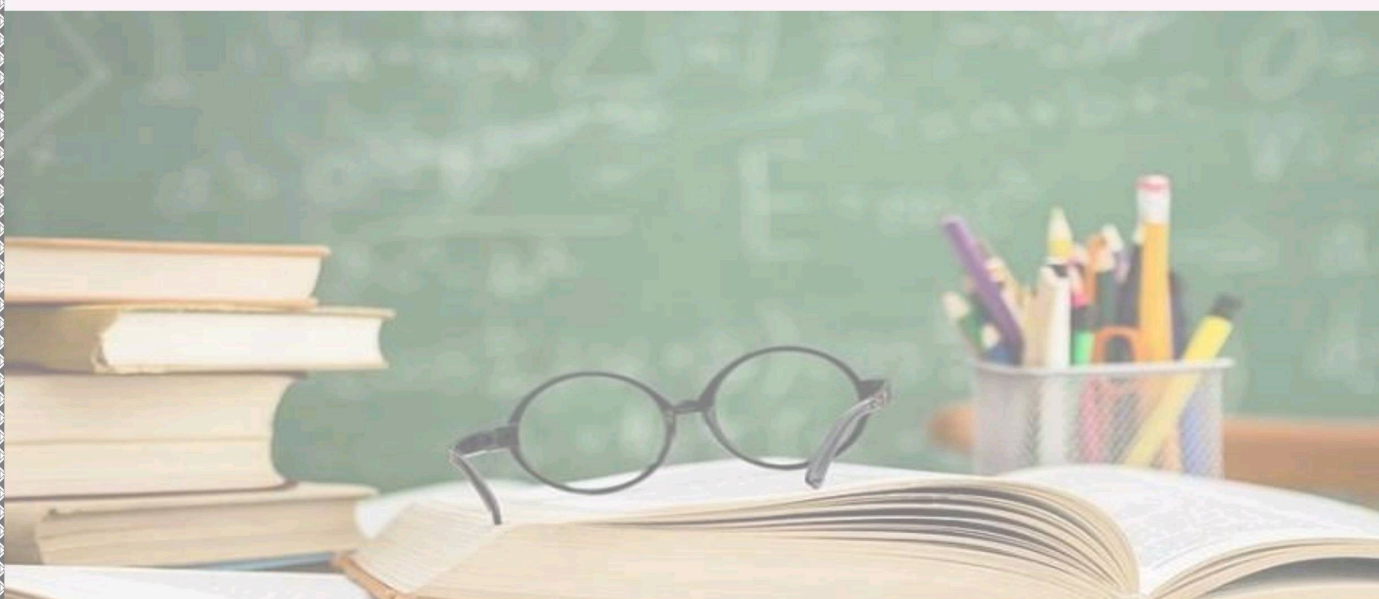
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## ENGLISH LANGUAGE AND ITS JOURNEY IN INDIA

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### **INTRODUCTION**

English Language in India is a lot more than just an official language. It has been the language of diplomacy, higher administration, higher education, superior judiciary and information technology. Besides, English is a language of opportunities and success for life in India. As was noted by the Education Commission of India in 1966, “when a degree holder from India goes to any of the developed countries he is not treated at par with a degree holder of that country” (1). This shows the poor pattern of Indian Educational System which has no great implication on the matter of English language. Moreover, most of our system of curriculum doesn’t make the learning of English mandatory. Hence the reluctance about learning or teaching of English language is seen as an inherent quality of Indian Educational System.

To eliminate this obstacle of academic growth, our ELT pattern has to be evaluated so as its outcome on curriculum. In this following analysis, we could know about how the Indian ELT has been across the nation and how its impacted the quality of education (2). India’s Status on English Language It was Lord Macaulay in 1835, who was the first to emphasis English language teaching in India through his “Minute of Education”. He imported English on Indians way back in 1835, and had little the how deeply entrenched its roots would become in a country that prided itself in Tamil and Sanskrit, the classical languages of the world (3).

In 1854, Sir Charles Wood Stated that English could be a suitable medium of higher levels of education, because a sound knowledge of English was a prerequisite to seek admission into any established university. But on contrary, grass root land response to English language was very pitiable as no one turned their heads towards learning English. English language was adopted as the medium of instruction for fundamental sciences and mathematic science, which resulted in the phenomenal development of secondary and higher education, especially in urban areas. Since from our Independence,



the need for English was greatly realised in the field of higher education and research. In this regard, the Kothari Commission referred to the study of English in India a report of study group appointed by the ministry of education, Government of India in 1964. The study group has supported the structural approach to the teaching of English, which is now extensively practiced in different parts of India. The study group also came up with a detailed syllabus for the study of the English language from class V to XII. Today, in this nation of billion plus population with a literate population of 74% in 2011, knowledge of English guarantees a job across the sectors. Be it a hairdresser, a bell boy or a waiter, salutations and courtesies in English are considered so essential that often a minimum skill in the language is non-negotiable with recruiters (4).

In case of ELT, effective learning takes place on when the learner is able to communicate fluently both in writing and speaking and able to use English for library purposes. Therefore, the promotion of ELT in India in modern times has an impeccable demand and gives a great deal of transformation from the odd ELT approaches. Approaches of English Language Teaching in India Indian practise on ELT has been a multi-purpose teaching approach. It differs on the basis of various purposes to learn English language. In that way, there has been three fundamental pattern/approaches of ELT in India, namely *f* English for Academic Purpose(EAP) *f* English for Occupational purpose(EOP) *f* English for Specific Purpose(ESP) Firstly, EAP refers to the teaching of English language in primary, secondary and common graduate level educational institutions. This approach aims to built-up the students to be aware of basics of English, and encourages the students to have general thought about the basic grammar, pronunciation and the use of English for common purpose.

Secondly, EOP refers to the teaching of English language for professional purpose which in practical requires a basic insight about the concerned profession and its relevance with use of English. The approach of ELT has been a great task for the tutors to educate the beneficiaries as it requires specialized knowledge about the particular occupational jargons. Thirdly, ESP refers to the teaching of English language for specific need in which the intention of the learners is restricted within the particular use. ESP advocates the designing of special courses instead of one multi-purpose course, to suit the needs of different courses of students. The concept of ESP is said to be





particularly adequate for teaching English to students of science and technology (EST). Moreover, English at the undergraduate level of engineering studies differs from English in other undergraduate courses because it has a specific purpose unlike a general purpose in other colleges. It differs from other courses in the three aspects, such as relevance, register and style (5). These three aspects gain supremacy in material designing because the course must engage the students for both academic and professional purposes. Their academic functions include oral and written communication, comprehension of lectures and books, note-making, note-taking, paper presentations, participation in regional, national and international seminars and taking interviews.

Officially English has a status of assistant language, but in fact it is the most important language of India. After Hindi it is the most commonly spoken language in India and probably the most read and written language in India. Indians who know English will always try to show that they know English. English symbolizes in Indians minds, better education, better culture and higher intellect. Indians who know English often mingle it with Indian languages in their conversations. It is also usual among Indians to abruptly move to speak fluent English in the middle of their conversations. English also serves as the communicator among Indians who speak different language. English is very important in some systems – legal, financial, educational, business – in India.

Until the beginning of 1990s, foreign movies in India weren't translated or dubbed in Indian languages, but were broadcast in English and were meant for English speakers only. The reason Indians give such importance to English is related to the fact that India was a British colony. When the British started ruling India, they searched for Indian mediators who could help them to administer India. The British turned to high caste Indians to work for them. Many high caste Indians, especially the Brahmans worked for them. The British policy was to create an Indian class who should think like the British, or as it was said then in Britain "Indians in blood and colour but English in taste, in opinions and morals and intellect". The British also established in India universities based on British models with emphasis on English. These Indians also got their education in British universities.



The English Christian missionaries came to India from 1813 and they also built schools at primary level for Indians in which the language of instruction was local language. Later on the missionaries built high schools with English as the language of instruction which obliged the Indians who wanted to study to have a good knowledge of English. The British rulers began building their universities in India from 1857. English became the first language in Indian education. The 'modern' leaders of that era in India also supported English language and claimed it to be the main key towards success. Indians who knew good English were seen as the new elite of India. Many new schools were established in which the language of instruction was English. According to the British laws the language of instruction at university level was English and therefore schools that emphasized English were preferred by ambitious Indians. Even after India's independence, English remained the main language of India. Officially it was given a status of an assistant language and was supposed to terminate officially after 15 years of India's independence, but it still remains the important language of India.

The English language came to India in the 17th century with the East India Company. It was formed to conduct trade with India and other countries in the east. Initially the Britishers tried to learn Indian languages to communicate with Indians. They started special colleges for this purpose. They also took the help of the translators. But when their political powers increased, they created the British Indian provinces like Bengal, Madras and Bombay. So the English traders gave more importance to English rather than to Indian languages. Some missionary institutions taught English to Indians. The East India Company took the responsibility of the education of the Indians. The Indians were also realizing the importance of the English language.

As A.P.R. Howatt notes: By the 1830s the Indian middle classes were becoming very demanding. They realized that English was the language required for a secure future in a government job, so why was English not taught in the secondary school? Private schools offering this service were already doing good business, particularly in Calcutta. The state was set for the first 'big moment' in the imperial history of English language teaching. Meanwhile some movements were started by Raja Ram Mohan Roy to introduce western scientific education through English. He wanted to replace traditional Sanskrit and Persian teaching. To take a decision on the issue, a



committee was formed. Lord Macaulay was the chairman of this committee. He advocated English as the medium of instruction in the place of Sanskrit and Persian.

Lord Macaulay wanted to make the people Indian in blood and colour but English in taste and opinion. He thought the members of this class would spread their knowledge through English. Macaulay's purposes were: i) to create the dominance of British culture over the Indians and to have the control over the minds of the Indian people through English. ii) to train Indians and make them fit for the employment. The British Government gave preference in jobs to the Indians who had the knowledge of English. A number of Indian students found poetry, drama and other writings difficult to get their degrees. Meanwhile many new colleges and universities were formed. The system of English education founded on English literature continued till the independence.

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## "A Time To Be Happy" a Feminist study

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### Abstract :

Nayantara Sehgal is one of the greatest novelist in Indian writing in English she began writing when she was a young Arnold deals with men women relationship especially women trying to establish her own identity in male dominated society the writer portraits the right of freedom for women in many offer characters in her novels suicide this time of morning a time to be happy and storm in Chandigarh Har fictional world consist of upper-class people business tycoon for an advisor journalist and highly qualified persons like ministers and ambassadors a political theme is combined with the team of man woman relationship their meritor problems there in compatibility the problems arising out of the Year sub Miss Universe in novel a time to be happy Sehgal try to explore women's struggle against the traditional society

Nayantharasehgal is one of the great Indian novelist in English. She began writing French he was very young. Her novel deals with woman's struggle against operation in male dominated Society she portrait woman's struggle for freedom in her different novels hello. Indian English literature is the expression of traditional rooted in Indian society Indian writer depicts Indian life and culture as well as the the spirit of Indian. The local is for the most talked time sharanpur a small town with the textile industry owned by British

Nayantharasehgal was not able to observe the unity of place as the narrator is seen shifting between Lucknow and Saharanpur the title of the novel a time to be happy indicates there is a don of freedom but it's implications are ironic the political freedom could not offer real happiness in life the novel is said in the immediate pre and post independence.

There are two groups of women characters the first group of women character includes women who brought up in orthodox Hindu culture and who accept it without any question the second group is of women who try to adjust to the changing circumstances and reveal shades of rebellion dear struggle does not AIMS at abolishing traditional structure to identify themselves with modern

Ammaji the mother of narrator belong to first generation the narrator of the novel points out that his father and heach traditional mother are wonderful suited to each other in spite of their disagreement" as their must have been some in a marriage that lasted 50 years"(Time To be Happy p.7) there is no conflict between Ammaji and husband due to her compromise with him. Her bold nature can be seen in her this approval of her husband do ammaji belongs to the traditional generation she tries to maintain her own individuality ammaji husband never try to understand ammaji's emotions and feelings instead he avoid situation which creates argument finally sea compromise to her lot and become passive like a traditional. "All my needs are here within the house she declared what is there for me in the world outside?."

