International Journal of Advanced Research in Physical Science (IJARPS)
Volume 2, Issue 10, October 2015, PP 14-18
ISSN 2349-7874 (Print) & ISSN 2349-7882 (Online)
www.arcjournals.org

Study of Relaxation Time and Gibb's Free Energy for *Adansonia Digitata AnD* Binary Liquid Mixture

S.Phadke

Department of Physics, Government Girls College Dhar, MP, INDIA
sushilphadke5@gmail.com

S. K. Ujle

Department of Physics, Government P.G. College Jhabua, MP, INDIA

B.D.Shrivastava

Department of Physics, Government P.G. College Biora, MP, INDIA

A.Mishra

School of studies in Physics, DAVV, Indore MP INDIA

N Dagaonkar

Department of Physics, Government P.G. College Dhar MP, INDIA

Abstract:*Viscoelasticity is the property of materials that exhibit both viscous and elastic characteristics when undergoing deformation. Elastic materials strain instantaneously when stretched and just as quickly return to their original state once the stress is removed. Viscoelasticity materials have elements of both of these properties and, as such, exhibit time-dependent strain. Viscosity is the result of the diffusion of atoms or molecules inside an amorphous material. The quantity called "free energy" is a more advanced and accurate replacement for the outdated term affinity, which was used by chemists in previous years to describe the force that caused reactions. In thermodynamics the Gibbs free energy is a thermodynamic potential that measures the "usefulness" or process-initiating work obtainable from a thermodynamic system at a constant temperature and pressure. The change in the wavelength of ultrasonic waves in different medium is due to the elastic properties and the induced particles vibrations in the medium. The study of propagation of ultrasonic wave in liquid systems and solids is now rather well established. Ultrasonic waves are an effective means for examining and analysing certain physical properties of the materials. In the present study , We have measured density, ultrasonic velocity, viscosity, surface tension of Adansonia digitata AnD binary liquid mixture with distil water, HNO_3 and HCl then calculated viscous relaxation time τ, Gibb's free energy ΔG at room temperature 303K. For the measurement of ultrasonic velocity, we used Multifrequency Ultrasonic interferometer Model M-81 S because ultrasonic is popular non destructive technique. Natural sample Adansonia digitata AnD was collected from Mandu Dhar, District of MP, India for this study.*

Keywords:*Adansonia digitata AnD, Viscoelasticity, amorphous, Gibbs free energy, viscous relaxation time.*

1. INTRODUCTION

India is veritable emporium of medicinal and aromatic trees, *Adansonia digitata AnD* one of them.*Adansonia digitata AnD* [1] was traditionally used in the treatment of fever, diarrhea, dysentery, haemoptysis, small pox and measles. It is a tree that can provide food, water, shelter and relief from sickness and helpful to change the living standard of tribal people. The study of molecular interactions and the variations in these interactions due to structural changes has been carried out by various experimental techniques. The complete understanding of the nature of intermolecular and intermolecular interaction may not be possible by any single method. A number of workers have reported the study through ultrasonic method [2-6]. Non-destructive testing (NDT) [7] are non-invasive techniques to determine the integrity of a material, component or structure or quantitatively measure some characteristic of an object. In contrast to destructive testing, NDT is an assessment without doing harm, stress or destroying the test object. The destruction of the test object usually makes destructive testing more costly and it is also inappropriate in many circumstances. Viscoelasticity is the property of materials that exhibit both viscous and elastic characteristics when undergoing deformation. Elastic materials strain instantaneously when stretched and just as quickly return to their original state once the stress is removed. Viscoelasticity materials have elements of both of these properties and, as such, exhibit time-dependent strain. Viscosity is the result of the

