EXCESS ULTRASONIC AND DIELECTRIC SETTINGS ANALYSIS: COMPLEX FORMATION BETWEEN 2-METHOXY ETHANOL (2-ME) AND ALLYL AMINE (AA)

[1]Munigala Vinod Kumar, [2]Umadevi Chilukuri
[1,2]Assistant Professor, [1,2]Department of Physics, Siddhartha Institute of Engineering and Technology, Hyderabad, India.

Abstract
Information on material dielectric and ultrasonic behaviour provides better insight into the choice of solid and liquid insulating materials. The excess characteristics of liquid mixes are discovered to be more responsive to intermolecular interaction between the constituent components. The degree of the contact between dissimilar molecules determines the sign and magnitude of the excess characteristics. Two liquid mixes' densities, viscosities, and ultrasonic velocities The relationship between Allyl Amine (AA) and 2-ethoxy ethanol (2-EE) has been studied at room temperature at a fixed frequency (2 MHz). When Allyl Amine (AA) is combined with 2-Methoxy Ethanol, the liquid dielectric constant () and dielectric loss () have been evaluated using Surber's approach at a single microwave frequency 9.85 GHz for varying mole fractions of AA. The ultrasonic velocity (U), viscosity(η) and density (ρ), dielectric constant (ἐ)are used to estimate acoustic and dielectric parameters along with their excess values. Ultrasonic and Dielectric parameters are being used to explain the formation of complexes in the system.

Keywords
Ultrasonic velocity, Molecular interaction, Complex formation, X-band microwave bench, AllylAmine (AA),2-Methoxy Ethanol (2-ME)

Introduction
The nonlinear fluctuation of ultrasonic velocity and associated acoustic and excess parameters is connected to the physiochemical characteristics of liquid mixtures. In 2004 (Jerie K.), (M. I. Alaraguppi. 2006) (2012) Sahu S. et al. (2013) Gangwar Munendra Kumar et al. Binary mixtures' composition and the development of complexes through molecular interaction were revealed by dielectric analysis. When molecules create complexes, their features are altered.
The current work focuses on the binary liquid combination of AA and 2-EE's acoustic and dielectric characteristics. Both are polar, with 2-EE acting as a solvent and AA as the solute. 2-EE is firmly connected by an intermolecular hydrogen bond because it is a good proton donor and acceptor.
The paper focused on the molecular interaction between binary mixtures of polar liquids. The possible formation of AA and 2-ME complex may be due to molecular association between theseliquids.

Material And Methods

In the present study allyl amine and 2-Methoxy Ethanol of AR grade were procuredfrom Across, Qualigen, Merck and S.D. fine chemical, Mumbai respectively and usedwithout further purification. Samples of solution with different mole fractions of Allylamine in 2-Methoxy Ethanol were prepared. The density (ρ), viscosity (η) andultrasonic velocity (U) of pure components and their mixtures were measured usingpycknometer, Ostwald's viscometer and ultrasonic frequency interferometer modelNo. M-83 provided by Mittal Enterprises, New Delhi, India, respectively. Acousticparameters were computed according to**R.S.Kawaleet al ; 2015.**The refractive indices for Sodium-D-lines were measured by Abbe'sRefractometer. The Dielectric constant measurements were carried out from theX-band microwave bench of oscillating frequency 9.85 GHz using Surber'sTechnique.The values of (ἐ)

and (ε̈) for low loss liquids are calculated according to**Hestone, W. H.et al** ;1950Other dielectric parameters Loss tangent loss tangent($tan\ \delta$),,molar polarization (P_{12}) and activation energy (E_A)are obtained according to **TumberphaleU.B:2013.**

Excess Acoustic impedance (ΔZ) etc. parameters were calculated using the relation. $\Delta Y = Y_m - (X_1Y_1+X_2Y_2)$

Where, ΔY is any excess parameter, and Y refers to above mentioned parameter. Thesubscripts m, 1 and 2 used in the above equation are respectively for the mixture,component (1) andcomponent (2). X_1 and X_2 are the mole fractions of twocomponents in the liquid mixture.

Results and Discussion:

The values of mole fraction ofAllyl Amine AA(X_A), density (ρ)Viscosity (η),Ultrasonic velocity (U), dielectric constant (ε̇), and refractive index (n^2_D) are reported in Table -1.

Table-1
Mole fraction of Allyl Amine AA(X_A), density (ρ)Viscosity (η) , Ultrasonic velocity (U),refractive index (n^2_D), dielectric constant (ε̇), and refractive index (n^2_D)for binary mixture at 30^0 C.