Maya the wife of Harish belongs to the second generation she does not want to loser on identity Maya is the first character of Nayantharasehgal who starts the journey towards self realisation Maya belongs to reach family her dreams and wishes were honoured at home before marriage but her marriage with Harish becomes unhappy women after marriage need s to be understood by their partner for women need some



time to adjust with new environment

Though Maya's marriage with Harish fruits failure Maya never thinks of extra marital relationship Maya believes in marriage that's why do she falls in love with narrator she never thinks of divorce. The narrator also cannot Express his love for my for both believes in traditional faith in marriage Maya leaves detached life from Har surroundings she try to forget misery of her failure in marriage engage herself in a social work to forget her own misery of disappointed marriage life the world of Maya and Harish is totally different Harish feels more at home in Paris and Rome than in India he gives more importance to money and power than human feelings in such a way Maya and Harish to couple as she is not interested in anything Harish likes she never goes to the club with him and she is always tong tide at parties(Time to be Happy. P.33)

Lakshmi the wife of going Narayan is satisfied to be a woman Govind Narayan is also traditional person both are good match for each other there is no conflict between them there arranged marriage is often considered a solid stable structure true and tried built on the theory that affection and mutual regard could reasonable be expected flourish between partners of the same social religious and provincial background.(sehgal 51) metal relationship between Kusum and Sanath is a maintained only due to the patience of Kusumtho she has interest in the world of to maintain her own marriage she tried to adjust Desire software husband she attended club parties and bring champagne.Jain says "the Clash of their expectations how your does not take place indema because sanadh by his determined quest for an identity and a sense of cell phone is able to reach so much that lies Beyond The Limited world of his a bringing. NayantharaSehgal reveals sensibility of Indian feminism as there are the different forms of feminism and Sharma refer

"Then there are other forms of feminism, besides those related to the Nations French feminism American feminism Afro American feminism African feminism English feminism Australian feminism etc."

Feminism originates operation of women man has enjoyed Supremacy over woman for long time in every region of world. In Indian society male chauvinism is deeply rooted women's position reduce to second ranks she is treated as a means of physical pleasure. Miserable condition of women has attracted attention of social reformers as well as foreign thinkers.

Indian writer like NayantharaSehgal try to reveal miserable flight of Indian women to her novel. Another eminent Prime Minister writer Shashi Deshpande also explores the preciousment of Indian womenHave positive approach to reveal problems related to Indian women

Sahgal's characters in the entire novels act as a crusader of individual freedom. She authentically represents the political, social and cultural changes due to her close observation of the society. Her novel also portrays how the individual characters are affected by such changes. Though her novels deals only with the advantaged and priveledged characters, her political background of the family helps her to understand and view critically how the woman's are forced to lead a trouble and dread ful life.NayantharaSehgal is prominent women Holistic price to redefine women through her novel after independence women writer like NayantharaSehgal could able to establish dear identity.

NayantharaSehgal is one of the prominent novelist of contemporary age. She is a well known as political novelist the changing pattern of our society waste issue of women's equality.Har work has strong realistic base and reflects the changing values of the society. Arnolds are greatly affected by her own experience ,she took education in abroad and her emotional a bringing is greatly affected by that her marriage with a person of her own



**Philosophical Counselling**  
(History, Development and Significance)

Willibald Vishal Francis

Department of Philosophy University of Delhi

choice futile about eat first time, "I came across shocking assumptions of inequality. A man's ego and ambition I learnt first be served." since women has been victim of male domination he has been considered as mean of physical enjoyment she is a weaker part of society

Bible also priest priority of man or woman according to Bible wife should be to hotel to her husband. Adam is considered superior who gives names to animals and plants man has been made master of all and controls everything on earth. time to be happy reveals womens attend to free herself from such constraints Nayanthara Sehgal focused on modern women's attempt to get out of this marriage the writer arch the need of women to get freedom to establish her own identity Maya and Kusum in a time to be happy are the product of modern changing situation.

Nayantara Sahgal is a thought Pro hacking writer her concept of feminism is vivid and provide overview of Indian urban culture she expects sex education in India she tried to depict changing social scenario. Nayantara se girls bodies confined to Urban classes and areas. Nayantara Sahgal try to find out rural background as her theme she wrote from her own experience sis see rights about characters see witnessed personally social realities are inculcated in her psychic Nayantara Sehgal arch the need of sex educational for a change in social system.

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2. Stormin Chandigarh, P-189.
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□□□

**Abstract :**

Human personality is a complex thing to comprehend. There are problems pertaining to human mind which fall under the domain of psychology and there are significant problems which are philosophical in nature. Philosophy has been a discipline which aimed at enhancing human life from its origin and the practice of Philosophical Counselling is a step towards this aim.

This new field started its practice around 1980s and since then it is spreading all over the world. Since not much has been written and researched about philosophical counselling, this paper attempts to find though not in very comprehensive way but briefly what is philosophical counselling? How it developed through the years? What are its types and methods? Is it an alternative to psychological counselling or can there be an interdisciplinary approach?

**Introduction :**

The manner in which the human mind perceives life situations and things related can be an issue to itself. Consequently erroneous experience of the reality and of the world can be problematic and disturbing for an individual mind. These are only a portion of the problems that people can face which chain their mind and curb their individual freedom. Considering these situations numerous areas of specializations come up to deal with such issues such as psychotherapy, physiotherapy, clinical psychology, counseling and guidance etc. but most of them only concern themselves with the issues that affect only emotional or affective



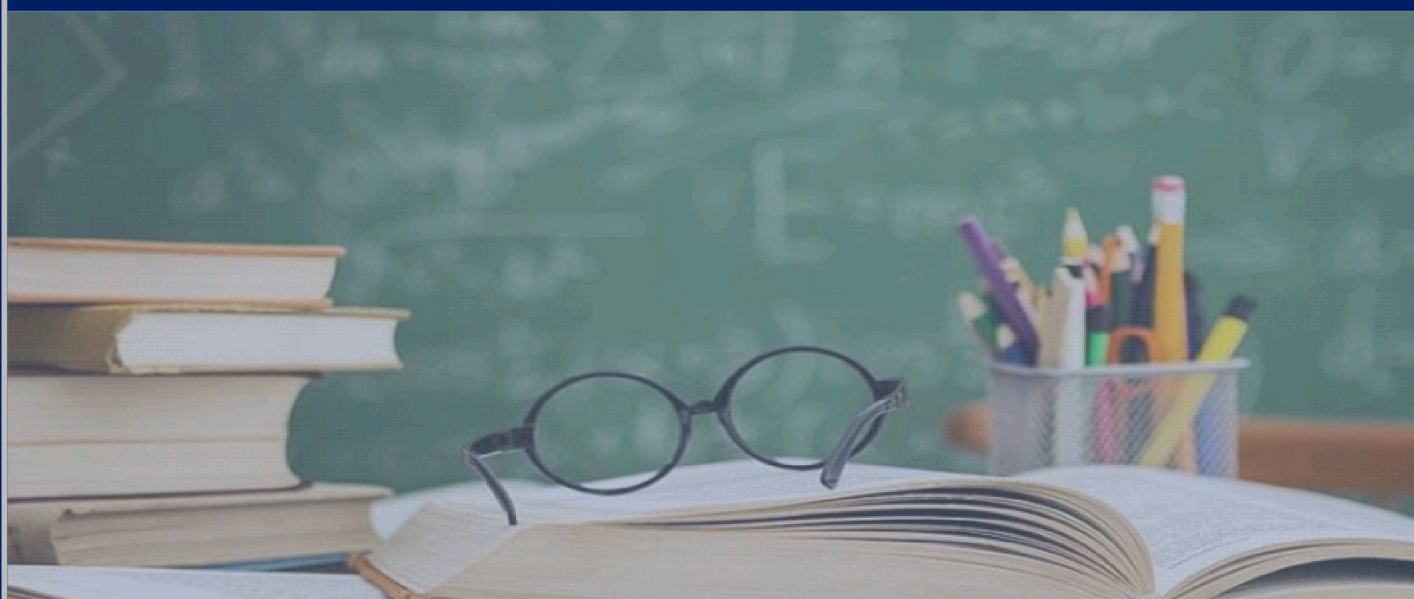
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## **Modernity in Munmun Ghosh's Thicker Than Blood**

**Dr. Shehjad Sidiqui Mohd Vikaroddin**

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### **Abstract**

In the era of modernity, the traditional role of woman has completely been changed and now women are not ready to succumb before the orthodox setting of Indian society. They put so many questions before the male dominated and male oriented society which does not allow a desired freedom to the half population of the country. Now, women are in no mood to surrender before the challenges. Women are in position to show their wit and intellect to challenge the age-old convincing things Munmun Ghosh writes in the novel.

The role of the women novelists in the first two decades of the twenty first century is extremely important and influencing for several reasons altogether. They prove themselves far ahead to their male counterparts in producing some of the classics in this modern era of development. The novelists like kiran Desai, Jhumpa Lahiri, Munmun Ghosh, Manju Kapur, Githa Hariharan, Madhuri Mukherjee, Chitra Banerjee, etc.-are more concerned towards the presentation of human predicament in the context of human life, ambition, emotion, passion and aspiration. They beautifully present the essence of human life with all its beauty and cultural remarks. They present woman in the context of male-dominated society. The novels like Custody and Brothers of Manju Kapur, Unhooked and Thicker than Blood of Munmun Ghosh, The Enchanters of Forest and The Palace of Illusions of Chitra Banerjee, Fugitive Histories and One Amazing Things by Githa Hariharan, etc. seem to be classics in terms of various thematic perceptions employed by the women novelists. Their handling of various thematic perceptions and stylistic devices are quite indicative of their talent and immense ability.



In the first two decades of the twenty-first century, the writers like Munmun Ghosh has attracted a large number of readers and reviewers with her two masterpieces-Unhooked and Thicker than Blood. The first novel Unhooked seems to be the intellectual brooding on the physical relationship between man and woman and deals with the essence of physical or sexual pleasure in the making of good and healthy relationship. The central protagonist of the novel fails to recognise the essence of perfection of human relationship which is quite necessary for staying in this vast world. About the quality of her novels, Dolly Thakore rightly remarks in these words

A very refreshing take on insecurities that plague educated, modern women, the language and turn of phrase that the author has used in unravelling the story is impressive<sup>1</sup>

The novels of Munmun Ghosh are more authentic in questioning some of the aspects and the role of woman in the family. Her novel Thicker than Blood deals with the question of completeness in woman's life. The novelist deals with the life of Mayuri who is the wife a rich and affluent businessman Vimal, wants to conceive a child as soon as possible because of several altogether. She applied many things to get the desired result but fails to do so. She meets doctors and go to the temple and meets with Yogis and Sadhus but does not find any success in his mission Munmun Ghosh puts question before the reader Is woman not complete without children and does motherhood and fatherhood have to be biological? The novel studies the mentality of Mayuri in the context of these vital issues and the novelist tries to get a unique debate through this novel without any hesitation.

This novel also shows the desperation of the woman to conceive a child to continue the legacy of the family. Child- bearing is considered as one of the sublime features of womanhood and religiously it is considered that without child-bearing, woman is incomplete in her duties. But child bearing is also natural and it is not only in the hands of woman. The





woman is not the machine to beget the child and apart from this, she has many duties to perform in her course of life.

Vimal and Mayuri married at good age. After a year, they are not able to produce a child and that is threatening to her. Her mother-in-law is also conscious about her child - bearing. Mayuri tells:

"These days, your mother is constantly after me to do this puja or attend that puja with her, despite knowing well that I have never been into performing rituals, my family never was. I'd rather see a doctor."<sup>2</sup>

Mayuri is more and more conscious about conceiving child in near future and that is why she suggests her husband to meet with a doctor to get some suggestion:

"Is not science or rather civilization all about bending nature to suit human needs? Why won't you meet Dr. Patel even once? Wouldn't you rush to an eye doctor if you had sight problems?"<sup>3</sup>

Mayuri does not want to miss any chance to do something for child bearing. Even a slight delay in meeting with the doctor makes her totally disturbed and distracted. When on one occasion, Vimal was little late, Mayuri became totally agitated because she was too obsessed with the question of her conceiving. She thinks

My heart dipped at once. I told myself that missing one day on the doctor's chart could not be so important. There was always another month and we were just in the beginning of our treatment, but it was not good. And then Vimal's cellphone went on the blink. No further messages. I felt lost.<sup>4</sup>

Both mayuri and Vimal would like to follow each and everything the doctor told them. Even they would like to follow shows the obsession of a woman who seems to be panic in this is able to read the mentality of a woman who is quite obsessive on the questions of conceiving.