diffusion of atoms or molecules inside an amorphous material [8]. Relaxation time and absorption coefficient are directly correlated. The absorption of a sound wave is the result of the time lag between the passing of the ultrasonic wave and the return of the molecules to their equilibrium position [9]. In thermodynamics the Gibbs free energy [10] is a thermodynamic potential that measures the "useful" or process-initiating work obtainable from an isothermal, isobaric thermodynamic system. Just as in mechanics, where potential energy is defined as capacity to do work, similarly different potentials have different meanings. Gibbs energy is the capacity of a system to do non-mechanical work and ΔG measures the non-mechanical work done on it. The Gibbs free energy is the maximum amount of non-expansion work that can be extracted from a closed system; this maximum can be attained only in a completely reversible process. When a system changes from a well-defined initial state to a well-defined final state, the Gibbs free energy ΔG equals the work exchanged by the system with its surroundings, minus the work of the pressure forces, during a reversible transformation of the system from the same initial state to the same final state.

2. MATERIAL AND METHOD

In the present study *Adansonia Digitata AnD* dry fruit brought from the market of Mandav district Dhar, (M.P.) India. The outer part of the fruit was separated from the inner fruit pulp. Further fruit pulp was separated from the seeds and placed under shade to remove the moisture contained nearly zero percent. The dried fruit pulp was powdered by means of mechanical grinder. After that we prepared the different binary liquid mixture according to detail given below by placing the fruit pulp powder in distil water, HNO_3, HCl for 24 hours at room temperature 303K.

Measurement of density, ultrasonic velocity, surface tension and viscosity was done by the method of our earlier publication [11]. Viscous relaxation time and Gibbs' free energy was calculated by the measured values of different parameters ultrasonic density, velocity, viscosity and surface tension.

Table1. *List of samples used in our studies.*

SNO	Name of the specimens/Sample material					Abbreviations
1	1gm AnD fruit pulp:100ml DW	1gm AnD fruit pulp:200ml DW	1gm AnD fruit pulp:300ml DW	2 gm AnD fruit pulp:100ml DW	3 gm AnD fruit pulp:100mlDW	ANDFPDW
2	1gm AnD fruit pulp:100ml HNO3	1gm AnD fruit pulp:200ml HNO3	1gm AnD fruit pulp:300ml HNO3	2 gm AnD fruit pulp:100ml HNO3	3 gm AnD fruit pulp:100ml HNO3	ANDFPHNO3
3	1gm AnD fruit pulp:100ml HCl	1gm AnD fruit pulp:200ml HCl	1gm AnD fruit pulp:300ml HCl	2 gm AnD fruit pulp:100ml HCl	3 gm AnD fruit pulp:100mlHCl	ANDFPHCl

3. THEORY AND CALCULATION

The viscous relaxation time was obtained using equation:

$$\tau = 4\eta/3\rho U^2 \quad (4)$$

Gibb's free energy was calculated from the relation:

$$\Delta G = k\,T \ln \{kT\tau/h\} \quad (5)$$

Or $\Delta G = k\,T\,2.303 \log_{10} \{kT\tau/h\}$

Where τ is the viscous relaxation time, k the Boltzman's constant (1.23×10^{-23} JK^{-1}), and the absolute temperature and h is the Plank's constant (6.6×10^{-34}Js) [12].

4. RESULT AND DISCUSSION

The experimentally measured values of density, viscosity, surface tension and ultrasonic velocity for the binary mixtures at 303K are presented in table 2. Table 2 also represents the values of viscous relaxation time and Gibbs' free energy at 303K for the binary liquid mixtures of *Adansonia digitata*

AnD. From the table 2 and figure 1 & 2, it was observed that density and ultrasonic velocity increases with the increasing ratio of dried fruit pulp of *Adansonia digitata AnD* in all the binary liquid mixture of *Adansonia digitata AnD* and decreases with the increasing ratio of solvent distil water, HCl and HNO_3.The viscosity and surface tension figure 3 & 4 also varies with interacting of molecule which are changing with the concentration ratio of *Adansonia digitata AnD* in distil water, HCl, HNO_3. The addition of interacting molecules breaks up the molecular clustering of the other, releasing several dipoles for the interactions. In view of greater force of interaction between the molecules there will be an increase in cohesive energy and the occurrence of structural changes, take place due to the existing of electrostatic field. The relaxation time decreases for system and increases with increase in concentration of *Adansonia digitata AnD* indistil water, HCl, HNO_3. The relaxation time figure 5, which is the order of 10^{-12} sec, is due to structural relaxation process and such situation it is suggested that the molecule gets rearranged due to co-operative process. The observed values of Gibbs' free energy figure 6 increases and decreases according to the concentration of binary liquid mixture of *Adansonia digitata AnD* in distil water, HCl, HNO_3. In figure 4 to figure 6, we used logarithmic scale due to large variation.