X_A	Densityρ	Viscosityη cp	Ultrasonicvelocity m/sec U (ms^{-1})	ε̇	N^2_D
0	0.9591	1.5225	1653.32	9.0615	1.9724
0.2578	0.9157	1.3340	1328.89	8.4503	1.9979
0.3847	0.8854	1.1845	1471.10	8.4703	2.0007
0.5103	0.8464	1.0182	1431.11	7.7720	1.9989
0.6346	0.8302	0.7705	1466.66	7.9383	2.0194
0.7576	0.8038	0.6068	1302.22	7.3701	2.0188
0.8794	0.7897	0.5312	1297.76	6.9952	2.0179
1	0.7610	0.4130	1275.55	6.3802	2.0170

The values of Excess ultrasonic velocity (ΔU), Excess adiabatic compressibility($\Delta\beta_{ad}$),Excess intermolecular free length (ΔL_f) and excess impedance (ΔZ) of the binaryliquid mixture of **AA+ 2-ME** with mole fraction ofAA are reported in Table - 2.

Table -2 Excess ultrasonic velocity (ΔU), Excess adiabatic compressibility($\Delta\beta_{ad}$),Excess intermolecular free length (ΔL_f) and excess impedance (ΔZ) of the binaryliquid mixture of **AA+ 2-ME** with mole fraction ofAA .

X_A	ΔU ms^{-1}	$\Delta \beta ad$ $(10^{-10}m^2 N^{-1})$	ΔL_f $(10^{-11}m)$	ΔZ $(10^6 kgm^{-2}s^{-1})$
0	0	0	0	0
0.1317	-222.601	1.225204	0.595354	-0.20633
0.2578	-275.67	1.638963	0.769354	-0.25608
0.3847	-36.8919	-0.23884	-0.02312	-0.04658
0.5103	110.0009	-1.38024	-0.50098	0.085285
0.6346	6.116031	-0.49982	-0.12869	-0.03047
0.7576	-111.3670	0.581823	0.297509	-0.11431
0.8794	-69.3614	0.342175	0.183712	-0.07663
1	0	0	0	0

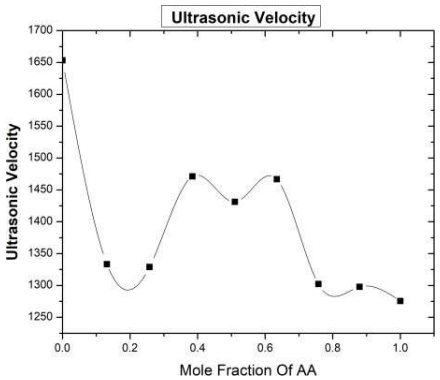
Excess parameter like dielectric constant ($\Delta\acute{\varepsilon}$), dielectric loss ($\Delta\ddot{\varepsilon}$), loss tangent ($\Delta$tan δ), activation Energy (ΔE_a) and molar polarization (ΔP_{12}) for binary mixture at 30^0 Calong withMole fraction (x) of Allyl Amine AA are reported in Table -3.

Table -3

Excess parameter dielectric constant ($\Delta\acute{\varepsilon}$), dielectric loss ($\Delta\ddot{\varepsilon}$), loss tangent ($\Delta$tan δ), activation Energy (ΔE_a) and molar polarization (ΔP_{12}) along withMole fraction (x_A) of Allyl Amine AA.

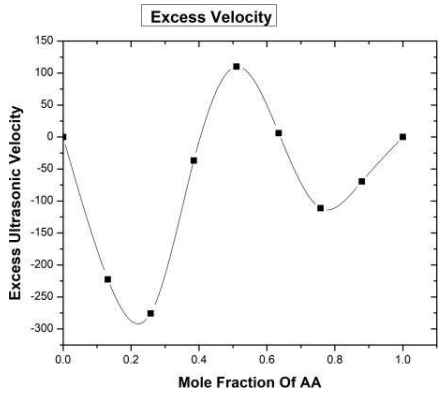
X_A	X_B	$\Delta\eta$	$\Delta\acute{\varepsilon}$	$\Delta\ddot{\varepsilon}$	Δtan	ΔP_{12}	ΔE_a
0	1	0	0	0	0	0	0
0.1317	0.8698	0.0975	0.2880	0.0872	0.0023	-0.2370	0.1180
0.2578	0.7422	0.0975	0.0800	0.0122	0.0009	-0.9920	0.1372
0.3847	0.6153	0.0888	0.4403	0.2083	0.0141	-0.0553	0.1631
0.5103	0.4897	0.0619	0.0788	0.0079	0.0011	0.7728	0.1683
0.6346	0.3654	-0.0479	0.5784	0.1336	0.0015	1.7765	0.0956
0.7576	0.2424	-0.0751	0.3400	0.1036	0.0050	1.5901	0.0459
0.8794	0.1206	-0.0156	0.2917	0.1167	0.0080	0.2628	0.0592
1	0	0	0	0	0	0	0

