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Study of dielectric measurement of benzonitrile in benzene solution at microwave frequency

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ABSTRACT

Dielectric constant (ε') and loss factor (ε") of benzonitrile in dilute solution benzene medium at room temperature and at 10.15 GHz frequency. Have been determined experimentally by using Smyth's method. Gopala Krishna single frequency concentration method based Debye equation has been utilized to analyze the dielectric data (ε' and ε") to obtain relaxation time (τ) electric dipole moment (μ) are utilized to explore the molecular structure .The values relaxation time (τ) electric dipole moment (μ) are obtained in this investigation are encouraging by in agreement with literature values.

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

INTRODUCTION

Studies of dielectric constant, of polar liquids and especially in dilute solutions in non-polar medium have a important role in liquid state [1-5] Dielectric constant is a molecular property of substances, which is due to contribution from orientation, vibration and electronic polarization. Dielectric investigation mainly probe weak forces and help to understand intermolecular reorientational dynamics of the solute as well. In the present paper, we have carried out dielectric measurements of a polar liquid Benzonitrile in a non-polar medium (benzene) at single microwave frequency (10.15GHz.) and at room temperature. The results are discussed to interpret molecular structure in terms of relaxation time (τ) electric dipole moment (μ) of reorientation motion of the dipole in the medium.

MATERIALS AND METHODS

The Benzonitrile (LOBA Chemie) and non-polar benzene (sd-fine chem.) of AR grade obtained commercially and ware used without any further purification. Dilute solutions of Benzonitrile for few dilute concentrations in benzene. 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 negligible 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 mirowave radiation.
λ_0 - Cutup wavelength in the wave guide.
λ_d - Wavelength of mirowave radiation in liquid medium.

The procedure of measurement on X-band is describe elsewhere [4-6]

A Gopala Krishna method [8] based on eq. (3) is is used to determine a relaxation time(τ) eq.(4) and electric dipole moment (μ) eq.(5) of polor liquid.

$[\epsilon^{*}-1/\ \epsilon^{*}-2]=[\epsilon_{\infty}-1]/\ [\epsilon_{\infty}-2]+[4\pi\eta\mu^2/9KT][1/(1+j\omega\tau)$----------(3)

Where,
$\epsilon^{*}= \epsilon'-j\epsilon''$
$\tau = (1/\omega)(dy/dx)$----------(4)
$\mu^2=9KTM/4\pi Nd_0\{1+(dy/dx)^2\}dx/dw$----------(5)

Where, x and y are the variables are depend on concentrations of the polar liquid in non-polar medium.

RESULTS AND DISCUSSION

The physical and Molecular constants of polar and non polar compounds are mentioned 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.^{o}C	B.P. ^{o}C	R.I.	Density gm/cc
1	Benzene	78.11	05	80	1.5010	0.874
2	Benzonitrile	103.12	13	188	1.5280	1.010

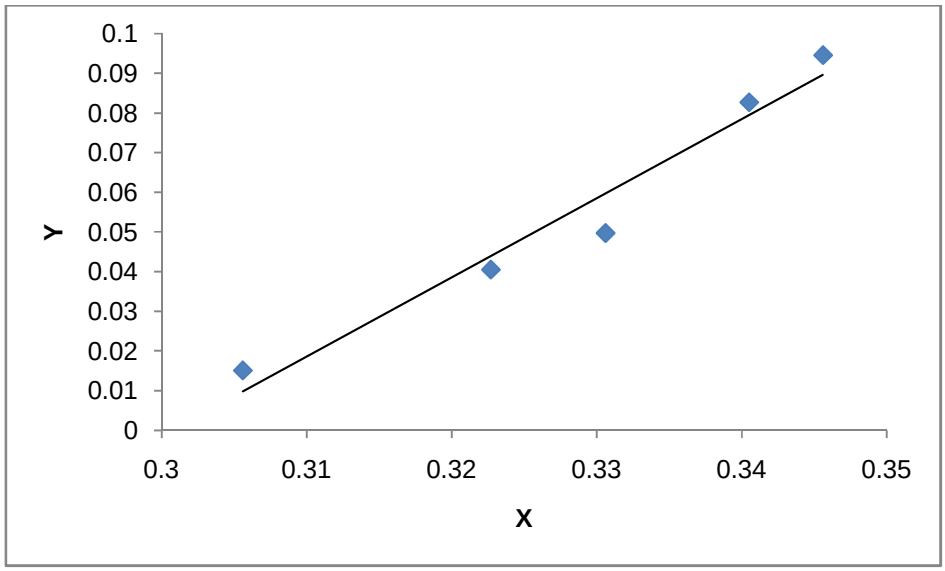
The determined values of dielectric constants (ε') and dielectric losses (ε'') of Benzonitrile in benzene are reported in Table 2, below.