Table2. *The measured and calculated values of density, ultrasonic velocity, surface tension, viscosity, viscous relaxation time and Gibbs' free energy.*

S.No.	Sample Binary Mixture	Density ρ X 10^3	Ultrasonic Velocity U	Surface Tension S	Viscosity η	Viscous relaxation time τ X10 $^{-12}$	Gibbs'free energy ΔG X10 $^{-18}$
IN MKS UNITS							
1	1gm AnD fruit pulp:100ml DW	0.9979	1497.7333	0.7607	0.00093	55.2160	0.196494
	2 gm AnD fruit pulp:100ml DW	0.997	1501.6	0.0720	0.00144	85.4080	0.304282
	3gm AnD fruit pulp:100ml DW	0.9981	1508.5333	0.0656	0.00115	67.2140	0.239027
	1 gm AnD fruit pulp:200ml DW	0.998	1502.9333	0.0855	0.00093	54.7700	0.195183
	1 gm AnD fruit pulp:300ml DW	0.9961	1499.7333	0.0911	0.00095	56.6920	0.202029
2	1gm AnD fruit pulp:100ml HNO3	0.9768	1496.9333	0.3814	0.00134	81.6270	0.290590
	2gm AnD fruit pulp:100mlHNO3	0.9776	1505.2	0.3954	0.00138	83.2550	0.295980
	3gm AnD fruit pulp:100ml HNO3	0.9784	1507.8	0.4065	0.00176	1.0550	0.375218
	1gm AnD fruit pulp:200ml HNO3	0.9963	1505.4667	0.4023	0.00141	83.1990	0.295980
	1 gm AnD fruit pulp:300ml HNO3	1.0057	1483.3333	0.3893	0.00147	88.2740	0.314333
3	1gm AnD fruit pulp:100ml HCl	1.0467	1515.5862	0.0743	1.42514	0.0806	0.000287
	2gm AnD fruit pulp:100ml HCl	1.0623	1516.4138	0.0782	1.45255	0.0778	0.000277
	3gm AnD fruit pulp:100ml HCl	1.0924	1520.4138	0.0803	1.50730	0.0796	0.000283
	1 gm AnD fruit pulp:200ml HCl	1.0532	1517.077	0.0730	1.37888	0.0758	0.000270
	1 gm AnD fruit pulp:300ml HCl	1.057	1527.1111	0.7503	1.23729	0.0669	0.000238

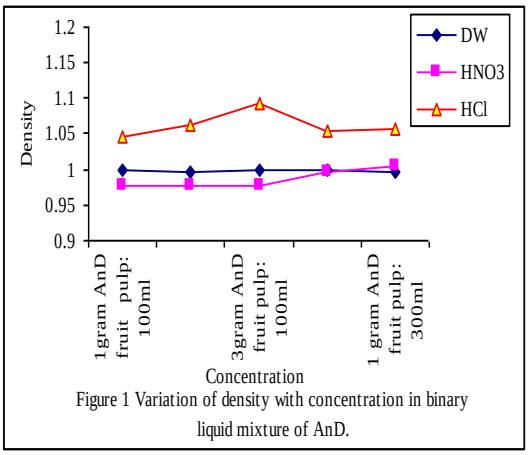

Figure 1 Variation of density with concentration in binary liquid mixture of AnD.