Figure-1



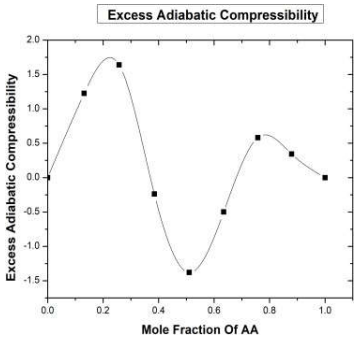
The ultrasonic velocity values vary nonlinearly in figure-1 shows the existence of strong interactions between the components of molecules in the binary mixtures. This indicates the Dipole-dipole interaction or hydrogen bonded complex formation between unlike molecules **(Ravichandran, S. 2011)**In present system the formation of the complex is likely to be at 0.5103. the minima between the two maxima **Deogaonkar VS (1977).**

Figure-2



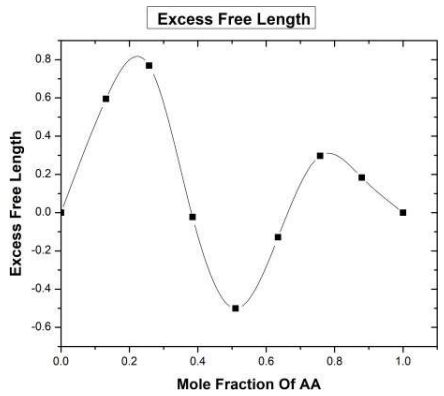
Excess **velocity fig-2** shows a slight negative deviation in allyl amine and 2-methoxy ethanol mixture and relatively large positive deviation at **X=** 0.5103 in allyl amine and 2 methoxy ethanol mixture suggesting the presence of weak and strong dipole – induced dipole interactions in the molecules respectively.

Figure-3



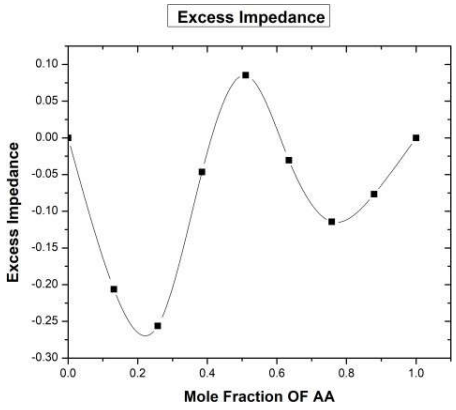
Variation of Excess adiabatic Compressibility(Δβad) with molar concentration (*X*) of AA in the mixture is depicted in figure-3 which is increasingly positive up to X= 0.3154 then negative and becomes positive for rich mole fraction of AA. At X = 0.5103 breaks dipolar associations in alcohols inducing dipole moments in molecules leads to dipole-induced dipole type of interactions making less compressible. At other compositions 2-EE is less bother to break dipolarassociations ,increasing space between the molecules and making them more compressible as exhibited by positive deviation in β_{ad}**.(Rita Mehra et al 2006)**

Figure-4



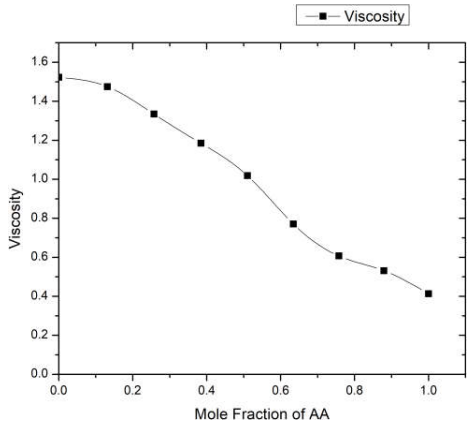
As observed from figure- 4 ΔL_fvalues are positive and negative. The maximum negative value of Excess free length (ΔL_f) at the 0.5103 mole fraction of AA indicates the formation of complex.This behavioursuggest that there exist strong interactions between the components of liquid mixture at negative values andpositive values suggest weak interactions between the components of liquid mixturedue to the existence of dispersion **forces.**

