ORIGINAL RESEARCH PAPER

Chemistry

KEY WORDS: Density, Ultrasonic Interferometer, UltrasonicVelocity, Viscosity, Water bathcyber pharmacy.

SOLVENT SOLVENT INTERACTION IN A TERTIARY MIXTURE AT DIFFERENT TEMPERATURES BY ULTRASONIC TECHNIQUE

S.R.Dudhat Asstt.Prof,SRES's ,College of Engineering,Kopargaon,SPPU,Pune,India

S.S.Chine* Asstt.Prof,SRES's ,College ofEngineering,Kopargaon,SPPU,Pune,India
*Corresponding Author

ABSTRACT

The basic parameters like viscosity ( ), density( ) and velocity (U) can be measured by ultrasonic Interferometer. From these three parameters various thermodynamical and acoustical parameters such as specific acoustic impedance (Z), Intermolecular free length (Lf), adiabatic compressibility's ( ) etc can be estimated using standard relations from measured values of Ultrasonic viscosities, densities and velocities in the wide range of concentrations at 350 C, 400C and 450C temperatures for Acetone + Propanol-2 +chloroform tertiary system. The solvent-solvent interactions are studied on the basis of increase or decrease in ultrasonic velocity, density, viscosity and other derived acoustical parameters in terms of structure making and structure breaking tendencies of various solvent molecules.

1. Introduction

The study of molecular interactions in the liquid mixtures is of considerable importance in the elucidation of the structural properties of the molecules. Lagemann and Dunbar [4] were the first to point out the sound velocity approach for qualitative determination of the degree of association in liquids. Recent developments have made it possible to use ultrasonic energy in medicine, engineering, agriculture and other industrial applications.[5,6] .Ozawa and Minamisawa [7] have observed concentration of ultrasonic velocity invariant with respect to temperature in alcohol-water mixtures. Hanel[8] has measured sound velocity and thickness of thin samples by time –resolved acoustic microscopy. Bae and Yun [9] have studied the ultrasonic velocity in binary solutions of silicon dioxide and water. Knowledge of thermodynamic and acoustical properties is of great importance in studying the physio-chemical behavior and molecular interactions in a variety of liquid mixtures(1,3). The compositional dependence of thermodynamic properties has proved to be a very useful tool in understanding the nature and extent of pattern of molecular aggregation resulting from intermolecular interaction between components.

2. Experimental details

Ultrasonic velocity for the mixture was measured using the ultrasonic interferometer (Model M 81) supplied by Mittal Enterprises, New Delhi, that has a reproducibility of ± 0.4 m/s at 250 C with a fixed frequency of 3 MHz. The temperature was maintained constant by circulating water from a thermodynamically controlled water bath (accuracy ±0.1 0 C). The temperature of the cell as measured using a thermocouple was found to accurate to ± 0.25 0 C. The density of the mixtures has been measured using a sensitive pycnometer with an accuracy of 0.5 kg/m3. Chemicals used in this study are ultra pure ,supplied by Sigma-Aldrich Ltd and used without purification. Tertiary system is studied at different temperatures, 350 C, 400C and 450C with different concentrations of the system .Especially for this system ultrasonic velocities, densities and viscosities of the mixtures have been measured at different temperatures.

3.Theory

Other acoustical parameters such as adiabatic compressibility (( ),Intermolecular free length (Lf) ,Molar Sound velocity(R), Specific acoustic impedance (Z) etc can also be determined.

Intermolecular free length (Lf) $=K\beta^{1/2}$ (1)

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

Where k values for different temperatures were taken from the work of Jacobson[29]; at 35,40 and 45o C the K values are 637, 642 & 647 respectively.

Molar sound velocity (R) =U1/3 V (3)

Molar compressibility(B) = $\left(\frac{M}{\rho}\right)\beta^{-1/7}$ (4)

where V and M are the molar volume and molecular weight of the mixtures, respectively.

