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Dielectric Relaxation Study of 1,2,6-hexanetriol+Allylamine Mixture Using Pico-second Time Domain Reflectometry Technique

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Abstract - The dielectric relaxation studies of 1,2,6-hexanetriol+Allylamine mixtures have been carried out in the frequency range of 10 MHz to 30GHz at different temperature using pico-second time domain reflectometry technique. The complex permittivity spectra of 1,2,6-hexanetriol+Allylamine mixtures were fitted in Havriliak-Negami equation. The static dielectric constant (ε_0), relaxation time (τ), and thermodynamic parameters in the mixtures have been determined.
Keywords-Dielectric relaxation; Time domain reflectometry; Thermodynamic parameters.

Introduction and Experimental:

Allylamine [$C_3H_5NH_2$] and Polyhydric alcohol have a wide range of chemical, biological, pharmaceutical, industrial and condensed matter physics applications [1-3]. Time domain reflectometry (TDR) is very useful technique to study the dielectric relaxation parameters of liquids [4-6]. The present paper reports the temperature dependant dielectric relaxation studies of allylamine-1,2,6-hexanetriol mixture in the frequency range of 10 MHz to 30 GHz using Time Domain Reflectometry technique.

The Allylamine, and 1,2,6-hexanetriol obtained from S. D. Fine Ltd. The Tektronix model no. DSA8200 along with the sampling module 80E08 has been used for the time domain reflectometry (TDR). Experimental method and data analysts were done earlier to determine complex permittivity spectra $\varepsilon^*(\omega)$ using non linear least squared fit method [5-9].

Result and discussion:

The dielectric permittivity ε' and dielectric loss ε'' of allylamine with 1,2,6-hexanetriol at 25˚C is shown in Fig.1. The complex permittivity spectra were fitted to a Havriliak-Negami equation in order to extract dielectric relaxation parameters [10-11].

$$\varepsilon^*(\omega) = \varepsilon_\infty + \frac{\varepsilon_0 - \varepsilon_\infty}{[1+(j\omega\tau)^{1-\alpha}]^\beta} \quad (1)$$

where ε_0 is the static permittivity, ε_∞ is the permittivity at high frequency, τ is the relaxation time, α and β are the relaxation distribution parameters. The temperature dependent dielectric parameters for allylamine-1,2,6-hexantriol mixtures are reported in Table 1.

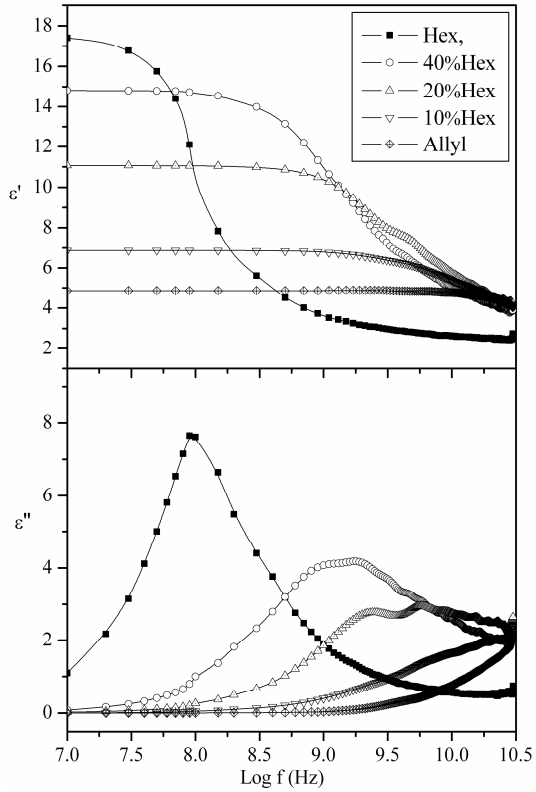

Figure 1. Complex permittivity spectra (ε′ & ε″) of allylamine-1,2,6-hexanetriol mixture at 25^0C.