Figure-5



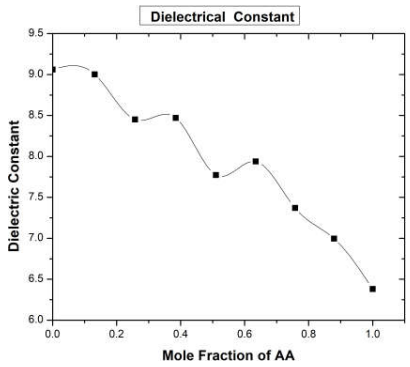
Excess impedance depicted ΔZin figure-5 are found to be negative except X=0.5103 suggesting the presence of weak interaction in both the system, reporting complex formation at this composition.**Sangeeta Sagar et al 2017** investigation reported similar kind of behaviour. It has been suggested that the concentration at which the excess functions exhibiting maxima orminima indicates strong interactions between the component molecules which in turn suggests the complex formation at this composition between the unlike molecules**. B. V. K. Naidu, 2003**.

Figure-6



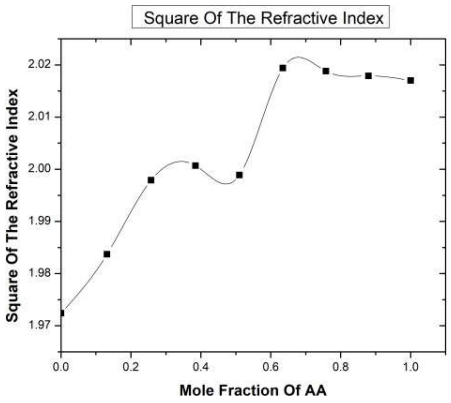
Viscositycurve figure -6 indicates that due to solute-solvent interaction, viscosity decreases with increase in the mole fraction of AA**R.J.Sengwa,et al :2006** ,so the molecules are held together by comparatively lesser intermolecular dipole-dipole interactions in the complex.

Figure-7



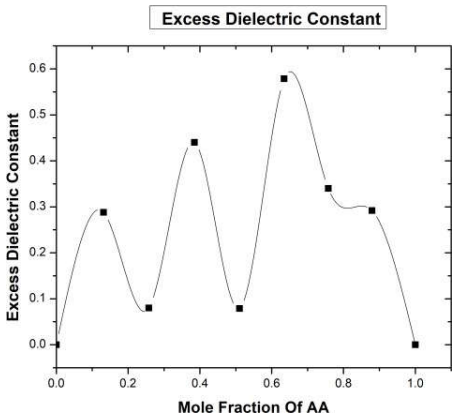
The dielectric constant varies non-linearly from figure -7 as a function of amine concentration in binarysystems, due to H-bond interaction between the mixture constituents. The wobbling nature of themixture may be due to –O– and –OH group in 2-ME results in multiplecomplexions .KinartC M et al ;2009.Bhupesh Nemmaniwar **et al ;2014 .**

Figure-8



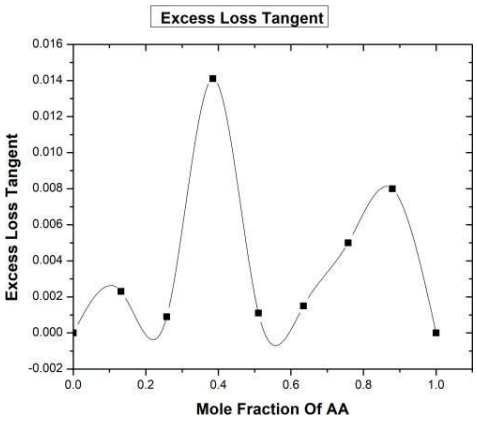
The values of square of refractive index are plotted against mole fraction of AA shown in **figure-8**In our investigation the graph shows minima at X=0.5103supports to our earlier conclusion of formation of complex at mole fraction X=0.5103 of AA.

