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Studies of Binary Liquid Mixtures with Dielectric Relaxation

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Abstract:

The dipole moment and dielectric relaxation of the various concentration binary mixtures of ethylene glycol, Propylène glycol and Butylene glycol with dilute 1.4-dioxane solutions at 33°C.The dielectric relaxation in microwave frequencies of the binary mixtures of polar liquids in non-polar solvents has been attempted, providing significant information on the intermolecular and intramolecular relation among solutes and solvent molecules.At 303K, dilute solutions of 1,4-Dioxane have been reported for the static dielectric constants (ε_0) of glycols such as ethylene glycol, propylene glycol or glycol. The dipole meter was calibrated at 2MHz. The dielectric permittivity ($\dot{\varepsilon}$) and dielectric loss factor (ε'') determination was achieved with X-band and J-band microwave benches working at 9.52GHz and 7.72GHz.For the different compositions of the binary mixtures, the values for molecular relaxation time (τ_0) and dipole time (ν) are calculated.

The relaxation time (τ_0) values of both bands (X-band) and (J-band) for different molecular binary mixture conformation of the two bands.

***Keywords**: Dielectric relaxation, Dipole moment, Hydrogen bonding, Binary mixtures.*

Introduction:

Dielectric microwave relaxation studies are helpful in the investigation of molecular and intramolecular motion, solvent-solute interaction, solvent-solvent interaction or molecular conformations. The dielectric relaxation behavior of the binary mixture of useful industrial and biological compounds of the polar solvents has created considerable interest over the last couple of decades in its pure liquid state or even in non-polar Solvents under various composition conditions. It helps to shape adequate liquid relaxation models and to get information about the relaxation processes and the creation of their binary mixtures of molecular interactions.Ethylene glycol mono alkyl ethers, propylene glycol or butylene glycol are trade-named cello solves. This is used as synthetic solvents, surfactants, detergents or wetting agents.The compound molecules have hydrogen sites or can enter into intramolecular and intermolecular hydrogen connections, resulting in a number of various conformations. The Kirkwood correlation factor(g) values are less than the unit with antiparallel arrangements of its dipole moment in a pure liquid state, the mono alkyl ether

molecles of ethylene glycol, propylene glycom or butylene glycol are found in a hydrogen bonded linear structure in dynamic equilibrium. The values of dielectric microwave rest period depend on the size, shape and intermolecular interaction of the molecules. The intermolecular reorientation of the intermolecular liquid requires hydrogen bonds in an alternating electric field to be broken or reformed. It is also of great importance, then that the derlectric comportment of different concentrations at binary mixtures of EG, PG and BG molecules in non-polar solvents is examined, in order to understand the effects of the non-polar solvent system with the concentration variance of the binary hydrogen mixtures. Moreover, measuring of different dielectric parameters can be investigated to determine the impact of the carbon quantities i.e. chain length, on dielectric times and the impact of a non-polar solvent system on molecular dynamics.

The dielectric constant (έ) and dielectrical loss factor (εÚ) were calculated using the micro-wave bench at 303K (X band) and (J band).The WTW dipole meter style DM 01 based on the heterodyne beat method concept was used to calculate static dielectric constant(ε_0) at 2MHz.Consequently, dielectric investigations on glycols such as EG, PG, and BG were suitable for the use of microwave bench (X-J band).The binary system's refractometer with sodium D light as source was decide by the Abbe's refractometer.Refractometer measurements are used to produce high frequency dielectrical constants ($\varepsilon_\infty = n_D^2$) for pure and binary device.