Table 1. Dielectric parameters for allylamines-1,2,6-hexantriol mixture at different (25^0C, 20^0C, 15^0C, 10^0C) temperatures

Vol % of Hexnatriol	ε_0	τ(ps)	ε_∞	β	ε_0	τ(ps)	ε_∞	β
	25^0C				**20^0C**			
0	5.24(17)	4.33(10)	2.42(1)	0.852(1)	5.54(8)	5.42(10)	2.14(1)	0.812(1)
10	6.89(3)	9.51(3)	2.29(2)	0.838(1)	8.20(5)	9.35(4)	2.39(3)	0.814(1)
20	11.44(3)	26.36(33)	2.10(1)	0.713(5)	12.13(10)	28.52(79)	2.75(3)	0.746(1)
40	15.36(5)	89.87(1)	3.08(1)	0.737(4)	16.85(7)	120.42(1)	3.66(1)	0.733(5)
100	19.30(19)	1470.54(34)	2.58(2)	0.884(8)	18.06(18)	1480.71(36)	2.80(2)	0.883(9)
	15^0C				**10^0C**			
0	6.21(9)	5.98(10)	2.46(1)	0.782(1)	7.64(1)	6.61(10)	2.93(8)	0.890(1)
10	9.73(8)	7.65(5)	2.48(5)	0.793(2)	11.69(1)	6.21(6)	2.59(9)	0.747(3)
20	12.95(5)	26.55(45)	2.69(2)	0.679(7)	14.99(8)	22.29(58)	2.32(3)	0.584(8)
40	18.69(8)	153.44(2)	4.78(2)	0.712(5)	20.18(10)	182.23(4)	6.01(2)	0.692(6)
100	17.55(15)	1348.74(33)	3.45(1)	0.895(9)	16.39(16)	1327.40(42)	4.26(1)	0.885(1)

Numbers in bracket denotes uncertainties in the last significant digits obtained by the least square fit method. e.g. 5.24(17) means 5.24±0.17 and 1470.54(34) means 1470.54±0.34

Thermodynamic parameters:

The thermodynamic parameters evaluated using Eyring equation is as follows [12]-

$\tau = (h/KT) \exp(\Delta H/RT) \exp(-\Delta S/R)$ (2)

where ΔS is the entropy of activation, ΔH is the activation energy in kJ/mol. T is the temperature in K. The temperature dependence of relaxation time is described by Arrhenius plot Fig. 2. Activation energy (ΔH) for entire concentrations is positive reported as Table 2.

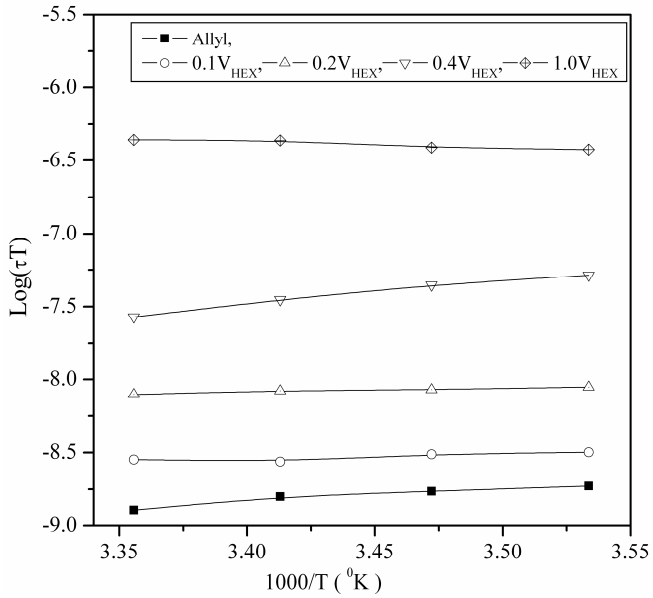

Figure 2. Arrhenious plot for allylamine+1,2,6-hexanetriol mixtures.

Table 2. Thermodyanmics parameters of amines-2,3-butanediol mixtures.

Vol % of Hexnatriol	*ΔH**	*ΔS**
0	16.69 (32)	0.258 (1)
10	6.00 (17)	0.216(6)
20	5.28 (88)	0.204(2)
40	30.65 (30)	0.279(3)
100	-7.84(13)	0.127(4)

*(ΔH** - Enthalpy, *ΔS** - Entropy), Numbers in bracket denotes uncertainties in the last significant digits obtained by the least square fit method. e.g. 16.69(32) means 16.69±0.32 and 0.258(1) means 0.258±0.001.

Conclusions:

The complex permittivity spectra of allylamines-1,2,6-hexantriol mixture have been studied using time domain reflectometry technique in the frequency range 10 MHz to 30 GHz.

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