Both Vimal and Mayuri came to realise the essence of human relationship. They overcome the timidity of blood relations and show broad perspectives in establishing new heights in adopting children from Bal Griha. They spent happy life along with their children. Now, Mayuri understands the futility of blood relations and realises the point that some relations are more and more important than blood relations. The novelist writes at the end of the novel:

Certainly, *Thicker than Blood* is one of the powerful observations in terms of human relationships, and also human bonds. Munmun Ghosh has created a wonderful character in the shape of Mayuri who emerges victorious at the end of the novel with her rediscovering of new heights in adopting two children Molly and Neel with whom she spends her life with much enthusiasm. After coming through multiple complexities and experience, she realises the importance of bonding which is far intimate than biological relationship.

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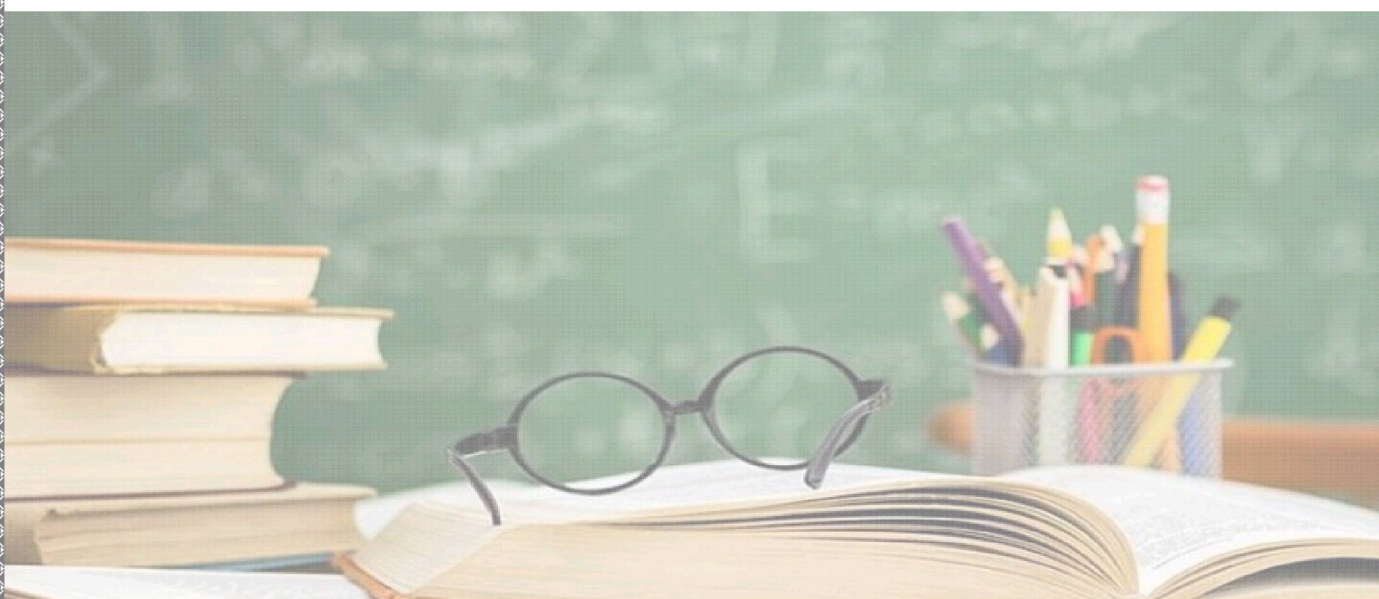
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## **Voice of Women's Identity In Munmun Ghosh's Unhooked**

**Dr. Shehjad Sidiqui Mohd Vikaroddin**

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### **Abstract**

This novel also shows the desperation of the woman to conceive a child to continue the legacy of the family. Child bearing is considered as one of the sublime features of womanhood and religiously it is considered that without child-bearing, woman is incomplete in her duties. But Child bearing is also natural and it is not only in the hands of woman. The woman is not the machine to beget the child and apart from this, She has many duties to perform in her course of life.

In the male dominated and male oriented society, it is difficult for a woman to aspire her liberty especially in terms of establishing relationship with man. The traditional and conventional Indian society still does not provide much liberty to woman to think and feel freely. They are extremely guided by the orthodox and traditional norms and they are denied in their option and selection because these things are still not in their hands. The male dominated and male-oriented society impose difficulties and hindrances before them and still they are so many deprived condition, they have to fight hard for their survival in the vast of making their own choice. In such conflicting and devastative universe of human emotions and passions. With such mindset, Munmun Ghosh writes this novel in order to show the desire and wish of woman as a free spirit, not so complicated but smooth and easy creature aspiring for real human status. A critic writes about Unhooked in The Telegraph in these words:

Unhooked is an interesting take on courtship. The novel's spark lies in the nuances in the characters desire and the way the author depicts those charmingly



annoying traits that are typical of most women in or looking for relationships-over- analysis and obsession.<sup>1</sup>

Even in the modern era, woman is regarded as slave to man especially in terms of physical or sexual relationship. It is the commonplace criticism that in the male dominated society, woman does not have such right to show their emotional need freely and they are denied of such human status. But in the modern era of awareness, woman has also become aware of their taste and need. They are also in favour of equality in love and sexual relationship. They would not like to tolerate the possessive attitude of man in this regard. Any kind of possessiveness and inequality in man-woman relationship results in chaos and anarchy in human relationship and society also. The novel seems to present all these things in unique manner without any hesitation. A critic writes in The Goan Observer in these words of praise about this novel

Unhooked deals delicately with man-woman sexual relationship. Can there be sex without love is the central issue which the novel addressed... it is touching story.<sup>2</sup>

The novel is full of conflicts and complications in terms of the portrayal of man-woman relationship. Can sexual relationship possible without love and affection? The narrative of the novel also puts this million-dollar question before the readers.

Man-Woman relationship is not all about sex or only physical pressure as people generally believe. If there is not sense of accomplishment in terms of mutual devotion, proper understanding, respect for each-other and platonic concept of love, the true nature of the relationship depends on the above mentioned ingredients in general but in the successful and everlasting man-woman relationship, the role of safety, security, especially in terms of financial support, come in the wake of modernity. In the modern era of economic and material prosperity, it is quite natural that the prospect of human relationship is certainly going to be influenced by modern developments.



In the case of Preeti, Anamika's friend, such issues are there. For her, marriage was essential because she was too thoughtful in this direction. She thinks that she is already in her thirties with no man and no real job. We have to understand the nature of fast-growing and fast-changing society in which economic interdependence plays a vital role in the shaping of human relationship. Woman also does not want to be burden on the shoulders of her male counterpart but she would like to become independent in this direction. Woman like Preeti has to face many problems intentionally or unintentionally both. Munmun Ghosh is aware of such dilemma burning in the mind of the woman on the one hand, their aspiration for love and life, and on the other hand, their sense of economic and materialistic prosperity or economic independence. For instance, Preeti says

"No, I cannot do it. But I feel pretty desperate these days. I will be twenty-nine in a month or so and in a year thirty. Imagine being thirty with no man, no real job... you at least have hooked yourself to a college."<sup>3</sup>

In the traditional and conventional society of India, people are very conservative in terms of man-woman relationship. The role of the parents is extremely important in guiding such relationship in detail. The question of caste and religion always occurs in the formation of such kind of relationship and the individuals have not courage at all to leave these things without consideration. When Brian comes in the life of Preeti, she becomes conscious about these things. For her, only love or affection or relationship is not important but at the same time, she has also to respect the emotion and feeling of her parents. She does not want to go beyond her parents anymore because of fear of the society or what people say or what will be happened to her parents when she will be married with a Christian. These things are very common in Indian society and we cannot ignore these things. Munmun Ghosh writes about these things in the novel





The problem, as it looks to me, is that people like Preeti and me, are unwilling to accept that everybody does not easily get romantic love. If our grandmothers, mothers, aunts, and generations of women married and went on to mother children at conventional ages, so that our singleness looks like an aberration and makes us uncomfortable, then we need to remember that they were not choosy about their marriage partners and quietly accepted the man selected by their family elders, placing the institution of marriage above the men they married, viewing marriage as a necessary instrument to commence their actual work of mothering children and raising families.<sup>4</sup>

There are many women in the novel who are the victims of time and space in the vast domain of human relationship. In the modern era when and where everything has become mechanised, it is quite difficult both for man and woman to find and see them in set doctrines or moral stability. The question of morality has become almost subsidiary for both of them. They are in search of new dimensions of human relationship and this brings conflict and dilemma in their mind. That is also the cause of distress and fomentation in human mind. Man and woman are supposed to be two separate poles standing on different schemes and aspiring for different notions and motives. The modern work culture has also imposed many problems also. Anamika remarks in this direction.

Why women in distress? Why not street children, orphans, abused seniors, variously physically handicapped, spastics? Why not them?<sup>5</sup>

Munmnun Ghos's *Unhooked* is certainly a wonderful book in the realm of fictional writing because the writer has shown an immense class as well as craftsmanship in handling other various thematic perceptions and assumptions related to man-woman relationship



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# ENGLISH LANGUAGE TEACHING STRATEGIES FROM THE INDIAN PERSPECTIVE

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## ABSTRACT

*English is a mostly used language in today's globalization that's why English is mentioned global language. It is also taught at second language around the world especially in India. In India English is used as link language to link Interstate. It is evident that in India for the many decades people in general and students in particular are eager to speak English. The importance of speaking English is day by day increasing in today's world of science and technology. So large of spoken English institutes has been established. Well known linguist RK bansal and JB Harrison in this concern says, several books are in the market for those who wish to improve their English pronunciation,, correct pattern of accent, rhythm and intonation son now it is become easy to learn to speak English it is evident that in 1940 and 90s the study of linguistic was not part of syllabus.*

## INTRODUCTION

All that was done in respect of language consist of lectures on the development of the English language with borrowing from Greek, Latin, German ET C English could be learn language through literature and the students speak it correctly without any training. A language is a way of human being To interact with each other in society. Please a scientific study of

**DR. SHEHJAD SIDIQII MOHD VIKARODDIN**

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language reveals it adds it is a type of pattern of human behavior. English language meant to be a kings and Queens language.

The language is available in variety of written and spoken form. The Scottish English is spoken by Highlanders and lowlanders but in India English language is spoken in vast. The role of English in education, is not clearly defined. Multilingualism in education is a great hindrance in learning English. And learning language methods, language material should be available according to the needs of classroom. Did national education Commission (1964 - 1966) Prescribed English as library language and a language of higher education. The library language over six decades has become dim and in school education. National policy on education 1986 based on multilingualism. Each language is a structured differently and the different structures offer user different suggestions to meaning. Henry meet a new language our brain tried to apply the first language experience by looking for familiar cues

The teacher used different method for English teaching. Different methods may appropriate to different context. There is no perfect method available for learning language. A teacher should adopt eclectic and pragmatic approach because no single approach is useful in all solutions. A good teacher should keep all method in his store and use any method depending upon classroom situation, knowing the latest method of language teaching is like taking a loan without knowing how, pain and where to invest it. It is worthwhile for the teacher to keep in mind for this approach is rather than a Pacific method post-op it is possible to be adaptable in English classroom if teacher let the class know from the first what his demands R pertaining class work and clearly we will all objectives. If we respect the student and plan our curriculum according to the need of classroom I think that it will easy to students to learn English. it is not essential for teacher to stick any single method or approach but rather combine different strategies to create effective classroom.

As a language teacher he must take into consideration needs of the students he should find out solutions on common problems. Teacher must be able to reduce dependency of students on the teacher. If the teacher of veggies the student with correct answers every time it gives birth to the habit of spoon feeding hey teacher should encourage students to give answers in the classroom. It is duty of the teacher to make language learning interesting. He should relate language learning with everyday experience. As a English language teacher you will encounter the students with various learning capabilities. Weak student should be inspired to give answers so that their confidence will boost.

Whole language approach it's a method of teaching reading and writing that emphasize learning whole words and phrases by encountering them in meaningful context. The focus is on the social construction of meaning and understanding through the process of writing and





reading the student first acquired literacy through their own writing and literature as well as experiences across the curriculum to science experiments recipes games instructions for making the things math solving interactive computer communications and map reading. the communicative language teaching is also based on communications the main characteristic of this method is signed by experiences of information gap choice feedback and authentic material.12 physical responses also necessary in language learning for it can make. Learning interesting. having fun makes the foreign language learner interested in acquiring the skills of language. The physical activities done at the beginning of the class make the student active in learning process. The language teacher should be selective in choice of the words. language to teach should start from the words comprising verbs of imperatives and concrete nouns so that it is easier for language learner to perform. Actions.