Figure-9



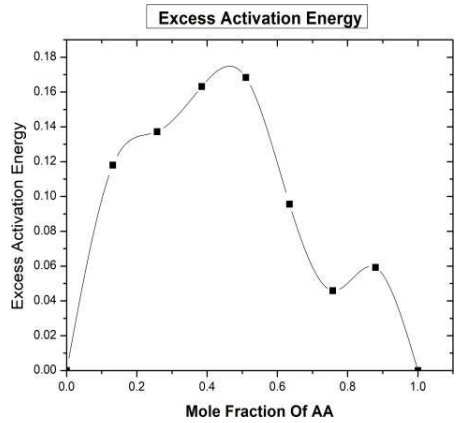
The positive excess dielectric constant (Δε), figure (9) also suggestthat the effective number of dipoles in the mixture might be greater than thecorresponding average number in the pure liquids, probably due to the creationof new structure leading to a higher macroscopicpermittivity **B G Lone et al ;2008 , V V Navarkhele et al ;**2010 . The number of effective number of dipoles in the mixture are maximum at X=0.5103 ,minima between two maxima.

Figure-10



Variation in excess loss tangent figure 10 supports the complex formationshowing minima at X =0.5103 and is positive for entire molar concentrationregion of AA.

Figure-11



Excess Activation energy ΔEa, noted in figure 11 is positive for entire mole fraction of AA indicating stronginteraction between AA and 2-ME molecules at about X= 0.5103 .The similar observation were noted in case of propane diol(PD) and Etyhylene diamine (EDA) molecules.**Rekha Pande et al ;2005.**

Conclusions:

For various mole fractions of AA, values for acoustic, dielectric parameter, ultrasonic velocity, viscosity, density, refractive index, and dielectric constant have been published. The possibility of complex formation at X= 0.5103 is suggested by excess parameters such as excess Ultrasonic velocity, excess adiabatic Compressibility(ad), excess free length(Lf), and excess acoustic impedance(Z), which is confirmed by the excess dielectric constant(), excess loss tangent(tan), and excess activation energy(Ea). Strong interaction between dissimilar molecules is indicated by excess activation energy. The combinations' positive excess permittivity further implies that any meaningful intermolecular interaction is evident at ambient temperature.

References

1]Jerie K. Bouranowski A. Prizbyaski J. Gliniski J. Journal Molecular Liquid .111 (2004),25

2]Alaraguppi M I .Baraggi J.C. J.Chemistry Thermodynamic 38,(2006) 434] 4,5

3][GangwarMunendra Kumar and Saxena Ashish Kumar,*Research Journal of ChemicalSciences.,* 3(2), 27-30 (2013)

4]Sahu S., Nath G. and Paikaray R, Research Journal ofChemicalSciences, 2(11), 64-66(2012)

5]R.S.Kawale, U.B. Tumberphale, B.S.Narwade, G.M. KalamseInternational Journal of Science and Research (IJSR) ISSN (Online): 2319-7064, International Symposium on Ultrasonics-2015, 22-24 January 2015 , 243-246.

6]5. Heston W H, Franklin A D, Hennely E J and Smyth C P, *J Am Chem Soc.,* 1950, **72(8),** 3443-3447.

7]33] TumberphaleU.B. Thesis, 2013.“Molecular Interaction Studies in Binary LiquidMixtures from Dielectric Data at MicrowaveFrequency

8]32] Ravichandran, S. Research Journal of Chemical Sciences, 1, 8, (2011), pp. 12-17.9]34]

Deogaonkar V.S (1977).. Indian Journal of Pure and Applied Physics 1598

10] Rita Mehra and Meenakshi Pancholi*Indian J. Phys.* 80 (3), 253-263 (2006)

11] Sangeeta Sagar*, Laxmi Kumari and Manisha Gupta J. Pure Appl. Ultrason. 39 (2017) pp. 71-78

12]41] B. V. K. Naidu, K. C. Rao, M. C. S. Subha, (2003) Journal of Chemical EngineeringData, 48:625.

13]24. R.J.Sengwa, Madhvi, Abhilasha and SonuSankhala Indian Journal of pure andapplied physics.Volume 44,(2006), 942.

14]26. Kinart C M and Klimczak M, J Mol Liq., 2009, 148(2-3), 132-139;DOI:10.1016/j.molliq.2009.07.009,

15]27. Bhupesh Nemmaniwar and Pothaji Kadam*Chemical Science TransactionsDOI:10.7598/cst2014.839 2014, 3 (3), 995-1000

16]29. BG Lone; PB Undre; SS Patil; PW Khirade and SC Mehrotra, J. Mol. Liq. 141,(2008) 47.17]30.

VVNavarkhele; MK Bhanarkar, J. Physics and Chemistry of Liquids, 48,(2010) 89 18]32. Rekha

Pande and G.M.Kalmase Int. J. Chem .Sci 3(1),2005,155-160.