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Research Article

DIELECTRIC BEHAVIOR OF ANILINE AND ETHANE DIOL BINARY MIXTURES AT 9.85 GHZ MICROWAVE FREQUENCY

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ABSTRACT
Using Surber's technique of measuring reflection coefficient from the air-dielectric boundary of liquid, the dielectric constant ($\in'$), dielectric loss ($\in''$) of Aniline (*AN*) with Ethane diol (*ED*) and their binary mixtures for different mole fraction of aniline have been estimated at 9.85 GHz microwave frequency at 22^0C. The values of Density (ρ), viscosity (η), Sq. refractive index (nD^2) of binary mixtures as well those of pure liquids are reported. The excess square refractive index (Δn_D^2), excess viscosity ($\Delta\eta$), excess activation energy (ΔEa) of viscous flow has been estimated. These parameters are used to explain the formation of complex in the system (*AN* + *ED*).

Key Words: *Dielectric Parameters, Polarization, Binary Mixture and Complex Formation*

INTRODUCTION
Ethane diol is an organic compound widely used as automotive antifreeze & a precursor to polymers. It is used as a minor ingredient in shoe polish & also in some inks & dyes.
Aniline is an organic compound consisting of a phenyl group attached to an Amino group having various applications in the field of medicine, dye industry etc. (http://en.wikipedia.org/wiki/Anilene)
Dielectric studies of Aniline + Ethane diol mixtures provide useful information regarding the molecular interactions & the formation of complexes in the mixtures. In the present paper the investigations include the evaluation of dielectric constant ($\in'$)**,** dielectric loss ($\in''$), molar polarization (P_{12}) excess permittivity's (**Δέ, Δε″**), excess refractive index, viscosity and Activation energy.

MATERIALS AND METHODS
Pure samples of Ethanediol (ED) and Aniline of AR grade were procured from Spectrochem Pvt Ltd. Mumbai, were used without further purification. The binary mixtures of Aniline+ Ethanediol (ED) were prepared and kept for six hours in well-stoppered bottles to ensure good thermal equilibrium. The density (ρ) and viscosity (η) of pure components and their mixtures were measured by using pyknometer and Oswald's viscometer respectively. The refractive indices at sodium 'D' line were measured by using Abbe's refractrometer.
The dielectric parameters were measured by using Surber's technique (Sisodia and Raghuwanshi, 1990; Narawade *et al*., 2005) of measuring reflection coefficient from the air-dielectric boundary of liquid at 9.85 GHz microwave frequency at 22^0c.
The free energy of activation (Ea) is obtained by using relation (Hill *et al.,* 1968)

$$\eta = \left(\frac{hN}{V}\right) exp\left(\frac{Ea}{RT}\right)$$

And the values of polarization were obtained using formula (Chelkowski, 1980; Job, 1928)

$$P_{12} = \left(\frac{\epsilon'-1}{\epsilon''+2}\right)\left[\frac{M1X1-M2X2}{\rho}\right]$$

Where, M_1 and M_2 are the molecular weights X_1 and X_2 are the molar concentrations of the constituents of mixture and ρ the density of the mixture.

The excess values of permittivity ($\Delta\varepsilon'$ and $\Delta\varepsilon''$),excess viscosity ($\Delta\eta$), excess squre of refractive index (Δn^2_D) and the excess activation energy (ΔE_a) for ethandiol +Aniline system are calculated by using the relation of the form

$$\Delta Y = Y_m - (X_1Y_1+X_2Y_2)$$

Where, ΔY is the excess parameter and Y refers to the above mentioned quantities. The subscripts m, 1 and 2 used in the equation are respectively for the mixture, component 1 and component 2. X_1 and X_2 are the mole fraction of the two components in the liquid mixture.

RESULTS AND DISCUSSION

The values of density (ρ), viscosity (η), square of refractive index (n_D^2), dielectric constant ($\in'$), loss factor ($\in''$), loss tangent (Tanδ), activation energy (E_a), and molar polarization (P_{12}) with increasing mole fraction (X) of Aniline in the binary mixture of Aniline + ED are listed in table-1.

The plot of variation of dielectric constant (ε') with mole fraction (X_A) of Aniline (*AN*) in the mixture is depicted in figure (1). According to Job (1928), if the relationship observed between dielectric constant (ε') and mole fraction (X_A) for one of the components is not linear in the binary mixture. There is an occurrence of complication and the curve of dielectric constant (ε') against mole fraction (X_A) shows a change in slope at the mole fraction corresponding to the complex. In the present investigation, the change in slope occurs for the mole fraction of aniline at $X_A \approx 0.4$ for Aniline + ED indicates that the formation of complexes in the mixture. The same nature is observed in the curve of dielectric loss (**ε''**) against mole fraction of aniline as shown in figure (2).