English language was introduced by British in India. English education was taught in school colleges or universities .. this english become medium of instruction in all. Education was thus limited to small circle of upper and middle class people who designed To power and position by earning the benefit of English education. This promoted the growth of unknown culture which was vastly different from the traditional culture of the country pushed up in this outlook moral and spiritual and even in the common matters of life like eating clothing eating see he reproduced European customs and manners and your thing become Prestige in India knowledge of English language does regarded as symbol of superiority introduction of English language in India proved as blessing in disguise. It ultimately lead to the moving of national spirit in the educated people. This is the file new movement arose in various sections in the national life political, religious and social eetc. The importance of learning English was increasing. To meet the demand rajaraman row established Hindu College in 1817 soon thereafter missionaries opened a number of schools and colleges in which the teaching of English was given a greatest importance. In 1835 that English was formally introduced as a medium of instruction. Macaulay in his minutes on education set out the aim of his mood it was to form a class of people who made translators between there and the millions whom they govern with different blood and color but English in taste in opinion in morals and intellect.(minutes by Macauley,<http://adalyjournal.com>) In 1853 the year in the companies agreement was renewed once again under the pressure of government personal to manage the widening domain of its India activities the company decided to open up highest civil services appointment to Indian by allowing them to appear for. A competitive examination set up for this purpose. To examination had English as a subject. Since the British rule English had central position in education. But later on education commissions focused on use of regional languages in education. while teaching English in India that's why regional languages cannot be neglected.



India is a developing country and the teaching of English has become a real challenge right from the beginning of the history of English language teaching till date though languages are the backbone of civilization across the world but still everybody in our country is lamenting on the Detroit ING condition of English. In school sand colleges. English as a language is insufficiently developed in the most of the students of schools especially government schools in region of remote area English language learning from first standard but though accepted but lack of proficient teacher is major problemIt is astonishing to note that English language has won international language status and all the evidence suggest that the position of English as a global language is going to become stronger. in such scenario of the world Indian education system also should take into consideration the importance of English language learning. Teacher should encourage individual participation Of weak students. Teacher plays the role of catalyst in the classroom and in order to inspire the week students to participate in interactive games where the students need to communicate in order to complete a task. In teaching foreign language, their proper use of mother tongue proves helpful. The English language is considered foreign language it's taught in an artificial environment and the influence. Great linguist Harmer says, "Grammar translation still has relevance. Though it is not practiced in the classrooms where the teacher still choose the old method or grammar translation method in teaching and learning English.(English as foreign language vol.15,sept.2015.p.126).the use of mother tongue in classroom creates the feeling of security. As far as concerned second language teacher it is duty of English teacher to encourage students to use English language.ESP refers to the teaching of English language for professional purpose with in practical require of basic perception about the concerned profession. And its relevance with use of English the aproach of Lt has been a great task for tutor to educate the beneficiaries as it require specialized knowledge about the particular professional terminologies. ESP refers special courses instead of multiple purpose course to suit the needs of different course of students the concept of. ESPN is said to be particularly adequate for teaching English to students of science and technology. Moreover English at the understanding level of engineering studies differs from English in *in other undergraduate courses*.

The aim and objective of teaching English is not clearly defined in India the student learn English adds objective to pass. The student should excitedly learn this new language as mean of communication. The teachers also are not acquainted with new techniques, methods and teaching material in English. Even they are trained with old techniques and methodology there is hardly scope to improve spontaneous knowledge. Teaching of English in India suffers from faulty method of teaching. Number of teachers still struck Elizabethan literature, translation of paragraph and writing the meaning of new words. Every method needs to relate with local situation. It is depend on skill of teacher how he relates contain two visual aid is





also essential in teaching with help of these aids which will make the teaching learning process easy.

The syllabus of English language need to frame according to needs of the students. It is major problem that syllabus it designed from exam point of view, even the students are studied in English they are not able to produce even a single sentence in it. Students aim is to only pass the exam and later on it becomes difficult for teacher to encourage the students to learn English as a language. Thuseclectic method is Suitable in Indian English classroom.

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## MARGARET ATWOOD'S 'SURFACING' : ECO FEMINIST STUDY

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### ABSTRACT

*The term Eco-feminism is mixture of ecology and feminism François d' Eaubonne say's Eco feminism refer close association of domination of woman and the domination of nature. In 'surfacing' Margaret Atwood reveals the exploitation of woman and nature her novels are put based on environmental crisis as and nature i Her oppression of women. Surfacing movingly dramatizes the eco feminist Idea of male domination. surfacing the narrator the exploitation of nature in Canada by civilized Society. When narrator returns to her hometown in search of her father She witnesses the exploitation of nature by Americans in name of economic development. The narrator in 'Surfacing!' compares herself with heron. She compares brutal murder of heron with the death of her psychology, she feels disgust with American's action of killing heron she feels it one kind of harassment of woman, Protagonist realizes the difference between the life of mother on island and her own. city life, Mother accepted The values and tradition, that respect the nature She was capable of protecting her family's life. But protagonist migrates to city and get exploited there.*

**Key Words.** : Ecology, Eco-feminism, protagonist, patriarchy, Exploitation.

### INTRODUCTION

Term Eco-feminism is mixture of ecology and feminism François d' Eaubonne say's Eco feminism refer close association of domination of woman and the domination of nature. In

**DR. SHEHJAD SIDIQUEI MOHD VIKARODDIN**

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‘surfacing’ Margaret Atwood reveals the exploitation of woman and nature her novels are put based on environmental crisis as and nature i Her oppression of women. Surfacing movingly dramatizes the eco feminist Idea of male domination. surfacing the narrator the exploitation of nature in Canada by civilized Society. When narrator returns to her hometown in search of her father She witnesses the exploitation of nature by Americans in name of economic development. The narrator in ‘Surfacing!’ compares herself with heron. She compares brutal murder of heron with the death of her psychology, she feels disgust with American’s action of killing heron she feels it one kind of harassment of woman, Protagonist realizes the difference between the life of mother on island and her own. city life, Mother accepted The values and tradition, that respect the nature She was capable of protecting her family’s life. But protagonist migrates to city and get exploited there.

The term Eco-feminism is mixture of ecology and feminism François d’ Eaubonne say’s Eco feminism refer close association of domination of woman and the domination of nature. The aim of eco feminism to liberate the woman and nature from the domination of patriarchy. In order to culminate domination of patriarchy, on woman as well as nature eco feminist emphasizes on the challenge to patriarchal power the present paper focused on inquisition to know eco feminism represented in ‘surfacing’ by Margaret Atwood.

In ‘surfacing’ Margaret Atwood reveals the exploitation of woman and nature her novels are put based on environmental crisis as and nature i Her oppression of women. Surfacing movingly dramatizes the eco feminist Idea of male domination. Ariel Salleh, a eco feminist is of opinion, “the basic premise in eco feminism is acknowledgement of the parceled in men’s thinking between their sight to exploit nature, on one hand and the use they make of women on the other.” [www. Socialalternatives.com](http://www.Socialalternatives.com)

Surfacing the narrator the exploitation of nature in Canada by civilized Society. When narrator returns to her hometown in search of her father She witnesses the exploitation of nature by Americans in name of economic development. She is more concerned for nature and reveals her consciousness of woman and nature bonding. Throughout the more Leader witnessed the hunting of animals by people only for pleasure Meaningless killing of animals is evidenced at two times as the shooting of heron and the explosion made by Americans for fishing. These incidents harm narrator. Woman naturally by nature is tender hearted, caring and loving so the narrator is always careful of nature. She realizes that human and nature have an intimate relationship because human being is akin to living with other human. The nature like a woman possess quality of nature, that the novel ‘surfacing’ reveals in one of the incidents in which the narrator is informed of the father’s missing the People think “ She should be filled with death, (she) should be in mourning, (surfacing, p.160) But in reality she is not in grief as know she is part of nature she know the and death is also part of it, The



narrator embraces the eco feminist intent when she realizes that the fulfillment of our humanity is profoundly linked with learning to appreciate the mature within us and without (Atwood, 1972 P-43). The protagonist of the later on rejects to go back to the - constructed woman without any change. then the novel decides to shift in orotund woman and wanted to live in a natural way a male pres from bad burden of culture, she puts herself in the entire natural world in the lake and there she wants to be. She immerses herself get power of salvation

*"Hence When she from the depth of the lake, she surfaces with new knowledge protagonist surfaces about herself that entails a re-assessment of herself in relation to the world" (Atwood p.82). The Protagonist reveals eco feminist bent of Mind by that human being are not radically separate from that the fulfillment of own humanity is profoundly linked with learning to appreciate the mature within us and without" (Atwood P. 40)*

The protagonist realizes she is artificially constructed woman when she encounters nature. Atwood emphasized the fact men exploits bodies of women for their needs. They even control the process of childbirth which nature has assigned only to women. The protagonist also questions, is the guise of assisting woman rob her of the ability to sense held bodily rhythm. The novelist tries to reveal the relationship between exploited narrator and the damaged landscape in Quebec. She realizes nature has helped her in discovering her real self!

The narrator in 'Surfacing!' compares herself with heron. She compares brutal murder of heron with the death of her psychology, she feels disgust with American's action of killing heron. She feels it one kind of harassment of woman, she says "Why had they strung it up like a fet victim, why didn't they just throw it away like the to thrash & To prove they I could do it, they had the power to kill, otherwise, it was valueless they only relations they could have to a thing like that was to destroy" (surfacing, p.80)

She links her own life with nature, she is able to perceive the rhythm of nature, its life cycle of life and death. She survives on natural resources as mushroom, plants and natural resources as marsh berries. She merges with the plants and trees. She feels

*"Through the freed the sun glances; The swamp around me smolders, energy of decay turning to growth, green rise. I remember the heron; by now it will be insects, frogs, Fish and other reasons. b. my body also changes, the creature in me, plant -animal sends but filaments in me, I Ferry et secure between death and life I multiply"*





Like a true ecologist she makes the earth her literal home for she knows that in the natural world all life is interrelated. She is not afraid one. She becomes one with her Sacred Mother earth. She throws away all her respect to seek harmony. That totally relies on nature. She gains freedom now. Firmly rooted to the earth like the original people.

Protagonist realizes the difference between the life of mother on island and her own city life. Mother accepted the values and tradition, that respect the nature. She was capable of protecting her family's life. But protagonist migrates to city and gets exploited there. She deceived by her lover. She becomes pregnant by him and compelled to abort child she hates how mechanized the process.

Thus in 'surfacing' Atwood tries to explore connection between woman's oppression and exploitation of nature. The narrator is a victim of exploitation by patriarchal society. She is married to a man with children. She is a representative of Canadian psyche, feminine, passive identity suffering. She becomes an embodiment of woman empowerment who protests against patriarchal domination.

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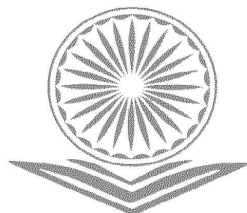
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विषय:- शिक्षकांची नियुक्ती, सेवांतर्गत पदोन्नती, मार्गदर्शक मान्यता इत्यादीसाठी शोधनिबंध (Research Paper) ग्राह्य धरणेबाबत.

विद्यापीठ अधिकार मंडळाने घेतलेल्या निर्णयानुसार शिक्षकांची नियुक्ती, सेवांतर्गत पदोन्नती (CAS) संशोधन मार्गदर्शक मान्यता (CAS) इत्यादीसाठी खालीलप्रमाणे शोध निबंध ग्राह्य धरण्यास मान्यता देण्यात येत आहे.

अ) UGC Approved List of Journals आणि UGC Care List अस्तित्वात येण्यापूर्वी ISSN क्रमांक असणाऱ्या सर्व संशोधन पत्रिकेतील शोध निबंध.

ब) बारकाईने पुनर्विलोकन केलेल्या (Peer Reviewed Journal) संशोधन पत्रिकेतील शोध निबंध, परंतु त्यासाठी सदरची प्रक्रिया Single blind review/Double blind review/Open or Transperent Peer Review पद्धतीने पूर्ण केल्याबाबतचे संबंधित संशोधन पत्रिका संपादकांचे प्रमाणपत्र आवश्यक राहिल. उपरोक्त प्रक्रिया न करता संशोधन पत्रिकेच्या संपादकाने केवळ बारकाईने पुनर्विलोकित केलेले (Peer Review Journal) असे नमूद केले असेल तर ते ग्राह्य धरण्यात येऊ नये.

क) वेळोवेळी प्रसिध्द केलेल्या UGC Care List मध्ये Index केलेल्या संशोधन पत्रिकेत प्रसिध्द शोध निबंध.