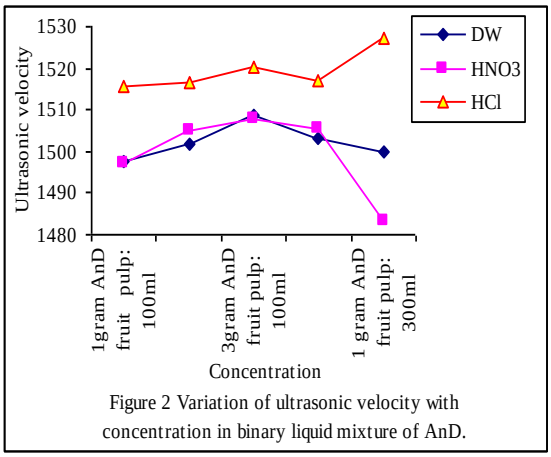

Figure 2 Variation of ultrasonic velocity with concentration in binary liquid mixture of AnD.

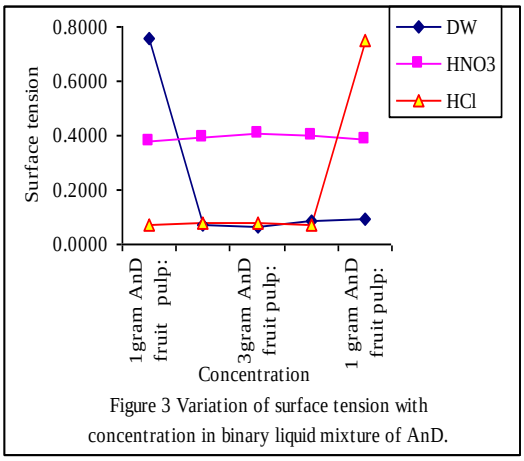

Figure 3 Variation of surface tension with concentration in binary liquid mixture of AnD.

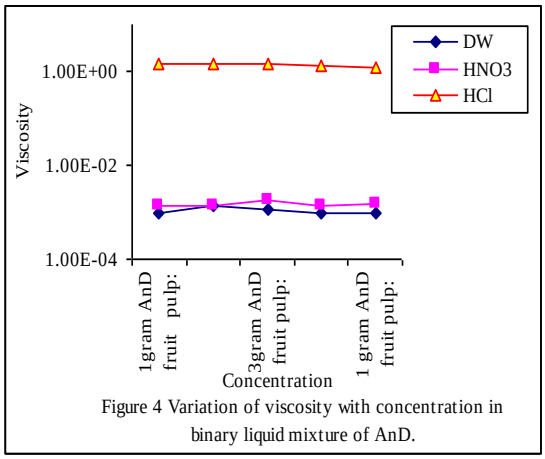

Figure 4 Variation of viscosity with concentration in binary liquid mixture of AnD.

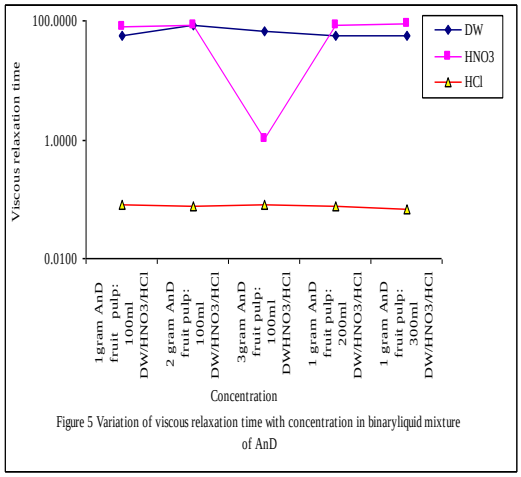

Figure 5 Variation of viscous relaxation time with concentration in binaryliquid mixture of AnD