Methodology:

Mono alkyl ethers of EG, PG and 1,4-Dioxane of puriss AR grade were obtained from Spectrochem Pvt.Ltd Mumbai(India). 1,4-Dioxane was used as

$$\left.\begin{aligned} \varepsilon_0 &= \varepsilon_1 + a_0 W_2 \\ \varepsilon' &= \varepsilon_1 + a'_0 W_2 \\ \varepsilon'' &= a'' W_2 \\ \varepsilon_\infty &= \varepsilon_{1\infty} + a_\infty W_2 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The Debyeequationintermsofa$_0$,a′,a″anda$_\infty$yieldstwoindependentequations

$$\tau_{(1)} = \frac{a''}{\omega(a' - a_\infty)}$$

$$\tau_{(2)} = \frac{a_0 - a'}{\omega a''} \quad \ldots\ldots\ldots\ldots\ldots\ldots..(2) \text{ and } (3)$$

Where $\tau_{(1)}$stands for the molecular relaxation time of the complex as a

$$\sqrt{\tau_{(1)} * \tau_{(2)}} = \tau_{(0)}$$

$\tau_{(2)}$whole and indicates the relaxation of the basemolecule.

may be called the mean h relaxation time. The free energy activation for dielectric relaxation (ΔF_τ) and viscous flow (ΔF_η) have been calculated using Eyring's equation (15)

$$\tau = \frac{}{KT}\exp\left[\frac{\Delta F\tau}{RT}\right] \quad \text{.....(4)}$$

$$\eta = \frac{NA\blacksquare}{V}\exp\left[\frac{\Delta F\eta}{RT}\right] \quad \text{.....(5)}$$

Where, h is planck,s constant, K is Boltzmann constant, N is Avagadro number and V is the molar volume.

Result and discussion

The dipole moment of the hydrogen bonded complexes will give information regarding structure and properties of the molecules . In the present study like EG, PG and BG are chosen for the study of molecular interaction with the non polar solvent. The dipole moment of the binary liquid systems were calculated by Onsager method.

The values are reported in the tables (1). In Onsager method, as the concentration of the solute increases the dipole moment values are decreases from many literatures it is found that Onsager's equation.

The linear correlation factor 'g' is a shape dependent parameter that helps in a quantitative interpretation of the liquid structure. In the case of these glycols with 1,4-Dioxane systems concentration increases 'g' values are decreases. The 'g' values decreases with the dilution can be explained by assuming conversion of α- multimers to β-multimers on dilution of an associated liquid with a non polar solvent, the value of 'g' undergoes a change, signifying the change in the nature of multimerization.

Table – 1:

Variation of ε_{12}, ε_{∞}, $\mu_{(D)}$, g, V^E and η^E with Mole fraction of glycols with 1,4 – Dioxane system

System	Mole Fraction of solute X_2	Static dielectric constant ε12	Dielectric constant at infinite dilution ε_{∞}	Onsager method μ(D)	Linear correlation factor (g)	Excess molar volume (V^E) x 10^{-6} m^3mol^{-1}	Excess viscosity (η^E) x 10^{-3} Nsm^{-2}
Ethylene Glycol	0.0160	2.3496	2.0036	2.6674	0.9671	0.6958	-0.1978
	0.0340	2.4732	2.0050	2.4421	0.9482	0.6931	-0.4381
	0.0500	2.5909	2.0064	2.3881	0.9372	0.6579	-0.6535
	0.0630	2.7672	2.0078	2.2173	0.9149	0.6344	-0.8628
	0.0650	2.8922	2.0093	2.0162	0.9055	0.4996	-0.7900
Propylene Glycol	0.0135	2.3543	2.0022	2.7822	0.9636	0.8378	-0.4714
	0.0352	2.5230	2.0050	2.6298	0.9462	0.8206	-1.2827
	0.0514	2.6222	2.0093	2.4720	0.9361	0.8183	-1.8832
	0.0669	2.7418	2.0121	2.4346	0.9238	0.8009	-2.4706
	0.0856	2.8984	2.0135	2.4205	0.9076	0.7898	-3.1334

Butylene Glycol	0.0169	2.3449	2.0022	2.6708	0.9646	1.1583	-1.1224
	0.0341	2.4983	2.0036	2.6189	0.9486	1.0476	-2.2188
	0.0520	2.6582	2.0050	2.5893	0.9319	1.0471	-3.3806
	0.0647	2.7141	2.0064	2.4526	0.9262	0.9189	-4.2002
	0.0855	2.8708	2.0078	2.4125	0.9100	0.7767	-5.5209

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