सदरचे धोरण पुर्वलक्षी प्रभावाने लागू करण्यात येत असून यापूर्वी विहित संख्येएवढे शोध निबंध प्रसिध्द नसल्याच्या कारणास्तव नाकारण्यात आलेले कोणतेही प्रस्ताव या धोरणाप्रमाणे मान्य होत असल्यास अशा अर्जदारांस पुन्हा नव्याने प्रस्ताव सादर करावा लागेल.

मा. प्राचार्य/मा. संचालक, सर्व संलग्न महाविद्यालये/मान्यताप्राप्त परिसंस्था आणि मा. विभागप्रमुख, विद्यापीठातील सर्व शैक्षणिक विभाग यांना विनंती की, सदर परिपत्रकाचा आशय सर्व संबंधितांच्या निदर्शनास आणून द्यावा.

गणेशखिंड, पुणे - ४११००७ )

जा.क्र. :- सीबी/६१६ )

दिनांक :- १२/०८/२०२२ )

(*Rajendra*)  
(डॉ. मुंजाजी रामवे)  
उपकुलसचिव

## 22. Many Faces of Resistance - A Study of Unlooked

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Indian woman in pre-Independence era had a different status in society. She was considered a burden, and mostly being illiterate, she was considered to be a non-entity whose only obligation was to attend to the needs of her family. In Indian English writings and in most of the writings of the regional writers, she maintained the image of Sati-Savitri, self-sacrificial, denying her personal needs. In some of the writings by the Indian authors, her image oscillated between two extremes-the westernized image and the image of an ideal mythical figure. But gradually, the impact of the social reformist's activities, the Gandhian ideology and spread of education brought a change in the set pattern which had been prevailing in India for the last so many centuries, advocating the belief that man is to rule and woman is to obey. The writers of old generation like Raja Rao, Mulk Raj Anand, R.K. Narayan and Kamala Markandaya delineated women in their true colours, not always docile, submissive and self-sacrificial. Later on, the writers of new generation-male as well as female-have tried to show a woman's strife of coming out of her image of a goddess or a lifeless object. Writers like Anita Desai, Nayantara Sahgal, Shashi Deshpande, Manju Kapur and others have depicted females who are not the silent sufferers, rather they have learnt to fight against injustice and humiliation they are subjected to. No doubt, the female protagonists of these Indian writers have to face many vicissitudes of family life but they keep abreast of all hurdles which come in their way in their marathon struggle for seeking their identities in this patriarchal society. They fight for their emancipation and empowerment. Education that has been their eye-opener has made these oppressed and suppressed women aware not only of their duties but also of their rights. The

writers have been dealing meticulously with this emancipated 'new woman' and her efforts to face challenges and also how she, while living within the bonds of marriage, frees herself from the inhibitions of society, culture and her own conflicting emotions. Still apart from the middle class or high class women, women of lower class are being victimized, physically as well as mentally.

Post-Independent Indian writers have depicted woman in all her shades. Generally, they have delineated three generations of married women. First are the wives of older generation who accept, willing or unwillingly, their husbands as pati parameshwar. Second is the generation of the women who fight for their individuality and have the courage to outface social forces that obstruct their forward march towards individuality. They manage to escape from the tyrannical order of the society without going out of the boundaries of wedlock. They resist the undesirable in order to follow the desirable ends. In the third generation are the women who step out of the conjugal bonds when they find it difficult to adjust with their spouse. Sometimes they go rebellious against the orthodoxical norms of life and violate the path of morality.

Munmun Ghosh's *Unhooked* is certainly a wonderful book in the realm of fictional writing because the writer has shown an immense class as well as craftsmanship in handling of the various thematic perceptions and assumptions related to man-woman relationship in the wake of the modern complications and intricacies which seem to influence the concept of human relationship. Her novel puts several questions before the readers, reviewers and critics regarding issues related to love and courtship, and physical compulsions in man-woman relationship in conflict with intellectual accomplishment and divine pleasure. The role of sex as well as economic security in making and shaping human relationship, especially man-woman relation has been manifested with much discussion with the portrayal of some characters in the mode of the conflict which also seems to be the core issue in the novel. Munmun Ghosh seems to be the representative of modern woman who would like to search real happiness and pleasure by locating herself in the perfect company of mental as well as physical fulfilment in love and sex both.

The novel is full of conflicts and complications in terms of the portrayal of man-woman relationship. Can sexual relationship possible without love and affection? The narrative of the novel also puts this million-dollar question before the readers.

The novelist pronounces this in the character of Anamika who seems to be brooding all time over such questions but does not arrive on any concrete conclusion. Her search has many assumptions are not practical in nature at all. She is but such assumptions always in search of love without sex. But how it is possible. Sex integral part of human need and its importance cannot be denied at all. Shobha De writes about this novel in these words:

Munmun Ghosh takes an unblinking view of contemporary concerns that confront thirty-something career women looking for love, but not necessarily sex! Her candid retelling of adventures, misadventures and plain emotional disasters as she navigates her way through relationships, makes this book a good read.<sup>1"</sup>

If we go through the opening pages of the novel, we find the notions of the novelist in detail and without any shyness. In the very first paragraph of the novel, she writes about her own dilemma to understand the motive of man in these words:

Men seek me out between relationships or denying tough times in relationships. I feel the emotional gaps in men's lives and keep them warm and loved till they find security and happiness in the arms of women they desire. My way to spread warmth is through words, conversations.<sup>2,"</sup>

Anamika does not seem to be an intellectual brooder, but she would like to understand man-woman relationship in terms of intellect and spirit. She would like to unfold some of the important tools of human relationship which is the foremost base or foundation of happiness and pleasure. Anamika is in search of such man who equally suits to her intellectual pursuits and flavour. But she is also conscious about the notions of men in making of man-woman relationship. Men are always conscious about the body of the women with whom they would like to establish relationship. The novelist writes about this. Anamika is quite careful about the intellect and spirit of man. Anamika tells:

When the men come to me, I must offer them conversation of a high intellectual order to keep them coming and coming. My mind is now my chief asset. But I am also careful to underplay my intellect, depending on the person, to not offend my man. The sharpness of a woman's mind can silver the male psyche.<sup>3,"</sup>

Anamika, being a lady of intellect and spirit, is in favour of such healthy relationship which might give her satisfaction in terms of true love and affection. For her, sex has no importance at all because she considers it quite useless in terms of a successful human relationships for many things altogether. She speculates too much and her this intellectual brooding too brings a sense of dullness in her life. She forms many assumptions of man in her mind. She thinks at the very beginning of the novel:

Men can be blinded enough by beauty to ignore the texture of a woman's mind-at least till marriage. The reward of social envy is tempting enough to persuade them to overlook my

undesirable keenness of intellect. I guess I am not beautiful enough to be spared. Moreover, I cringe from availing of the plethora of treatments available today to rev up one's persona. Perhaps I am unfairly biased towards the mind. Have always been so.<sup>4</sup>

Varun was the first man to come in the life of Anamika intellectually. Anamika would like to test him intellectually before establishing relationship with him. The imagination of Anamika always hovers around her thoughts which are not supported by her feelings. She talks about Varun in these words:

Varun would always be quarrying my mind. Probing every thought, every significant memory and every future dream. I would do likewise, exhilarated by our intellectual transactions. I had assumed it was the beginning of a complete relationship and that our bodies would soon fuse too. To me, the body was an extension of the mind.<sup>5</sup>

But Varun does not respond at all to the demands of Anamika. She wishes that Varun must come forward to hold her hands and shows some parts of love with much enthusiasm. But he does not respond at all. She feels a unique kind of lackness in the attitude of Varun which disturbs her too much:

For a long time, I waited for Varun to hold my hand, casually graze my wrist, anything! I was puzzled when he did not make the transition.<sup>6</sup>

(Man-woman relationship is not all about sex or only physical pleasure as people generally believe. If there is no sense of accomplishment in terms of mutual devotion, proper understanding, respect for each-other and platonic concept of love, the true nature of the relationship cannot be achieved at all. The successful human relationship depends on the above mentioned ingredients in general but in the successful.

In the traditional and conventional society of India, people are very conservative in terms of man-woman relationship. The role of the parents is extremely important in guiding such relationship in detail. The question of caste and religion always occurs in the formation of such kind of relationship and the individuals have not courage at all to leave these things without consideration. When Brian comes in the life of Preeti, she becomes conscious about these things. For her, only love or affection or relationship is not important but at the same time, she has also to respect the emotion and feeling of her parents. She does not want to go beyond her parents anymore because of fear of the society or what people say or what will be happened to her parents when she will be married with a Christian. These things are very common in Indian



society and we cannot ignore these things. Munmun Ghosh writes about these things in the novel.

The problem, as it looks to me, is that people like Preeti and me, are unwilling to accept that everybody does not easily get romantic love. If our grandmothers, mothers, aunts, and generations of women married and went on to mother children at conventional ages, so that our singleness looks like an aberration and makes us uncomfortable, then we need to remember that they were not choosy about their marriage partners and quietly accepted the man selected by their family elders, placing the institution of marriage above the men they married, viewing marriage as a necessary instrument to commence their actual work of mothering children and raising families.

There are many women in the novel who are the victims of time and space in the vast domain of human relationship. In the modern era when and where everything has become mechanised, it is quite difficult both for man and woman to find and see them in set doctrines or moral stability. The question of morality has become almost subsidiary for both of them. They are in search of new dimensions of human relationship and this brings conflict and dilemma in their mind. That is also the cause of distress and fomentation in human mind. Man and woman are supposed to be two separate poles standing on different schemes and aspiring for different notions and motives. The modern work culture has also imposed many problems also. Anamika remarks in this direction:

Why women in distress? Why not street children, orphans, abused seniors, variously physically handicapped, spastics? Why not them?"

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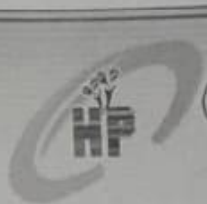
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(विशेष संदर्भ २००० नंतरचे साहित्य)

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प्राचार्य डॉ. अशोक घोलकर

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डॉ. भारत हंडीबाग

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करून घेतले जातात. आणि त्यांचे आर्थिक शोषण केले जाते परंतु देवाच्या कोपाच्या भीतीमुळे हे लोक त्यांची शिकारबनतात.

निष्कर्ष :

- १) स्त्रियांच्या मासिक पाळी दरम्यान ओझे उचलणे रात्री, अपरात्रीकामावर जाणे यामुळे त्यांच्या आरोग्याचे प्रश्न निर्माण होतात.
- २) ऊसतोड कामगारांच्या मुलांमध्ये क्षमता आणि योग्यता असूनही परिस्थितीमुळे त्यांना शिक्षण घेता येत नाही.
- ३) ऊसतोड कामगारांचे वृद्ध आई-वडील यांच्या आरोग्याकडे सहानुभूतीने लक्ष देण्याची गरज आहे.
- ४) ऊसतोड कामगारांच्या गरोदर माता-भगिनींना तात्काळ उपचारांच्या सुविधा उपलब्ध करून देणे गरजेचे.
- ५) बहुसंख्य ऊसतोड कामगारांच्या दारिद्र्याचे कारण हे त्यांच्या मुला-मुलींच्या लग्नाचा अनावश्यक खर्च आहे त्यामुळे सारखे कारखान्याकडून याऊसतोड कामगारांच्या मुला-मुलींचे सामूहिक विवाह पार पाडले जाऊ शकतात.
- ६) ऊसतोड कामगारांच्या शैचाल्याचा प्रश्न गंभीर आहे. याकडेही गांभीर्याने लक्ष देणे गरजेचे आहे.

संदर्भ ग्रंथ

- १) दौंड कैलास रा. पाणधुई शांती पब्लिकेशन पुणे 41 10 43. प्रथम आवृत्ती. पृष्ठ क्र. 18.
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- ४) 'यसन' उनिपृष्ठ क्र. 231, 232.
- ५) 'यसन' उनिपृष्ठ क्र. 17.
- ६) 'यसन' उनिपृष्ठ क्र. 7, 8.
- ७) वाघमारे योगीराज घुराळा हर्ष प्रकाशन सोलापूर 41 3004 पृष्ठ क्र. 54.
- ८) 'यसन' उनिपृष्ठ क्र. 91.
- ९) 'यसन' उनिपृष्ठ क्र. 58, 59.
- १०) 'यसन' उनिपृष्ठ क्र. 60.

