Microwave Absorbsion Of Dielectric Polar Liquids In Benzene

Shashikant B. Gedam[1*], Dr.Gopal Panda[2]

[1*,2]Department of Physics, Sarvepalli Radhakrishnan University ,Bhopal (India).

***Corresponding Author:** Shashikant B. Gedam
E-mail:- dr.shashigedam@rediffmail.com

Abstract
Dielectric constant (ε') and loss factor (ε") of polar liquids 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.

Keywords: 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 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 ethanol (LOBA Chemie) and non-polar benzene (sd-fine chem.) of AR grade obtained commercially and ware used without any further purification. Dilute solutions of polar liquids ethanol, nitrobenzene ,acetone and pyridine 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.

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

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

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 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.

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

Where,

$$\varepsilon^*=\varepsilon'-j\varepsilon''$$

$$\tau = (1/\omega)(dy/dx) \text{ -- } (4)$$

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

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

RESULT 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.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
3	Nitrobenzene	123.11	5.6	210	1.5513	1.196
4	Acetone	58.08	-94	56	1.3585	0.791
5	Pyridine	79.10	-42	115	1.5102	0.978

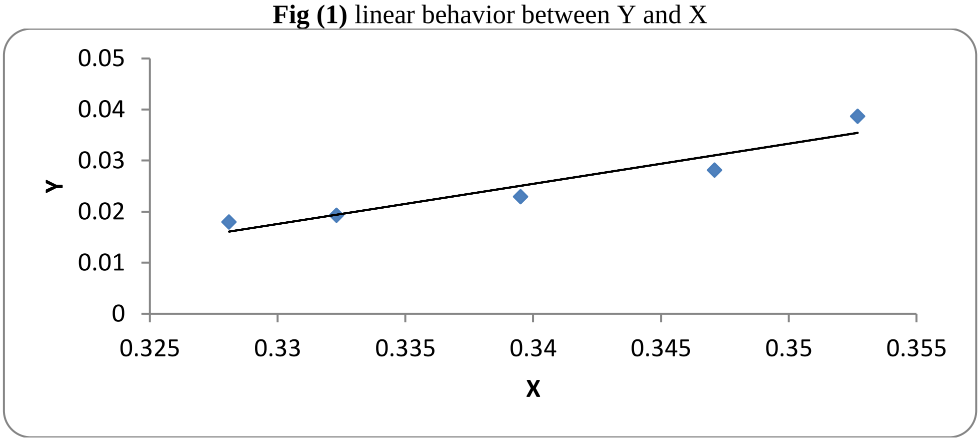
The determined values of dielectric constants (ε') and dielectric losses (ε'') of ethanol, in benzene are reported in Table 2, below.

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

Sr. No.	Wt. fraction (W)	**ε'**	**ε''**	$n^2=\varepsilon_\infty$	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

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

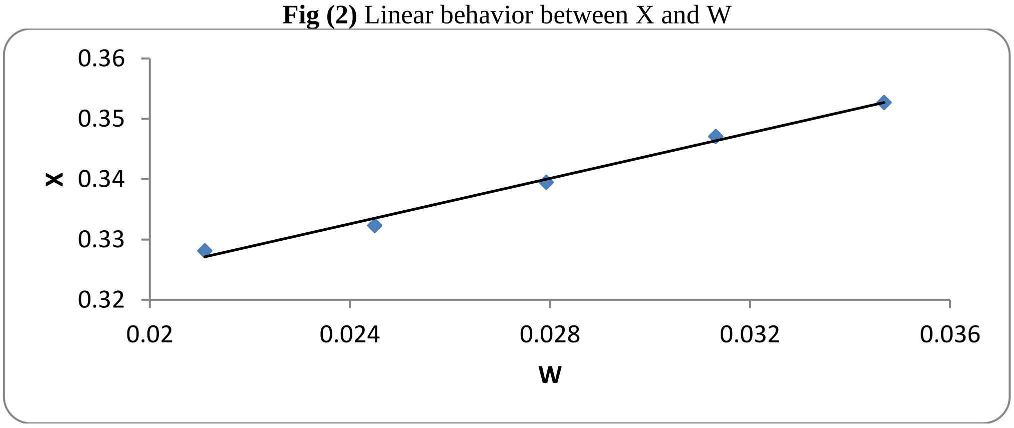
Fig (1) linear behavior between Y and X



Fig(1)

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

Fig (2) Linear behavior between X and W



Fig(2)

The determined values of dielectric constants (ε') and dielectric losses (ε'') of Nitrobenzene, in benzene are reported in Table 3, below.

