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Physico Chemical Properties of Brompheniramine with 1-Methanol at 303K

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***Abstract*: Density (ρ), viscosity (η) and ultrasonic velocity (U) were measured of a binary liquid mixture consists of brompheniramine and 1-methanol at 303K. Adiabatic compressibility (β), free length (L_f), free volume (V_f), viscous relaxation time (τ) and Gibbs free energy (ΔG) were determined from the observed experimental values. Excess values of these parameters were calculated and correlated in terms of molecular interactions. Deviations in the excess values from the ideal mixing suggested that intermolecular interactions present in the selected liquid mixtures.**

***Keywords*: Brompheniramine, hydrogen bonding, intermolecular interaction and 1-methanol**

1. Introduction

Physico chemical studies in various binary and ternary liquid mixtures are used in the field of applied and theoretical research [1]-[3]. Ultrasonic velocity changes with the binding forces acting in a liquid mixture. Ultrasonic velocity changes with various concentrations are used to determine the intermolecular interaction present in the liquid systems [4]-[6]. Brompheniramine is an amine group compound used in common cold, allergic rhinitis. 1-methanol is polar and self-associated through hydrogen bonding in pure state [7]-[10]. In this present work report the physico chemical property changes in the brompheniramine with 1-methanol at 303K by using ultrasonic technique.

2. Theory

Using the experimental data, the following acoustical parameters have been calculated.

Ultrasonic wavelength $\lambda = \frac{2d}{n}$ (1)

Where d is the distance moved by the reflector and n is the number of oscillation produced by the ultrasonic interferometer.

Ultrasonic velocity $U = f\lambda$ (2)

Where, f is the frequency of ultrasonic wave.

Adiabatic compressibility $\beta = \frac{1}{U^2\rho}$ (3)

Where, ρ represents density of the liquid mixture.

Intermolecular free length $L_f = K_T\sqrt{\beta}$ (4)

Where K_T is a temperature dependent constant and is given as,

$K_T = (93.875+0.375\ T)\times10^{-8}$kelvin (5)

Suryanarayana *et al*. [11] have related the free volume in terms of ultrasonic velocity (U) and co efficient of viscosity (η) as given below,

Free volume $V_f = \left[\frac{M_{eff}U}{\eta K}\right]^{3/2}$ (6)

Here M_{eff} is the effective molecular weight; K is a temperature independent constant which is equal to 4.281 x 10^9 in S.I units for all liquid systems.

The viscous relaxation time $\tau = \frac{4}{3}\beta\eta$ (7)

Gibbs free energy $\Delta G = kT\ln\left(\frac{kT\tau}{h}\right)$ (8)

Where k is Boltzmann constant; T is absolute temperature and h is Planck's constant.

Excess parameters have been calculated using the following relation

$A^E = A_{exp}\text{-}A_{id}$ (9)

Here $A_{id} = \Sigma A_i\ x_i$ (10)

A_i represents any acoustical parameter and x_i is the corresponding mole fraction.

In all the mixtures x_1 and x_2 are represented the mole fraction of brompheniramine and 1-methanol respectively.

3. Experimental

Binary liquid mixtures were prepared by taking appropriate concentration of the liquids in the standard flasks. Masses of the liquid components were determined using digital electronic balance (ACM-78094L,ACMAS Ltd,India) with accuracy ±1mg. Density and viscosity were obtained by using specific

gravity bottle and Ostwald's viscometer with uncertainty ±0.01kgm^{-3} and ±0.001Nsm^{-2} respectively. A single crystal ultrasonic interferometer operated at 2MHz was used to determine ultrasonic velocity of the liquid system and the accuracy was in the order of ±1ms^{-1}.A constant temperature bath [INSREF model IRI-016C,India] with accuracy ±0.01K was used to maintained the temperature of the liquid components. Analytical Grade of brompheniramine and 1-methanol were used in this study without further purifications.

4. Result and discussions

Density (ρ), viscosity (η) and ultrasonic velocity (U) were experimentally measured. From the experimental data, adiabatic compressibility (β), free length (L_f), free volume (V_f), viscous relaxation time (τ) , Gibbs free energy (ΔG) were calculated for a binary mixture of brompheniramine and 1-methanol at 303K.

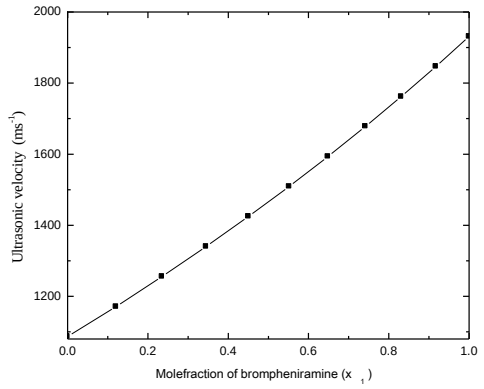

Fig. 1. Ultrasonic velocity variation with brompheniramine concentrations

Density of the binary mixtures increased with increasing concentration of the brompheniramine. These trends reveal that increasing concentration of the brompheniramine leads to associate the number of particles in a given region [12],[13].Decreasing the values of viscosity with increasing mole fraction of 1-methanol is show that that the intermolecular interaction between the brompheniramine and 1-methanol is weakend. The increases in density and viscosity with increase in concentration of brompheniramine leads the intermolecular forces in the liquid mixture [14], [15].