□□□

22

## समकालीन जीवनाचा वेध घेणारी कादंबरी : बारोमास

प्रा.डॉ. यशवंत हाके

प्राध्यापक व विभाग प्रमुख,

कला, विज्ञान व वाणिज्य महाविद्यालय, बदनापूर,  
ता. बदनापूर जि. जालना

\*\*\*\*\*

सदानंद देशमुख हे मराठीतील सुप्रसिद्ध साहित्यिक म्हणून सर्वपरिचित आहेत. त्यांनी कथा, कविता कादंबरी व ललित गद्य आशा विविध वाङ्मय प्रकारांमध्ये लेखन केले आहे. त्यांचे 'खुदलघास' 'गाभूळगाभा' 'रगडा' 'लचांड' 'उठावण' 'महालूट' 'जमीनजुमला' इत्यादी कथासंग्रह प्रकाशित आहेत. तसेच 'गावकळा' हा कवितासंग्रह प्रसिद्ध असून 'भूर्डिगणी' हा ललित गद्य देखील प्रकाशित आहे. याशिवाय त्यांनी 'तहान', 'बारोमास', 'चारीमेग' या कादंबऱ्यांचे लेखन केले आहे. सदानंद देशमुख यांना साहित्यकृतीच्या लेखनासाठी विविध पुरस्कार प्राप्त झाले आहेत. यामध्ये महाराष्ट्र शासनाचा राज्य पुरस्कार, पद्मश्री विखे पाटील साहित्य पुरस्कार, महाराष्ट्र साहित्य परिषदेचा ह. ना. आपटे पुरस्कार इत्यादी अनेक पुरस्कार प्राप्त झाले आहेत. त्यांच्या अनेक साहित्यकृतींचा विविध विद्यापीठांच्या अभ्यासक्रमांमध्ये समावेश करण्यात आला आहे. तसेच त्यांच्या अनेक साहित्यकृतींचा विविध भाषांमध्ये अनुवाद झालेला आहे.

सदानंद देशमुख यांच्या 'बारोमास' या कादंबरीला २००४ मध्ये साहित्य अकादमी पुरस्कार प्राप्त झाला आहे. तसेच या कादंबरीचे हिंदी, इंग्रजी, उर्दू इत्यादी भाषेमध्ये अनुवाद झालेले असून या कादंबरीवर आधारित हिंदी भाषेतून चित्रपटही प्रदर्शित झालेला आहे.

सदानंद देशमुख यांनी 'बारोमास' या कादंबरी मधून समकालीन जीवनातील विविध प्रश्नांचा वेध घेतलेला दिसून येतो. यामध्ये प्रामुख्याने शेतकरी व शेतकऱ्यांच्या जीवनामध्ये येणारी अस्मानी व सुलतानी संकटे, नापिकी, दुबार पेरणी, अतिवृष्टी, ओला व कोरडा दुष्काळ, शासनाचे धोरण, व्यापारी वृत्ती, खासगी



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*Original Article*

# Numerical Simulations of Prey-predator System with Holling Type-IV Functional Response

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## Abstract

In this paper, we consider a mathematical model for a prey-predator system with a simplified Holling type-IV functional response. Sufficient conditions are derived for the stability of the system around equilibrium points. By numerical simulation, it shows that the system exhibits rich dynamics under different sets of conditions and by taking the different parameter values of  $\alpha$ .

**AMS Subject Classifications:** 92B05, 92D25, 93A30, 93C15, 93D99.

**Keywords:** Prey-predator model; Holling type-IV functional response; Equilibrium points; Dynamical behaviour.

## 1 Introduction

In the study of population dynamics, a functional response is the center of attention in many prey-predator mathematical models. Already, many authors proposed prey-predator models with different types of functional responses and studied global stability, limit cycle, Hopf bifurcation and chaotic behavior of their systems see [2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15, 16, 17, 19, 22, 23, 24, 25]. Holling [11] describes predator-prey model with Holling type-I functional response. Tripathi et al. [21] discussed the dynamics of prey-predator model with Beddington–DeAngelis type function response. Huang and Xiao [13] examined the prey-predator model with Holling type-IV function of the form

$$R(x) = \frac{mx}{a + bx + x^2}. \quad (R_1)$$

Already, the functional response ( $R_1$ ) is proposed by Andrews in [1]. Sokol and Howell proposed the experiment by consideration of simplified Holling type-IV function of the form

$$R(x) = \frac{mx}{a + x^2}, \quad (R_2)$$

Table 1: Definition of parameters in the model.

| Parameter | Definition                                                        |
|-----------|-------------------------------------------------------------------|
| $r$       | The maximum growth rate of the prey species.                      |
| $\alpha$  | The coefficient of intra-specific competition in the prey species |
| $a_1$     | The maximum predation rate of the predator species.               |
| $a_2$     | The interaction rate of the predator species.                     |
| $k$       | The half-saturation constant.                                     |
| $d$       | The death rate of the predator species.                           |

and found best kinetics parameters by non-linear least squares techniques see [20]. Ruan and Xiao [18] investigated the predator-prey model with simplified Holling type-IV functional response ( $R_2$ ). They studied the the saddle-node bifurcation, the supercritical and subcritical Hopf bifurcation, and the homoclinic bifurcation of the system.

In this paper, we consider the model equations of a prey-predator system with Holling type-IV functional response as follows:

$$\begin{aligned}\frac{dN_1}{dt} &= \left( r - \alpha N_1 - \frac{a_1 N_2}{k + N_1^2} \right) N_1 \\ \frac{dN_2}{dt} &= \left( \frac{a_2 N_1}{k + N_1^2} - d \right) N_2\end{aligned}\tag{1}$$

where  $N_i, i = 1, 2$  represent the population densities of prey and predator respectively and  $r, \alpha, a_i (i = 1, 2), k$  and  $d$  are assumed to be nonnegative constants defined in Table 1.

The main purpose of this paper is to study the dynamical behaviour of prey-predator system with simplified Holling type-IV functional response. In Section 2, we identified all possible equilibrium points of the model and discussed stability of the system under sufficient conditions. In Section 3, numerical simulations are performed and shows that the system exhibits rich dynamics under different sets of conditions and by taking the different parameter values of  $\alpha$ . Section 4 is the concluding section where results are discussed.

## 2 Equilibria and their stability

In this section, the existence of the equilibrium points of system (1) and their stability of each one are investigated. The system (1) always has trivial equilibrium point  $E_0(0, 0)$  and axial equilibrium point  $E_1(\frac{r}{\alpha}, 0)$ . The co-existence equilibrium point of the system

(1) is the intersection of the nullclines  $f_1(N_1, N_2) = 0$  and  $f_2(N_1, N_2) = 0$ , where

$$f_1(N_1, N_2) = r - \alpha N_1 - \frac{a_1 N_2}{k + N_1^2} \quad (2)$$

$$f_2(N_1, N_2) = \frac{a_2 N_1}{k + N_1^2} - d. \quad (3)$$

From (3), we have

$$N_1 = \frac{a_2 \pm \sqrt{a_2^2 - 4kd^2}}{2d}. \quad (4)$$

From (2) and (4), it is easy to see that if  $a_2^2 - 4kd^2 < 0$ , the system (1) does not have co-existing interior equilibrium point and if  $a_2^2 - 4kd^2 = 0$ , the system (1) has an interior equilibrium point  $E_2(\widehat{N}_1, \widehat{N}_2)$ , where

$$\widehat{N}_1 = \frac{a_2}{2d}, \quad \widehat{N}_2 = \frac{(r - \alpha \widehat{N}_1)(k + \widehat{N}_1^2)}{a_1}$$

exist if  $\frac{r}{\alpha} > \widehat{N}_1$  and if  $a_2^2 - 4kd^2 > 0$ , the system (1) has two interior equilibrium points i.e.  $E_3(\overline{N}_1, \overline{N}_2)$ , where

$$\overline{N}_1 = \frac{a_2 - \sqrt{a_2^2 - 4kd^2}}{2d}, \quad \overline{N}_2 = \frac{(r - \alpha \overline{N}_1)(k + \overline{N}_1^2)}{a_1}$$

exist if  $\frac{r}{\alpha} > \overline{N}_1$  and  $E_4(N_1^*, N_2^*)$ , where

$$N_1^* = \frac{a_2 + \sqrt{a_2^2 - 4kd^2}}{2d}, \quad N_2^* = \frac{(r - \alpha N_1^*)(k + N_1^{*2})}{a_1}$$

exists if  $\frac{r}{\alpha} > N_1^*$ .

For sake of simplicity, we denote  $\widetilde{N}_3 = \frac{2a_2 - \sqrt{a_2^2 - 4kd^2}}{2d}$  and  $\widetilde{N}_4 = \frac{2a_2 + \sqrt{a_2^2 - 4kd^2}}{2d}$ . The dynamical behavior of the system (1) at the equilibrium points can be studied by computing of the variational matrix  $J$  of the form

$$J = \begin{bmatrix} r - 2\alpha N_1 - \frac{a_1(k - N_1^2)N_2}{(k + N_1^2)^2} & -\frac{a_1 N_1}{k + N_1^2} \\ \frac{a_2(k - N_1^2)N_2}{(k + N_1^2)^2} & \frac{a_2 N_1}{k + N_1^2} - d \end{bmatrix} \quad (5)$$

**Theorem 1.** *The following statements hold for the system (1):*

- (i) *The trivial equilibrium point  $E_0$  is always a saddle point.*
- (ii) *The axial equilibrium point  $E_1$  is a stable node if  $d > \frac{a_2 r \alpha}{k \alpha^2 + r^2}$  and a saddle point if  $d < \frac{a_2 r \alpha}{k \alpha^2 + r^2}$ .*

*Proof.* (i) From some calculation, eigenvalues of the variational matrix (5) about the equilibrium point  $E_0$  is  $\lambda_1 = -d$  and  $\lambda_2 = r$ . Hence, the equilibrium point  $E_0$  is always a saddle point.

(ii) The variational matrix (5) about the equilibrium point  $E_1$  is given by

$$J(E_1) = \begin{bmatrix} -r & -\frac{a_1 r \alpha}{k\alpha^2 + r^2} \\ 0 & \frac{a_2 r \alpha}{k\alpha^2 + r^2} - d \end{bmatrix} \quad (6)$$

The eigenvalues of the variational matrix (6) are  $\lambda_1 = -r$  and  $\lambda_2 = \frac{a_2 r \alpha}{k\alpha^2 + r^2} - d$ . Hence, the equilibrium point  $E_1$  is a stable node if  $d > \frac{a_2 r \alpha}{k\alpha^2 + r^2}$  and  $E_1$  becomes a saddle point for  $d < \frac{a_2 r \alpha}{k\alpha^2 + r^2}$ . □

We have used the results proved in [18] to explore the dynamical behavior of the system (1) about the interior equilibrium points and stated in the following theorems.

**Theorem 2.** *The following statements hold for the system (1):*

- (i) *If  $4kd^2 < a_2^2 \leq \frac{16}{3}kd^2$  and  $\frac{r}{N_1^*} < \alpha < \frac{r}{N_1}$ , then system (1) has three equilibria: two saddle points  $E_0(0, 0)$  and  $E_1(\frac{r}{\alpha}, 0)$  and a globally asymptotically stable equilibrium  $E_3(\overline{N_1}, \overline{N_2})$  in the interior of the first quadrant.*
- (ii) *If  $4kd^2 < a_2^2 \leq \frac{16}{3}kd^2$  and  $\frac{r}{N_3} \leq \alpha < \frac{r}{N_1^*}$ , then system (1) has four equilibria: two saddle points  $E_0(0, 0)$  and  $E_4(N_1^*, N_2^*)$ , a stable node  $E_1(\frac{r}{\alpha}, 0)$  and a stable equilibrium point  $E_3(\overline{N_1}, \overline{N_2})$ , and system (1) has no closed orbit.*
- (iii) *If  $4kd^2 < a_2^2 \leq \frac{16}{3}kd^2$  and  $\frac{rd}{a_2} < \alpha < \frac{r}{N_3}$  then system (1) has four equilibria: two saddle points  $E_0(0, 0)$  and  $E_4(N_1^*, N_2^*)$ , a stable equilibrium point  $E_1(\frac{r}{\alpha}, 0)$  and a unstable equilibrium point  $E_3(\overline{N_1}, \overline{N_2})$ , and system (1) has unique limit cycle exists in the interior of the first quadrant.*
- (iv) *If  $4kd^2 < a_2^2 \leq \frac{16}{3}kd^2$  and  $\frac{r}{N_4} \leq \alpha \leq \frac{rd}{a_2}$  (or  $\alpha < \frac{r}{N_4}$ ) then system (1) has four equilibria: three saddle points  $E_0(0, 0)$ ,  $E_3(\overline{N_1}, \overline{N_2})$  and  $E_4(N_1^*, N_2^*)$  and  $E_1(\frac{r}{\alpha}, 0)$  a stable equilibrium and system (1) has no limit cycle exists (or has no closed orbit).*