Table 3: determined values of dielectric constants (ε') and dielectric losses (ε'') of Nitrobenzene

S N	Wt. fraction (W)	ε'	ε''	$n^2=\varepsilon_\infty$	X	Y
1	0.002729	2.3196	0.07866	2.25	0.3057	0.01264
2	0.005443	2.4083	0.1901	2.25	0.3207	0.02929
3	0.008143	2.4159	0.3220	2.25	0.3242	0.04928
4	0.010528	2.4782	0.3473	2.25	0.3341	0.05164
5	0.013499	2.5476	0.5648	2.25	0.3503	0.08069

To determine relaxation time (τ) Y and X are plotted, which linear fig (3).

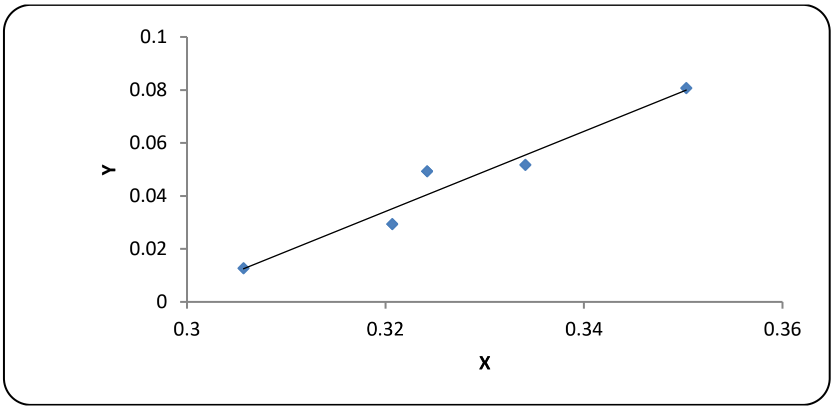


Fig. (3 linear behavior of Nitrobenzene between Y and X

X and W are plotted which is also linear fig (4) determines Dipole moment (μ) of Nitrobenzene in non- polar benzene medium

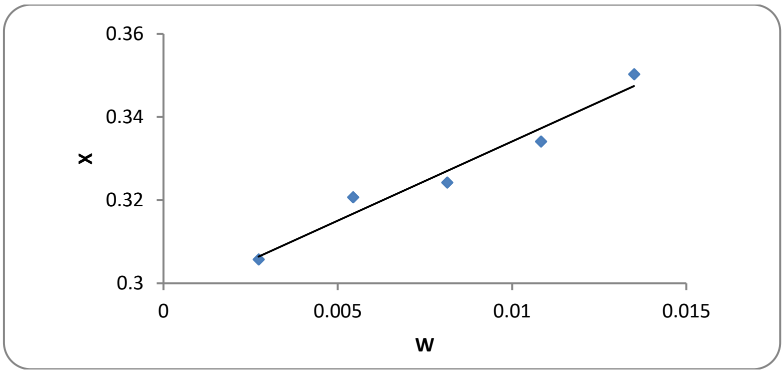


Fig. (4) linear behavior of Nitrobenzene between X and W

Table 4: determined values of dielectric constants (ε') and dielectric losses (ε'') of Acetone

S N	Wt. fraction (W)	ε'	ε''	$n^2=\varepsilon_\infty$	X	Y
1	0.003607	2.3188	0.04043	2.2620	0.3054	0.006502
2	0.007188	2.3719	0.04960	2.2620	0.3138	0.007784
3	0.008969	2.4045	0.07871	2.2620	0.3191	0.012168
4	0.01074	2.4225	0.1238	2.2620	0.3222	0.01897
5	0.01427	2.5309	0.1658	2.2620	0.3388	0.02420

To determine relaxation time (τ) Y and X are plotted, which linear fig (5).

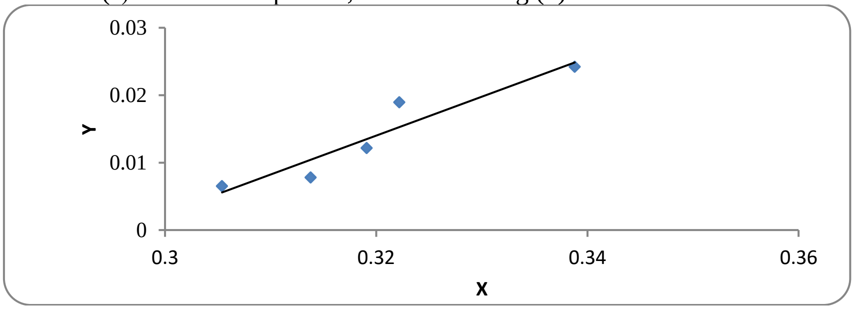


Fig. (5) linear behavior of Acetone between Y and X

X and W are plotted which is also linear fig (6) determines Dipole moment (μ) of polar liquids in non- polar benzen medium .

