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DIELECTRIC RELAXATION OFETHANOL IN BENZENE AT 300 K and 10.15 GHz

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Abstract:

Experimental measurements of dielectric constant (ε') and loss (ε") of ethanol in dilute solutions of benzene at room temperature and at 10.15 GHz frequency were carried out by Gopala Krishna single frequency concentration method which based on Debye equation has been utilized to analyze the dielectric data (ε' and ε") to obtain relaxation time (τ) electric dipole moment (μ).The values of relaxation time (τ) and electric dipole moment (μ) are thus obtained in this investigation are encouraging by in agreement with literature values.

Keywords:

Dielectric constant, Dilute solution, Microwave frequency, Dipole moment, Relaxation time.

Introduction:

Studies of dielectric constant, of polar liquids in dilute solutions in non-polar medium have a important role in liquid state [1-5] Dielectric constant is an electrical property of substances, which is due to contribution from orientation, vibration and electronic polarization. Dielectric measurement is mainly a probe to detect weak forces within the molecule and help to understand intermolecular dynamics of the solute. In the present paper, we have carried out dielectric measurements of a polar liquid ethanol in a non-polar medium (benzene) at single microwave frequency (10.15 GHz.) and at room temperature. The results are discussed to interpret molecular structure in terms of relaxation time (τ) electric dipole moment (μ) of of the dipole in the medium. Ethanol is a good industrial solvent useful in medicines and is a promising liquid to absorb microwave radiation. Therefore, methanol is taken as a system whose relaxation time studies have been carried out in this paper.

Material and Method:

The ethanol (LOBA Chemie) and non-polar benzene (sd-fine chem.) of AR grade obtained commercially and were used without any further purification. Dilute solutions of ethanol in benzene have been prepared in benzene at room temperature. The solution were mixed well and kept for 12Hrs. in a well stopper volumetric flask to ensured good thermal equilibrium. These systems in non-polar benzene were assumed to be dilute solutions. The X-band microwave bench was used to measure the wavelength of the microwave radiation in liquid dielectric cell. The liquid sample was hold vertically in a liquid cell by supporting a thin mica sheet whose VSWR and attenuation were assumed to be negligibly small. The liquid dielectric cell was attached at the end of microwave bench and maintained at room temperature. The following equations [6-7] are used to calculate dielectric constant, dielectric losses at microwave frequency.

$\varepsilon' = \{\lambda_0 / \lambda_c\}^2 + \{\lambda_0 / \lambda_d\}^2$ --(1)

$\varepsilon'' = 2/\pi[\lambda_0 / \lambda_d]^2[\lambda_g/\lambda_d]^2$--(2)

Where, λ_0 - Wavelength of microwave radiation. λ_0 – Cut off wavelength in the wave guide. λ_d - Wavelength of microwave radiation in liquid medium. The detailed procedure of measurement on X-band is describe elsewhere[4-6] A Gopala Krishna's single frequency method [8] based on Debye model is used to determine a relaxation time(τ) and electric dipole moment (μ) of polar liquid.

$[\varepsilon^*_1/ \varepsilon^*_2]=[\varepsilon_\infty-1]/ [\varepsilon_\infty-2]+[4\pi\eta\mu^2/9KT][1/(1+j\omega\tau)$------------------------------(3)

Where, $\varepsilon^*=\varepsilon'-j\varepsilon''$ $\tau = (1/\omega)(dy/dx)$--(4)

$\mu^2=9KTM/4\pi Nd_0\{1+(dy/dx)^2\}dx/dw$--(5)

Where, X and Y are the variables depend on concentrations of the polar liquid in non-polar medium.Refractive index of the dilute solutions were measured at room temperature using the Abbe's Refractometer.

Result and Discussion:

The physical and Molecular constants of polar and non polar compounds are reported in table No.1, below. Table no.1 The physical and Molecular constants of polar and non polar compounds S.No. compound Mol. Wt. M.P.oC B.P.oC R.I. Density gm/cc 1 Benzene 78.11 05 80 1.5010 0.874 2 Ehanol 46.07 130 98 1.3600 0.785 The determined values of dielectric constants (ε') and dielectric losses (ε") of ethanol in benzene are reported in Table 2, below. Table 2: Dielectric constants (ε') and dielectric losses (ε") of Ethanol in benzene medium at room temperature at microwave frequency. Sr. No. Wt. fraction (W) ε' ε" n2=ε∞ X Y 1 0.0211 2.4620 0.1197 2.2365 0.3281 0.0180 2 0.0245 2.4893 0.1296 2.2365 0.3323 0.01927 3 0.02793 2.5364 0.1574 2.2365 0.3395 0.02291 4 0.03132 2.5862 0.1977 2.2365 0.3471 0.02815 5 0.3468 2.6182 0.2758 2.2365 0.3527 0.03866 The parameters Y and X are plotted, which is linear in nature. From the slope of the straight line value of relaxation time (τ) is determined (τ = 3.9562 pS) and from the plot values of X and corresponding concentrations W, which is also linear in nature, whose slopes is used to determine the value of electric dipole moment of the ethanol (μ = 1.80 D) Fig (1) linear behavior between Y and X Fig (2) Linear behavior between X and W

Conclusion:

The values of dielectric constant (ε'), and dielectric loss (ε") of ethanol in dilute solution of benzene is increases with of concentration of polar substance in benzene. These vary with the concentration of the solution confirming that the solutions were sufficiently dilute. The optical dielectric constant for all concentrations indicating that the entire medium acts like benzene medium. The values of relaxation time (τ) = 3.9562ps and electric dipole moment (μ) = 1.8023D of ethanol in benzene which agree well with the values quoted in the literature[10]

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