Ultrasonic velocity increased with increasing mole fraction of brompheniramine is as shown in figure1. These changes signify that structural occurring in the selected liquid system. Adiabatic compressibility increased with increasing mole fraction of 1-methanol is suggested that the medium is easily compressed. Increasing values of free volume with brompheniramine concentrations reveal that dipolar interaction between the amine group of brompheniramine and hydroxyl group present in the 1-methanol.Viscous relaxation time increased with increase in concentration of brompheniramine up to a critical mole fraction 0.5516, above which decreased with decreasing 1-methanol concentration . Gibbs free energy decreased in the liquid mixture supported the intermolecular interaction in the present liquid system as listed in Table 1.

Excess values of β^E, L_f^E , V_f^E, τ^E and ΔG^E were shown in Table 2. Positive excess values signified the dispersion forces, while the negative values suggested that dipole-dipole, charge transfer interaction and hydrogen bonding between the liquid mixtures.

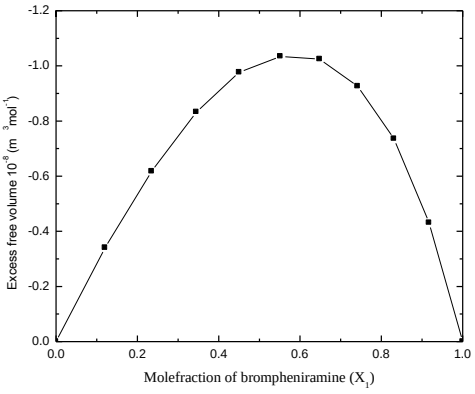

Fig. 2. Excess free volume variation with brompheniramine concentrations

Fort *et al.* [16] reported that the negative excess compressibility values increased with the strength of molecular interaction of binary liquid mixtures. In this present work, excess compressibility β^E values were negative. It was

Table 1
Physical and acoustical change in parameters of brompheniramine with 1- methanol at 303K

X_1	ρ (Kgm^{-3})	η × 10^{-3} (Nsm^{-2})	U (ms^{-1})	β ×10^{-10} (m^{2}N^{-1})	L_f ×10^{-10} (m)	V_f × 10^{-8} (m^{3}mol^{-1})	τ × 10^{-12} (s)	ΔG × 10^{-20} (KJmol^{-1})
0.0000	781.9	0.4958	1087	10.824	0.6826	6.6466	0.7155	0.6304
0.1203	830.0	0.7487	1171	8.7802	0.6148	6.9927	0.8764	0.6075
0.2352	878.1	1.0016	1256	7.2211	0.5575	7.3714	0.9643	0.5843
0.3452	926.2	1.2546	1340	6.0109	0.5087	7.7845	1.0054	0.5608
0.4506	974.3	1.5075	1425	5.0571	0.4666	8.2423	1.0164	0.5368
0.5516	1022.5	1.7604	1509	4.2952	0.4300	8.7610	1.0081	0.5114
0.6485	1070.6	2.0133	1593	3.6791	0.3980	9.3246	0.9875	0.4862
0.7416	1118.7	2.2662	1678	3.1755	0.3697	9.9538	0.9594	0.4604
0.8311	1166.8	2.5192	1762	2.7599	0.3447	10.6551	0.9270	0.4339
0.9172	1214.9	2.7721	1847	2.4139	0.3223	11.4516	0.8921	0.4064
1.0000	1263.0	3.0250	1931	2.1324	0.3023	12.3552	0.8564	0.3780

Table 2
Excess parameters change in brompheniramine with 1- methanol at 303K

X_1	β^E $\times 10^{-10}$ (m^2N^{-1})	L_f^E $\times 10^{-10}$ (m)	V_f^E $\times 10^{-8}$ (m^3mol^{-1})	τ^E $\times 10^{-12}$ (s)	ΔG^E $\times 10^{-20}$ ($KJmol^{-1}$)
0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1203	-0.9975	-0.0221	-0.3404	0.1440	0.0075
0.2352	-1.5564	-0.0356	-0.6179	0.2157	0.0133
0.3452	-1.8095	-0.0426	-0.8328	0.2148	0.0175
0.4506	-1.8465	-0.0446	-0.9765	0.2095	0.0201
0.5516	-1.7295	-0.0428	-1.0345	0.1937	0.0202
0.6485	-1.5022	-0.0380	-1.0243	0.1806	0.0195
0.7416	-1.1959	-0.0309	-0.9265	0.1394	0.0172
0.8311	-0.8330	-0.0218	-0.7359	0.0944	0.0133
0.9172	-0.4302	-0.0115	-0.4307	0.0474	0.0075
1.0000	0.0000	0.0000	0.0000	0.0000	0.0000

increased in the lower concentrations and decreased in the higher concentrations of brompheniramine. Moreover increasing negative excess free length L_f^E suggested that the strength of molecular interaction increased with the molefraction of brompheniramine.

Variation of excess free volume with the concentration of brompheniramine was as shown in Fig. 2. The changes signify that the negative excess free volume increased in a critical mole fraction (x_1=0.5516) then decreased in the higher concentration.

Hence, the negative excess free volume can be supported the hydrogen bonding (N-H·····O-H) occurred in the liquid mixtures. The higher concentration ($x_1 > 0.5516$) of brompheniramine rupture of hydrogen bonding associate with 1-methanol. Positive excess relaxation time τ^E and excess Gibbs free energy ΔG^E increased with concentrations of brompheniramine. It is suggested that the molecules also rearranged due to cooperative process.

5. Conclusion

Physico chemical properties were determined in the binary mixture of brompeniramine and 1-methanol at 303K.The determined excess values and their sign suggested the hydrogen bonding interaction formed between the amine group of brompheniramine and hydroxyl group of 1-methanol. Moreover increase in ultrasonic velocity with increase in the concentration of brompheniramine supported that strong intermolecular forces present in the liquid system based on the brompheniramine concentrations.

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