**Theorem 3.** *The following statements hold for the system (1):*

- (i) *If  $\frac{16}{3}kd^2 < a_2^2$  and  $\frac{r}{N_3} < \alpha < \frac{r}{N_1}$  then system (1) has three equilibria: two saddle points  $E_0(0, 0)$  and  $E_1(\frac{r}{\alpha}, 0)$  and  $E_3(\overline{N_1}, \overline{N_2})$  is a stable focus.*
- (ii) *If  $\frac{16}{3}kd^2 < a_2^2$  and  $\frac{r}{N_1^*} \leq \alpha \leq \frac{r}{N_3}$  then system (1) has three equilibria: two saddle points  $E_0(0, 0)$  and  $E_1(\frac{r}{\alpha}, 0)$  and  $E_3(\overline{N_1}, \overline{N_2})$  is a unstable focus and system (1) has unique limit cycle which is stable.*

| Stability of equilibria for parameter values $r = 0.6, a_1 = 1, a_2 = 1.1,$<br>$k = 0.5, d = 0.7$ and different values of $\alpha$ . |        |        |       |          |        |                                          |
|--------------------------------------------------------------------------------------------------------------------------------------|--------|--------|-------|----------|--------|------------------------------------------|
| Different values of $\alpha$                                                                                                         | $E_0$  | $E_1$  | $E_2$ | $E_3$    | $E_4$  | Remark                                   |
| 0.75                                                                                                                                 | Saddle | Saddle | -     | Stable   | -      | $E_3$ is globally asymptotically stable. |
| 0.50                                                                                                                                 | Saddle | Stable | -     | Stable   | Saddle | No closed orbit exists.                  |
| 0.44                                                                                                                                 | Saddle | Stable | -     | Unstable | Saddle | A stable limit cycle around $E_3$ .      |
| 0.35                                                                                                                                 | Saddle | Stable | -     | Unstable | Saddle | No limit cycle and closed orbit.         |
| 0.24                                                                                                                                 | Saddle | Stable | -     | Unstable | Saddle |                                          |

Table 2: Dynamical Behaviour of the equilibria shown in Figure 1 to 4.

- (iii) If  $\frac{16}{3}kd^2 < a_2^2$  and  $\frac{rd}{a_2} < \alpha < \frac{r}{N_1^*}$  then system (1) has four equilibria: two saddle points  $E_0(0, 0), E_4(N_1^*, N_2^*)$  and stable equilibrium point  $E_1(\frac{r}{\alpha}, 0)$  and  $E_3(\overline{N_1}, \overline{N_2})$  is unstable focus.
- (iv) If  $\frac{16}{3}kd^2 < a_2^2$  and  $\frac{r}{N_4} \leq \alpha \leq \frac{rd}{a_2}$  (or  $\alpha < \frac{r}{N_4}$ ) then system (1) has four equilibria: two saddle points  $E_0(0, 0), E_4(N_1^*, N_2^*)$  and stable equilibrium point  $E_1(\frac{r}{\alpha}, 0)$  and  $E_3(\overline{N_1}, \overline{N_2})$  is unstable focus and system (1) has no limit cycle exists (or no closed orbits).

In the next section, we have carried out numerical simulations to prove and verify the statements shown in Theorem 2 and 3.

### 3 Numerical Simulations

We take two sets of parameter values, in the first set we fix  $r = 0.6, a_1 = 1, a_2 = 1.1, k = 0.5$  and  $d = 0.7$  for numerical simulations with initial condition  $N_1(0) = 0.5$  and  $N_2(0) = 0.5$  and different values of  $\alpha$ . For  $\alpha = 0.75$ , the interior equilibrium point  $E_3$  is globally asymptotically stable is shown in the Figure-1. Figure-2 represents the interior equilibrium point  $E_3$  is stable focus and system (1) has no closed orbit for  $\alpha = 0.50$ . If we take  $\alpha = 0.44$ , then the interior equilibrium point  $E_3$  is unstable and system (1) has unique limit cycle exists as shown in Figure-3. For  $\alpha = 0.35$  and  $0.24$ , the interior equilibrium point  $E_3$  is unstable and system (1) has no limit cycle and no closed orbit exists as shown in Figure-4. From the above first set, we have proved the statements in Theorem 2 numerically and the stability of equilibrium points is shown in Table 2.

**Stability of equilibria for parameter values  $r = 0.6, a_1 = 1, a_2 = 1.1,$   
 $k = 0.5, d = 0.5$  and different values of  $\alpha$ .**

| Different values of $\alpha$ | $E_0$  | $E_1$  | $E_2$ | $E_3$    | $E_4$  | Remark                              |
|------------------------------|--------|--------|-------|----------|--------|-------------------------------------|
| 0.50                         | Saddle | Saddle | -     | Stable   | -      | No closed orbit exists.             |
| 0.44                         | Saddle | saddle | -     | Unstable | -      | A stable limit cycle around $E_3$ . |
| 0.30                         | Saddle | Stable | -     | Unstable | Saddle | -                                   |
| 0.24                         | Saddle | Stable | -     | Unstable | Saddle | No limit cycle and closed orbit.    |
| 0.17                         | Saddle | Stable | -     | Unstable | Saddle |                                     |

Table 3: Dynamical Behaviour of the equilibria shown in Figure 5 to 8.

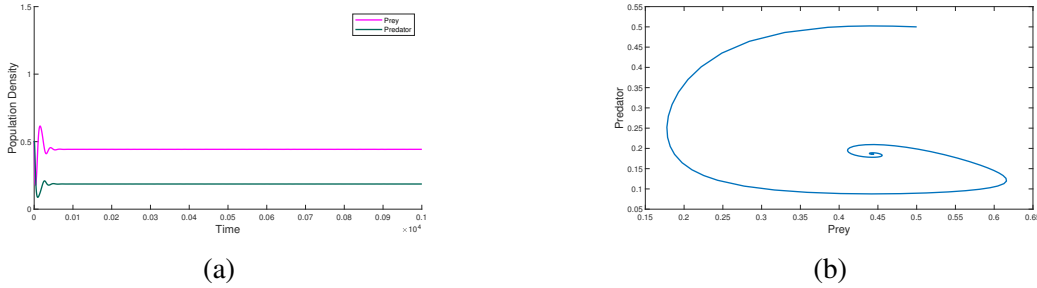


Figure 1: (1a) time series and (1b) a phase portrait of system (1) for  $\alpha = 0.75$ .

Now, we fix  $d = 0.5$  in the second set and remaining parameter values are same as in the first set with initial condition  $N_1(0) = 0.5$  and  $N_2(0) = 0.5$  and different values of  $\alpha$  for the numerical simulations. For  $\alpha = 0.50$ , the interior equilibrium point  $E_3$  is stable focus and system (1) has no closed orbit as shown in Figure-5. Figure-6 represents the interior equilibrium point  $E_3$  is unstable and system (1) has unique limit cycle exists for  $\alpha = 0.44$ . If we take  $\alpha = 0.30$ , then the interior equilibrium point  $E_3$  is unstable as shown in Figure-7. For  $\alpha = 0.24$  and  $0.17$ , the interior equilibrium point  $E_3$  is unstable and system (1) has no limit cycle and no closed orbit exists as shown in Figure-8. Based on the parameter values in the second set, we have verified the conditions in Theorem 3 and the stability of equilibrium points is shown in Table 3.

If we take  $k = 1.21, \alpha = 0.5$  and the rest of the parameter values are same as in the second set, then we have  $a_2^2 - 4kd^2 = 0$ . Therefore, the system (1) exhibits three equilibrium points:  $E_0$  is a saddle point,  $E_1$  and  $E_2$  are stable, and dynamical behaviour of the system is shown in Figure-9.



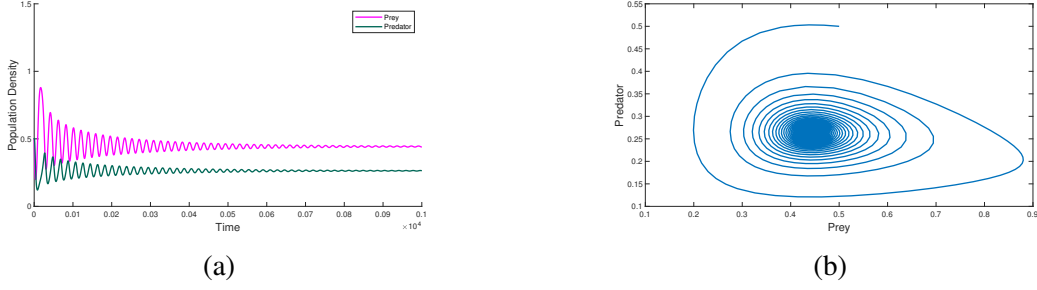


Figure 2: (2a) time series and (2b) a phase portrait of system (1) for  $\alpha = 0.50$ .

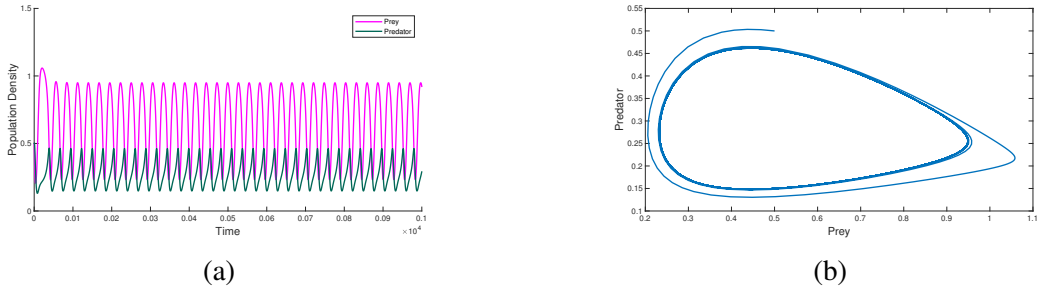


Figure 3: (3a) time series and (3b) a phase portrait of system (1) for  $\alpha = 0.44$ .

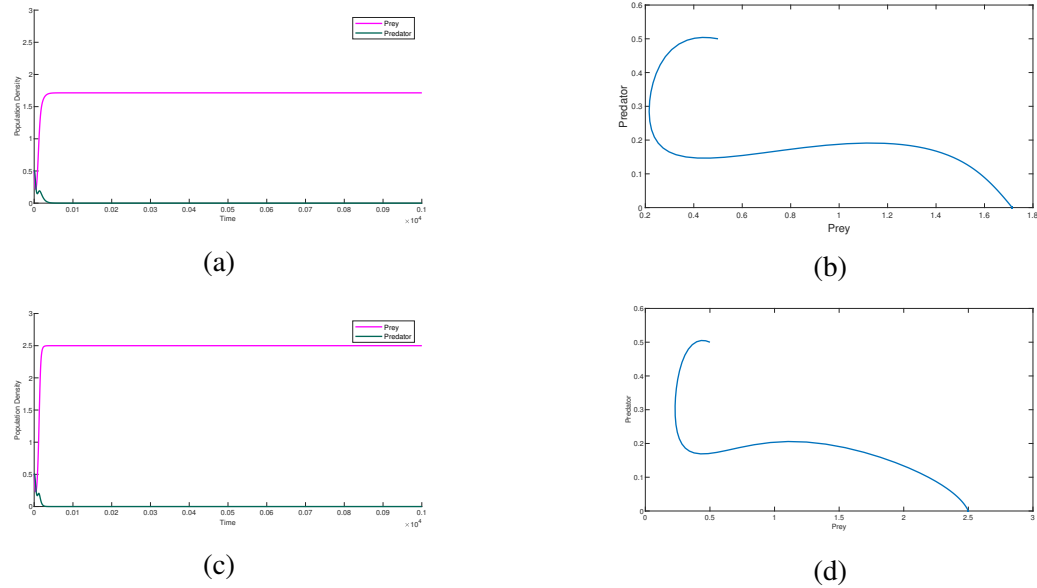


Figure 4: (4a) time series and (4b) a phase portrait for  $\alpha = 0.35$  and (4c) time series and (4d) a phase portrait of system (1) for  $\alpha = 0.24$ .