Table 1: Values of dielectric parameters of binary liquid mixtures of aniline and ED at22^{0}c

S. No.	X_A	Density ρ	Viscosity η c.p.	n^2_D	έ	ε''	Tan δ	E_a	P_{12}
1	0.0000	1.113861	16.68855	2.04644	8.22717	2.20368	0.26785	4.80290	39.3789
2	0.0803	1.104276	17.35593	2.09852	7.25930	1.86495	0.25690	4.82573	39.52405
3	0.1692	1.08842	16.20741	2.15414	6.88518	1.78277	0.25892	4.78590	40.97093
4	0.2683	1.07888	15.12652	2.20157	6.75306	1.78625	0.26451	4.74559	42.89034
5	0.3793	1.066405	12.56774	2.27059	6.30212	1.60802	0.25515	4.63775	44.22778
6	0.5046	1.05597	10.27771	2.28575	6.14966	1.6277	0.26468	4.52061	46.5209
7	0.6471	1.04538	8.78125	2.39320	5.93231	1.57148	0.26490	4.42897	48.8746
8	0.8105	1.03337	6.15770	2.41491	5.72715	1.50929	0.26352	4.22229	51.64882
9	1.0000	1.01535	3.63536	2.50905	5.59721	1.44898	0.25850	3.91540	55.50227

Table 2: Values of excess dielectric parameters of binary liquid mixtures of aniline and ED at22^{0}c

S. No.	X_A	Δέ	$\Delta\varepsilon''$	Δη	Δn^2_D	ΔE_a
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0803	-0.75667	-0.27812	1.71555	0.01494	0.09410
3	0.1692	-0.896994	-0.29312	1.72746	0.02943	0.13316
4	0.2683	-0.768494	-0.21493	1.94013	0.03102	0.18080
5	0.3793	-0.92750	-0.30939	0.83026	0.04869	0.17148
6	0.5046	-0.75043	-0.19515	0.75803	0.00588	0.16554
7	0.6471	-0.59301	-0.14383	0.53539	0.04741	0.20037
8	0.8105	-0.36843	-0.08270	0.048759	0.00647	0.13871
9	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000

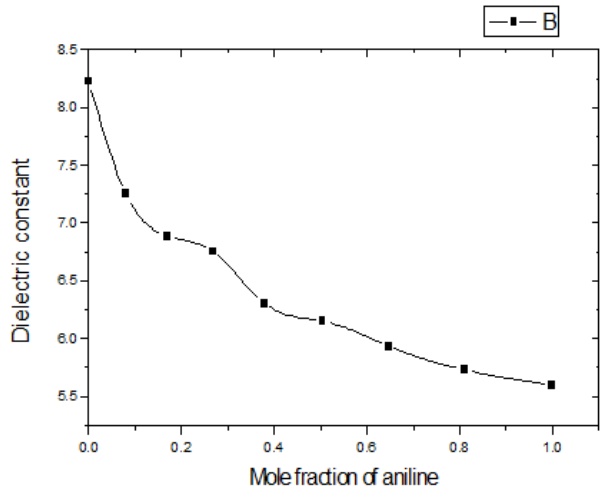

Figure 1: Variation of (ε') with (X_A)

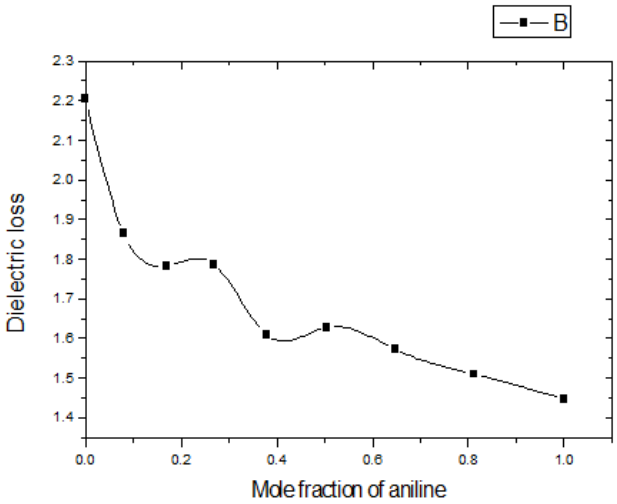

Figure 2: Variation of (ε") with (X_A)

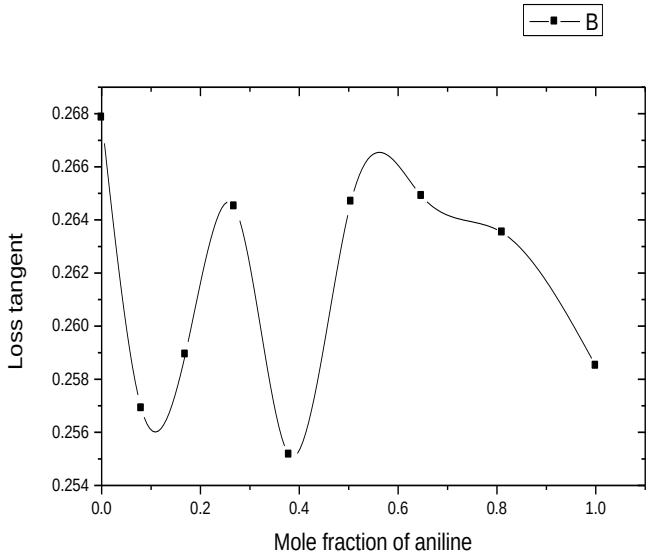

Figure 3: Variation (Tanδ) of with (X_A)

The variation of Tanδ with mole fraction of aniline. Two maximas and a minima was observed in the system Aniline + ED. Same type of behavior was obtained by Degonkar *et al.*, (1977). Since both amine and alcohol are polar liquids and in mixture of theses liquids a number of complexes may be formed due to the H-bond association the formation of such complexes may be responsible for the wobbling nature of the absorption curve. The values of excess viscosity ($\Delta\eta$), excess activation energy (ΔE_a) are positive indicating strong interactions between Aniline and ED molecules.

Conclusion

Values of dielectric parameters, viscosity, activation energy, excess dielectric parameters have been reported for different mole fractions of Aniline in the binary mixture of Aniline + ED. These studies suggest the strong interaction between Amine and Alcohol molecules.

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