Specific acoustic impedance (Z) =ρU (5)

The excess adiabatic compressibility (βE) and excess intermolecular free length (LfE) are evaluated by the following expressions:

$\beta E = \beta exp - \beta ideal$ (6)

$(L_f^E) = L_{f.exp} - L_{f.ideal}$ (7)

For β_{ideal} and $Lf._{ideal}$, the densities and the ultrasonic velocities of various components in pure state at the three given temperatures have been measured. Further, the velocities of both the systems at different concentrations and temperatures have been evaluated theoretically using volume additive rule[21] as :

$U_{ideal} = U_1 \emptyset_1 + U_2\emptyset_2 + U_3\emptyset_3$ (8)

Where U_1, U_2, and U_3 are the velocities of the three components of the ternary liquid mixture in pure state and $\emptyset_1, \emptyset_2$ and $\emptyset_3$ are their volume fractions .

Simillarly ideal density is evaluated using

$P_{ideal} = \rho_1 \emptyset_1 + \rho_2 \emptyset_2 + \rho_3 \emptyset_3$ (9)

Finally βideal and $Lf._{ideal}$ are evaluated using following equations

$\beta_{ideal} = \frac{1}{U^2_{ideal.}\, \rho ideal}$ (10)

and

$L_{f.ideal} = K\beta^{1/2}_{ideal}$ (11)

Table 1 Conversion of CGS units to SI units.

No	Parameter	CGS units	SI units
1	Ultrasonic velocity (U)	1 cms^{-1}	$10^{-2} ms^{-1}$
2	Density (ρ)	1 g cm^{-3}	10^{3} Kg m^{-3}
3	Adiabatic compressibility (β)	1dyn^{-1} cm^2	10 $N^{-1}m^2$
4	Intermolecular free length (L_f)	1A°	10^{-10} m
5	Molar sound velocity (R)	1 cm^3 mol^{-1} $(cm\ s^{-1})^{1/3}$	$10^{-20/3}$ m^3 mol^{-1} $(ms^{-1})^{1/3}$
7	Molar compressibility (B)	1 cm^3 mol^{-1} $(dyn^{-1}$ $cm^2)^{-1/7}$	$10^{-43/7}$ m^3 mol^{-1} $(N^{-1}m^2)^{-1/7}$
8	Wave number (λ)	1 cm^{-1}	10 m^{-1}

Table 2 Ultrasonic velocity, Density and viscosity of Tertiary mixture at different temperatures

Temp	Mole Fraction (Acetone) X_1	(Propanol) X_2	(Chloroform) X_3	Ultrasonic velocity m/sec	Density(ρ) gm/cm^3	Viscosity (η) centipoise
35 ^{0} C	0.1432	0.05851	0.8362	931	1.3009	0.5424
	0.1431	0.05852	0.8364	933	1.3001	0.5420
	0.1430	0.05854	0.8366	934	1.2291	0.5413
	0.1429	0.05858	0.8367	936	1.2290	0.5410
	0.1425	0.05859	0.8369	938	1.2289	0.5406
	0.1424	0.05862	0.8371	941	1.2288	0.5404
	0.1423	0.05866	0.8373	940	1.2286	0.5401
	0.1421	0.05869	0.8375	939	1.2284	0.5399
	0.1419	0.05871	0.8378	939	1.2280	0.5397
	0.1417	0.05875	0.8375	938	1.2279	0.5392
40^0 C	0.1432	0.05851	0.8362	937	1.2278	0.5391
	0.1431	0.05852	0.8364	939	1.2275	0.5389
	0.1430	0.05854	0.8366	941	1.2271	0.5386
	0.1429	0.05858	0.8367	945	1.2269	0.5384
	0.1425	0.05859	0.8369	946	1.2267	0.5381
	0.1424	0.05862	0.8371	948	1.2265	0.5378
	0.1423	0.05866	0.8373	945	1.2263	0.5376
	0.1421	0.05869	0.8375	943	1.2261	0.5372
	0.1419	0.05871	0.8378	941	1.2259	0.5373
	0.1417	0.05875	0.8375	938	1.2258	0.5371
45^0 C	0.1432	0.05851	0.8362	938	1.2252	0.5369
	0.1431	0.05852	0.8364	940	1.2250	0.5367
	0.1430	0.05854	0.8366	944	1.2247	0.5365
	0.1429	0.05858	0.8367	948	1.2243	0.5362
	0.1425	0.05859	0.8369	950	1.2242	0.5358
	0.1424	0.05862	0.8371	953	1.2241	0.5355
	0.1423	0.05866	0.8373	951	1.2239	0.5352
	0.1421	0.05869	0.8375	949	1.2237	0.5349
	0.1419	0.05871	0.8378	947	1.2233	0.5342
	0.1417	0.05875	0.8375	946	1.2229	0.5340

4.RESULTS

Ultrasonic velocity, density and viscosity for the acetone,propanol-2 and chloroform have been listed in table 2.The appropriate conversion of CGS units to SI units have been provided in Table 1 .