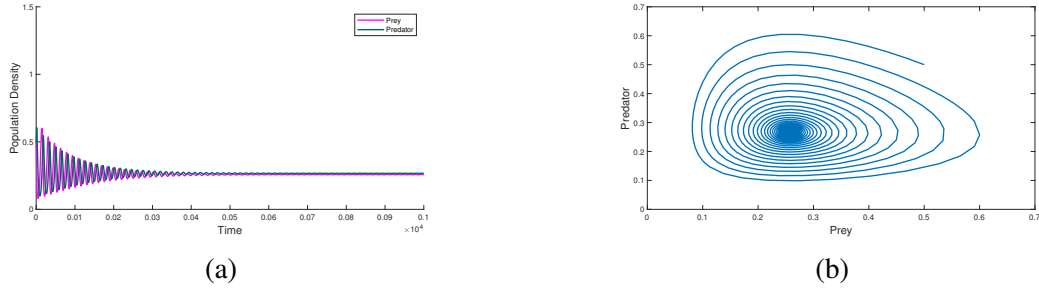


Figure 5: (5a) time series and (5b) a phase portrait of system (1) for  $\alpha = 0.50$ .

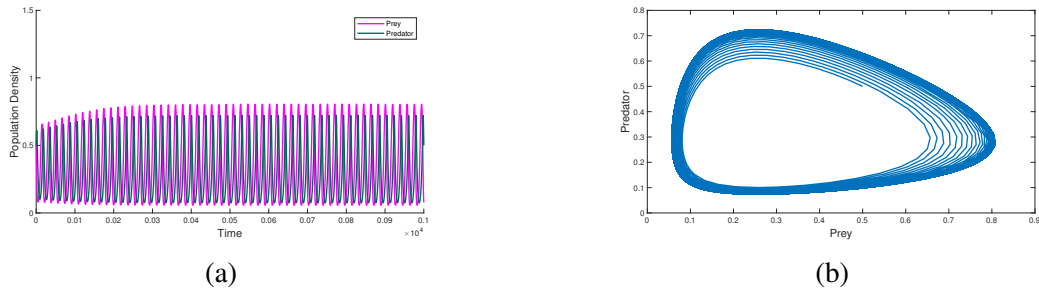


Figure 6: (6a) time series and (6b) a phase portrait of system (1) for  $\alpha = 0.44$ .

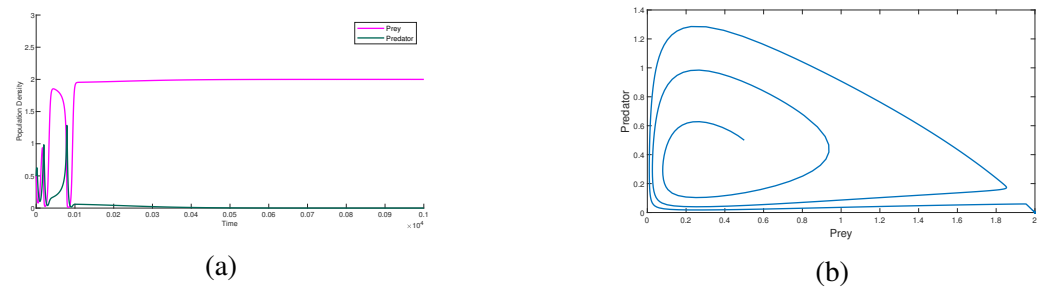


Figure 7: (7a) time series and (7b) a phase portrait of system (1) for  $\alpha = 0.30$ .

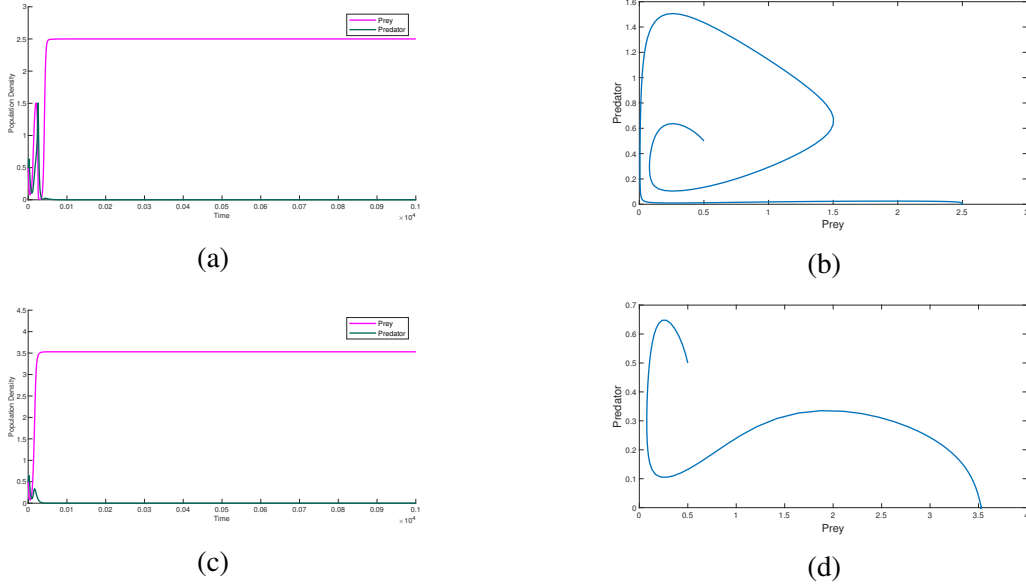


Figure 8: (8a) time series and (8b) a phase portrait for  $\alpha = 0.24$  and (8c) time series and (8d) a phase portrait of system (1) for  $\alpha = 0.17$ .

## 4 Conclusion

In this paper, the dynamical behaviour of the prey-predator system have been studied. The interaction between prey and predator is assumed to be governed by simplified Holling type-IV functional response. By using the results of Ruan and Xiao [18], we carried out the numerical simulations and exhibits the dynamical behaviour of the system (1). We consider two sets of parameter values and shows that the dynamical behaviour is rich and very sensitive for different values of  $\alpha$  (see Figures 1 to 9).

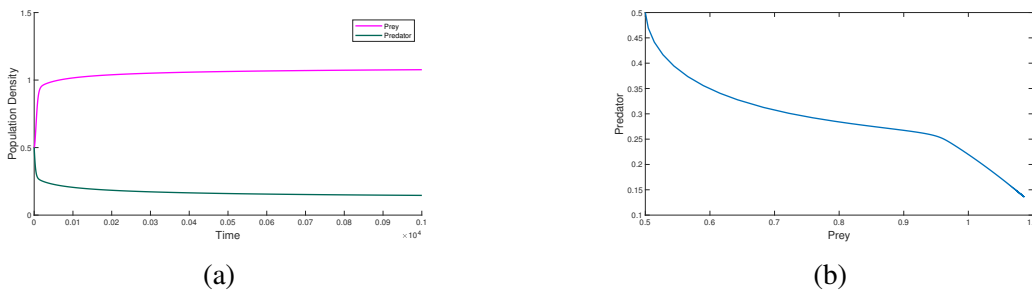


Figure 9: (9a) time series and (9b) a phase portrait of system (1) for  $r = 0.6, \alpha = 0.5, a_1 = 1, a_2 = 1.1, k = 1.21$  and  $d = 0.5$ .

## Conflicts of Interest

The author declare that there are no conflicts of interest.

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## National Development: Reality And Illusion

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## Abstract :-

The capacity of the country to improve the standard of living of its citizens is a National Development. The objective of this paper is to examine factors which responsible for National development. The hypothesis for this research paper is Indian National development figures shows exact condition in all sectors of the country. It has been evolved National development and reality at ground level. Indian development meets projected ratio and removes all sort of dissimilarities in different sectors. In India national development targeted through long term planning and in first phase priority has given to meet basic needs of the common people and after that priority diverted to achieve projected growth. Development was a big challenge in India specially in early period after independence because every sector in the country need development with lack of adequate resources. National development counts on various factors but basically main factor is fulfillment of basic needs of the common people. Development is a process that creates growth with positive change.

**Keywords:-** Development, Growth, Livelihood, Employment

## Introduction:-

National development is a term which includes improvement in living standard of the people, providing social amenities, increase in per capita income, medical care, education, social and other services to the people of the country. National development depends on the available resources and how much percentage of resources has been utilized for development. After independence India targeted developmental priorities with vast population, low per capita income, low agriculture and industrial productivity and limited resources. India adopted economic planning to achieve development priorities. India adopted mixed economic system which establish control of government over the economy and which was also useful for social justice. The economy of India is characterized as a developing market economy, it is the world's fifth largest economy by nominal GDP and third largest by purchasing power parity. According to IMF, on a per capita income basis, India ranked 142 by GDP and 119 by GDP in purchasing power parity, per capita income<sup>1</sup>. National developmental policies mainly focus on social infrastructure which includes education, health and other social services. Main objective of the national development policies is to improve living standard of the common people by removing dissimilarities in the society. National development shows ability of the Nation counts by various international organization and even compare with other countries. National development is measured by average income and per capita income, human development etc.

## National Development:-

National development includes to the improvement of a country in all areas, such as political, economic, social, cultural, scientific and material spheres. The capacity of a Nation to enhance its citizens standard of living is an indicator of the nation's level of development. Development target achieved in India, as shown 2020-2021 data that poverty headcount ratio is 10%, life expectancy found 70 years, still continuous growth of population is 0.8%, human capital index as (0-1) scale is 0.5<sup>2</sup>. This data shows continuous development of the Nation. As per count of US Dolor GDP is 3.18, as per per capita income GDP is 2256.6 that means growth of the GDP is 8.7%, unemployment reaches to the 6.0%, and as per consumer prize inflation reach to the 5.1%. As per the available data in India, forest area is 24.3%, as per population ratio access of electricity is 99.0%, people using safely manages sanitation services is 46%, Central governments total debt is 46.5% of GDP, 43% peoples individually using internet, 1.4% net inflow foreign direct investment of GDP. This year counted 3.71 tones per hectare crop production in India. Trade in goods and services is 18.4% of GDP<sup>3</sup>. National development counts all

sectors may be economic, social, cultural, trade, agri, production, industries etc. each common citizen consider as a beneficiary of achievement of National development. Development strategies occurs changes in every field. With a GDP of \$3.1 trillion, India is the world's sixth largest economy. The country has one of the highest GDP growth rates in the world. India's GDP will likely grow by 8 to 8.5% in financial year 2022. The economic growth has steadily accelerated in India, The GDP has increased from 4.4% in the 1970s and 1980s to 5.5% during the 1990s and further to 7% in the late 2010s. The country aims to become a \$5 trillion economy by 2025. Post 1991 liberalization, the growth rate has not only accelerated it also became stable. The transition of economy towards a stable service sector has also helped add stability to the economy. In 1917 GDP decreased by 1.46% as compare to 1916, In 1918 GDP decreased by 0.34% and in the year 2019 GDP decreased by 2.72%. In the year 2020 GDP decreased by 10.33% and in the year 2021 GDP increased to 15.54%. The main downfall of the GDP in the year 2019 – 2020, the reason behind is COVID – 19 pandemic situation. According to government estimates released in early January the Indian economy is seen expanding 7% in the 2022 – 2023 fiscal year. It follows an 8.7% growth in the previous year<sup>4</sup>. In its monetary policy meeting in December, the Reserve Bank of India revised its GDP growth forecast downwards to 6.8%. The IMF also projected 6.8% growth. The gross value added rose 6.7% with trade, hotels, transport boking the biggest gain (13.7%), followed by construction 9.1%, utilities (9%), financial and real estate (6.4%). Meanwhile, manufacturing grew a merge 1.6% and agriculture 3.5% .

## Reality and Illusion :-

The economy of India is characterized as a development market economy. The long term growth perspective of the Indian economy remains positive due to its young population and corresponding low dependency ratio, healthy savings and investment rates and its increasing integration into the global economy<sup>5</sup>. Indian economy achieved desirable goals of development but development could not achieve be balance goal. In India many sectors reaches to the targeted goal about development but benefits of this achieved development goal not equally distributed. Sector like rural areas still remain ignored as compare to other sectors specially technical sectors. Government tries to providing urban facilities in rural areas but still we can't find basic facilities in rural areas, such as proper roads, safe drinking water, sanitation, transportation etc. Large percentage of population still involved in traditional businesses related to agri and they can't find way to boost their income to meet their daily needs, it is a example of lack of human resources planning and management in the rural area. In our national development planning we are not prioritize rural development and we trying to provide infrastructure facilities related to foreign and other investments only. This kind of lack of strategy for rural development causes for migration and severe urban problems. Economic and other resources still centered in particular group of people or a class. Resources and assets should be distributed in society equally as possible. According to 2016 data when official data shows economic boosts but the reality shows that, in two decades private investment has shrunk,