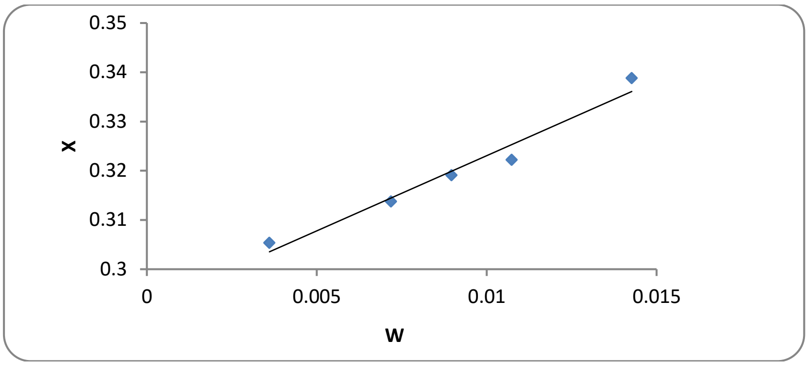


fig (6) linear behavior of Acetone between X and W

The determined values of dielectric constant (ε') and dielectric losses (ε'') of Pyridine in benzene solution are reported in Table 3.

S N	**Wt. fraction (W)**	**ε'**	**ε''**	$n^2=\varepsilon_\infty$	**X**	**Y**
1	0.01107	2.3064	0.0531	2.2590	0.3035	0.008589
2	0.01325	2.3747	0.0627	2.2590	0.3144	0.009826
3	0.01542	2.4140	0.1073	2.2590	0.3207	0.01651
4	0.01759	2.4314	0.1243	2.2590	0.3235	0.01897
5	0.01974	2..4712	0.2032	2.2590	0.3304	0.03043

To determine relaxation time (τ) and dipole moment (μ) X and Y are plotted, which linear fig (7).

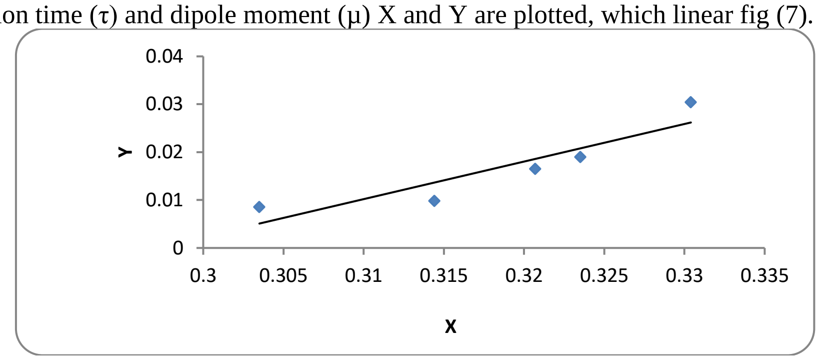


fig. (7) linear behavior relation of Pyridine between Y and X

X and W are plotted which is also linear fig (4) determines Dipole moment (μ) of polar liquids in non- polar benzen medium

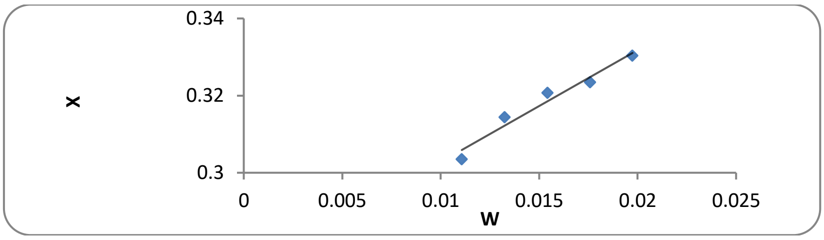


Fig. (8) linear behavior of Pyridine between X and W

Determines Dipole moment (μ) and relaxation time (τ) of polar liquids in non- polar benzen medium is given in Table 5. below.

Table. 5

Polar Liquids	Mol. Wt.	Relaxation Time in ps		Dipole moment in D	
		Exp	Lit.	Expt	Lit
Ethanol	46.07	3.9562	3.90	1.8023	1.70
Nitrobenzene	123.11	10.738	11.0	4.3208	3.96
Acetone	58.0	2.3940	2.15	2.4801	2.67
Pyridine	79.10	3.319	4.35	2.2799	2.25

CONCLUSIONS

The values of dielectric constant (ε'), and dielectric loss (ε'') polar liquids in dilute solution of benzene is increases as function of concentration of polar substance. They vary with the concentration of the solution were sufficiently dilute to minimize the solute-solute interaction. The optical dielectric constant for all concentrations indicating the entire medium acts like benzene medium The values of relaxation time (τ) and electric dipole moment (μ) of polar liquids in benzene agree well with the values quoted in the literature[10-12]

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