5.CONCLUSION

It is seen from that at 350 C ultrasonic velocity (U) increases with increasing concentration attains a maximum value at 0.1424 mole fractions. The non- linear variation of ultrasonic velocity with concentration indicates occurrence of complex formation between unlike molecules. The molecular association becomes maximum at those concentrations where velocity maxima occurs. This may be interpreted due to the formation of strong hydrogen bonding resulting into complex formation producing displacement of electrons and nuclei. The chemical interaction may involve the association due to hydrogen bonding, due to dipole –dipole interaction or due to the formation of charge transfer complexes. All these processes may lead to strong interaction of forces.(fort and Moore,1965). The density and viscosity of the tertiary solution decreases with decrease in concentration of the solution..

ACKNOWLEDGEMENT : I am very much thankful to our Principal Dr.D.N.Kyatanavar and our Management for encouraging and supporting me for doing the Research work
in our institute and made the facilities available for the same.

REFERENCES

[1] R.J.Lagemann, W.S.Dunbar, "Solvent-Solvent interaction in a aqueous medium of binary mixture at different temperature", Indian Journal of pure Physics and Chemistry, 49,1945 pp. 231-237.
[2] S.K.Chauhan, V.R.Singh, "Solvent-Solvent interaction in a aqueous medium of binary mixture", Indian Journal of pure Physics and Chemistry, 31, pp. 635.
[3] R.L.Blokhra, A.Nag, "Study of Solvent-Solvent interaction in a aqueous medium", Indian Journal of pure Physics and Chemistry , 29, 1991,pp. 756.
[4] A.Ozawa, A.Minamisawa, "Study of Solvent-Solvent interaction in a aqueous medium", Indian Journal of pure Physics and Chemistry , 37,1998, pp. 279.
[5] Hanel, A.Skumiel, Acustica, "Solvent-Solvent interaction in a aqueous medium of binary mixture", Indian Journal of pure and Applied Physics,81,1995,pp. 117.
[6] Bae , Yun, "Study of Solvent-Solvent interaction in a aqueous medium", Journal of Applied Physics, 84,1998,pp. 668.
[7] M.Rastogi, A.Awasthi, M.Gupta, P.Shukla, "Solvent-Solvent interaction in a aqueous medium of binary mixture", Journal of.Molecular Liquid(Netherland), 107,2003 pp. 185.
[8] M.Rastogi, A.Awasthi, M.Gupta, J.P.Shukla., "Study of Solvent-Solvent interaction in a aqueous medium", Indian Journal of pure Physics and Chemistry, Journal of.Molecular Liquid, 80,(1),1999 pp. 77.
[9] S.B.Khasare, B.A.Patki, "Solvent-Solvent interaction in a aqueous medium of binary mixture", Indian Journal of pure and Applied Physics, 25,1987 pp. 180,
[10] A.awasthi, J.P.Shukla, "Study of Solvent-Solvent interaction of binary mixture at different temperatures",Ultrasonics (GB), 41,2003,pp.477,
[11] A.N.Kannappan, R.Palani,. "Solvent-Solvent interaction in a aqueous medium of binary mixture"Indian Jurnal of Physics vol.No.70B(1),1996,pp 59.
[12] S.K.Saxena,M.C.Saxena, "Study of Solvent-Solvent interaction of binary mixture at different temperatures" 19,1981 ,pp 550.
[13] D.D.Perrin,W.L.F.Armarego,Purification of Laboratory Chemistry,third ed.,Pergamon Press.Oxford,1988.
[14] H.Dunken,H.Fitsche, "Study of Solvent-Solvent interaction of binary mixture at different temperatures"Journal of Chem and Physics, vol. no.2 pp345, 1962.
[15] B.Jacobson, "Solvent-Solvent interaction in a aqueous medium of binary mixture" Journal of Chemistry and Physic,8,1952,pp 927.