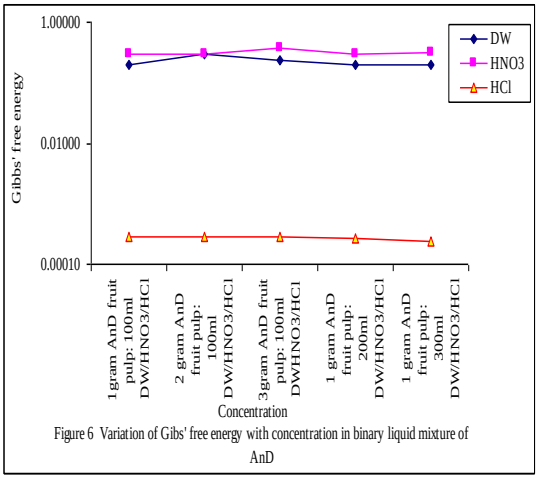

Figure 6 Variation of Gibs' free energy with concentration in binary liquid mixture of AnD

5. CONCLUSION

The solute - solvent molecular association arise due to dipole-dipole inter action and the polar nature of different molecular entities in the binary mixture. The solute-solvent association arises due to slightly polar solute and polar nature of the solvent. It is proposed that the molecular association arise because of interaction of the fractional change at the site of ingredient different atoms of *Adansonia digitata AnD* in distil water, HCl, HNO_3.

ACKNOWLEDGEMENT

One of the authors B.D.Shrivastava is highly thankful to University Grants Commission, New Delhi for awarding a Project. Our sincere thanks to Dr. R.K. Dave Principal Govt. P.G. College, Dhar (MP), Dr. S. N. Mandloi Principal Govt. Girls College, Dhar (MP), Dr. Nagesh Dagaonkar HOD, Physics Govt. P.G. College, Dhar (MP) and Prof. Sushil Phadke HOD, Physics Govt. Girls College, Dhar (MP) for providing lab facility and maximum cooperation.

REFERENCE

[1] Ujle S., Shrivastava B.D., Mishra A., Phadkeb S. and Dagaonkar N., Elastic constant of *Adansonia Digitata AnD* in anisotropic longitudinal direction by Non Destructive method, Advanced materials research, Vol.616-618(2013), p. 1889-1893.

[2] Deshpande, D.D.and Bhatgadde, L.G., Sound velocities, adiabatic compressibilities and free volumes in aniline solutions J. Phys. Chem., 72(1968), p. 261-266.

[3] Prakash S.:Sound Velocities and Related Properties in Ternary Solutions of o-Xylene. J.Chem.Eng.Data 22 (1977), pp 49-50.

[4] Tojo J.:Thermodynamic Properties of the Ternary Mixture Acetone + Methanol + Ethanol at 298.15 K. J.Chem.Eng.Data 43 (1998), pp 776-780.

[5] Prakash S.:Sound Velocities and Related Properties in Ternary Solutions of o-Xylene. [1] J.Chem.Eng.Data 22 (1977) pp49-50

[6] Kannappan, V. and Jaya Santhi, R., J. Acous. Soc. Ind. (2001), 29,p. 192.

[7] C.Hillier, Handbook of Nondestructive Evaluation, McGraw-Hill Professional, 2001.

[8] Meyers and Chawla, Mechanical Behaviour of Materials (1999), pp 98-103.

[9] Perrin D.D., Armarego W.L.F., Subhi Kemal Hassun, Acoustics Letters, 11(10), 195.6., Purification of Laboratory Chemicals, Pergamon Press, Oxford 1980, 1988.

[10] Greiner, Walter, Neise, Ludwig, Stöcker, Horst Thermodynamics and statistical mechanics Springer, Verlag(1995). p. 101.

[11] Phadke S., Shrivastava B.D. & .Mishra A, Thermodynamic, Acoustical, Volumetric and Viscometric study of Borassus flabellifier at 313.15 K., Ultra Scientist of Physical Sciences, (ISSN 0970-9150) Vol. 21(3) Dec (2009), p. 499-504.

[12] A.N. Kannappan, R. Kesavasamy and V. Ponnuswamy , Molecular interaction studies in the ternary liquid mixture of peredine, benzene and N,N- dimethylformamide by ultrasonic velocity measurements, ARPN Journal of Engineering and Applied Sciences, Vol. 3, No. 4 (2008),p. 41-45.