Table 2: determined values of dielectric constants (ε') and dielectric losses (ε'') of Benzonitrile

Sr. N.	Wt. fraction (W)	**ε'**	**ε''**	X	Y
1	0.002305	2.3185	0.09415	0.3056	0.01513
2	0.0046011	2.4136	0.2640	0.3227	0.04051
3	0.006885	2.4572	0.3312	0.3306	0.049732
4	0.009160	2.4785	0.5615	0.3405	0.08268
5	0.01142	2.4907	0.6489	0.3456	0.09455

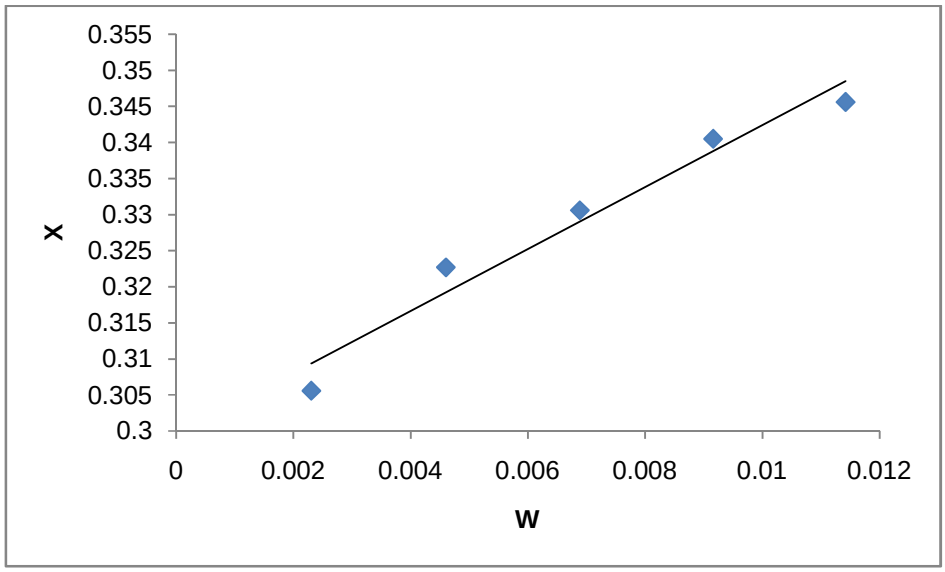
To determine relaxation time (τ) and dipole moment (μ) Y and X are plotted, Fig . (1).

Fig (1) linear behavior between Y and X



X and W are plotted which is also linear fig. (2), Determines relaxation time (τ) and dipole moment (μ) of Benzonitrile in non-polar Benzene medium.

Fig (2) Linear behavior between X and W



CONCLUSION

The values of dielectric constant (ε'), and dielectric loss (ε'') Benzonitrile in dilute solution of benzene is increases as function of concentration of polar substance. There vary with the concentration of the solution were sufficiently dilute to minimize the solute-solute interaction. The values of relaxation time (τ) = 7.7656 ps and electric dipole moment (μ) = 3.8499 D of Benzonitrile in benzene agree well with the values quoted in the literature [10]

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REFERENCES

[1]N.E.Hill, W.E.Voughan,A.P.Price and M. Davies, "Dialectic properties and molecular behavior", VanNorstand, Reinhold, London, **1969**, 232.
[2]A Chelkows, Dielectric Physics, Elsevies Scientific Publishing Co., New York, **1980**
[3]ANVRavi. Dhar and P.S.Sastry, *Ind.J.P.App.Phy.,Vol.27*, **1989**, 178.
[4]R.Pande, P.G.Gawali, B.S. Narwade, G.Rabbani and G.M.Kalmase in M.D.Shirsat(Ed.) Microwaves and Optoelectronics, Anamaya Pub. Delhi, **2004**, 90.
[5]A.N.Prajapati, V.A.Rana and A.D.Vyas in M.D.Shirsat(Ed.) Microwaves and Optoelectronics, Anamaya Pub. Delhi, **2004**, 94.
[6]M.L.Sisodia and G.S.Raghuvanshi, 'Basic microwave Techniques and laboratory manual', WielyEstern Ltd., New Delhi, **1990**
[7]W.M.Heston, A.D.Franklin,E.J.Hennell and C.P.Smyth, *J.Am. Chem.Soci.,Vol. 72*, **1950**, 3443.
[8]K.V.Gopala Krishna, Trans Farad. Soc. 53, 767, **1957**
[9]M.Ghosh, K.Sengupta and S.K.Roy, *Ind. J.Pure.App.Phy.*, 17, **1973**, 750.1
[10]V.S. Rangra and D.R.Sharam. *I.J.P. Appl.Phys. Vol. 41*, 630, **2003**
[11]B. M. Suryavanshi and S.C.Mehrotra.*Ind J. Pure Appl. Phys*., 29, 482,**1991**
[12] B. M. Suryavanshi: Study of rotational dielectric relaxation by non-resonance spectroscopy at microwave Frequency .Ph.D.Thesis submitted to Dr.B.A.M. Uni. Aurangabad.**Aug.1987**.