Study of Viscous Relaxation Time for BF and AnD Aqueous Binary Mixture

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Abstract- The dynamics of molecular liquids and polymers exhibit various ''transitions'', associated with characteristic changes in properties. The study of molecular motions in dense fluids is of long-standing interest to physicists, chemists, and biologists. The time scale of the dynamics varies with temperature, pressure, entropy, etc., reflects the nature of the intermolecular potential, thus providing fundamental insights into chemical structure and the forces between molecules. The relaxation behaviour also governs to a large extent the physical and mechanical properties underlying many applications of materials so that such studies facilitate material engineering and development. The transient elongation stress growth in the fluids depends on the concentration and molecular weight of the solute as well as the background of viscosity and thermodynamic quality of the solvent. In the present investigation, first we measured density, surface tension, viscosity and ultrasonic velocity then calculated viscous relaxation time *'Borassus Flabellifier'* BF and *Adansonia digitata* AnD aqueous binary mixture at room temperature. Density bottle, pyknometer, and stalogometer used for measurement of density , viscosity and surface tension while ultrasonic velocity in liquid mixture were measured using ultrasonic interferometer Model M-84 made by M/s Mittal Enterprises, New Delhi, at a fixed frequency of 2MHz.

I.   INTRODUCTION

The importance of liquid viscosity in chemical process design makes it one of the most measured transport properties. Liquid viscosity has a direct and large effect on heat transfer coefficients, which are especially important for heat exchangers and various other heat transfer considerations, and are also somewhat important in distillation calculations. Fluid flow plays a very important part in the processing of materials. Most processes are based on the use of fluids either as raw materials, reagents, or heat transfer media. The rates of heat transfer, mass transfer and chemical reaction between two phases depend on the fluid flow phenomena in the system. It is therefore necessary to start our study of rate phenomena in processing systems by examining the motion of fluids. The behaviour of a fluid in flow is very much related to two intrinsic properties of the fluid: density and viscosity. For example, a solid body moving through a gas has to overcome a certain resistance which depends on the relative velocity [1] between fluid and solid, the shape of the solid, the density of the gas and its viscosity. The power required to move a fluid through a conduit is a function of the fluid velocity, the diameter of the conduit and the fluid density and viscosity. At the interface between two materials physical properties change rapidly over distances comparable to the molecular separation scale. Since a molecule at the interface is exposed to a different environment than inside the material, it will also have a different binding energy. Molecules sitting at a free liquid surface against vacuum or gas have weaker binding than molecules in the bulk. The missing (negative) binding energy can therefore be viewed as a positive energy added to the surface itself. Since a larger area of the surface contains larger surface energy, external forces must perform positive work against internal surface forces to increase the total area of the surface. Mathematically, the internal surface forces are represented by surface tension, defined as the normal force per unit of length. This is quite analogous to bulk tension (i.e. negative pressure), defined as the normal force per unit of area. The study of molecular motions [2] in dense fluids is of long-standing interest to physicists, chemists, and biologists. How the time scale of the dynamics varies with temperature, pressure, entropy, etc., reflects the nature of the intermolecular potential, thus providing fundamental insights into chemical structure and the forces between molecules. The relaxation behaviour also governs to a large extent the physical and mechanical properties underlying many applications of materials, so that such studies facilitate material engineering and development. Both small molecules and polymers exhibit a spectacular variation of their ''structural'' relaxation time, τ, over the range of the liquid state. This relaxation time is a measure of the time scale for reorientation of the molecule or, in the case of polymers, correlated conformational transitions of a couple of backbone bonds (''local segmental dynamics''). Large changes in t are especially evident when crystallization is avoided. *Adansonia digitata* AnD [3] fruit is an important constituent of certain legumes, cereals and forage plants which is capable of chelating divalent cationic minerals like calcium, iron,

magnesium and zinc. *'Borassus Flabellifier'* BF [4] fruit have been used in treating gonorrhea, dysentery, and respiratory disease. BF fruit sap is prized as a tonic, diuretic, stimulant, laxative, anti-phlegmatic and amebicide [5].

II. MATERIAL AND METHOD

The fresh fruits of *Borassus flabellifier* BF *and Adansonia digitata* And were bought from market Kukshi and Mandu of district Dhar (M.P.). The fresh fruits were washed and air dried. Pods/bark of the fruit were removed, cut into pieces and blended. Aqueous extract of each was obtained, filtered and stored in a clean sample container in the fridge until needed for analysis [6]. The velocity of ultrasonic waves was measured, using a multi-frequency ultrasonic interferometer with a high degree of accuracy operating Model M-84 by M/s Mittal Enterprises, New Delhi, at a fixed frequency of 2MHz. Density bottle, Pyknometer, and Stalogometer were used for measurement of density, viscosity and surface tension [7]. After measuring density, viscosity and ultrasonic velocity, we calculated viscous relaxation time [8] of BF and AnD Aqueous Binary Mixture. The viscous relaxation time are calculated from
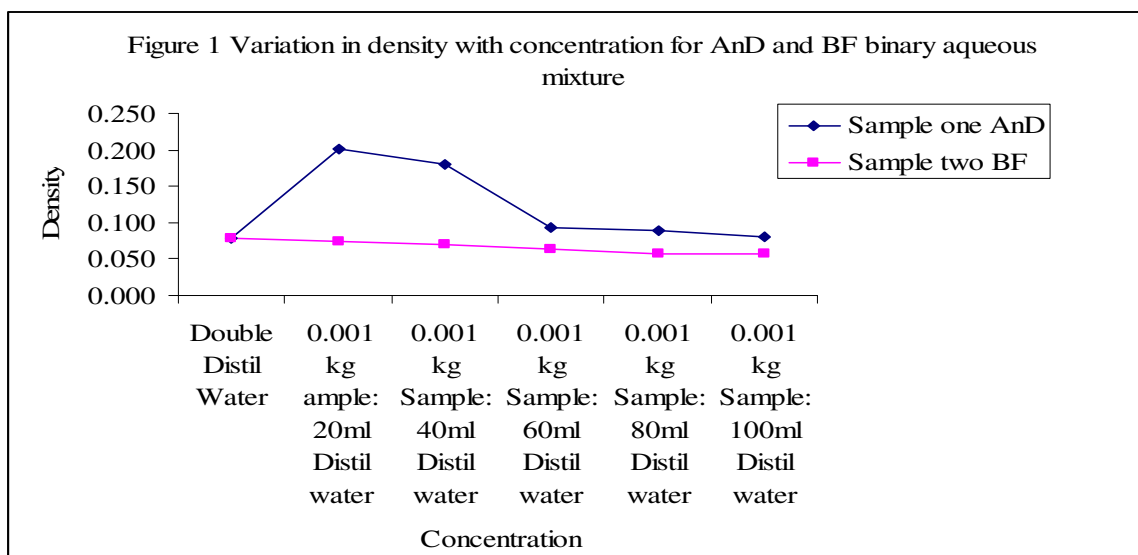
the relation $\tau = 4\eta/3\rho U^2$, Where ρ, U, η and τ are density, ultrasonic velocity, viscosity and viscous relaxation time.
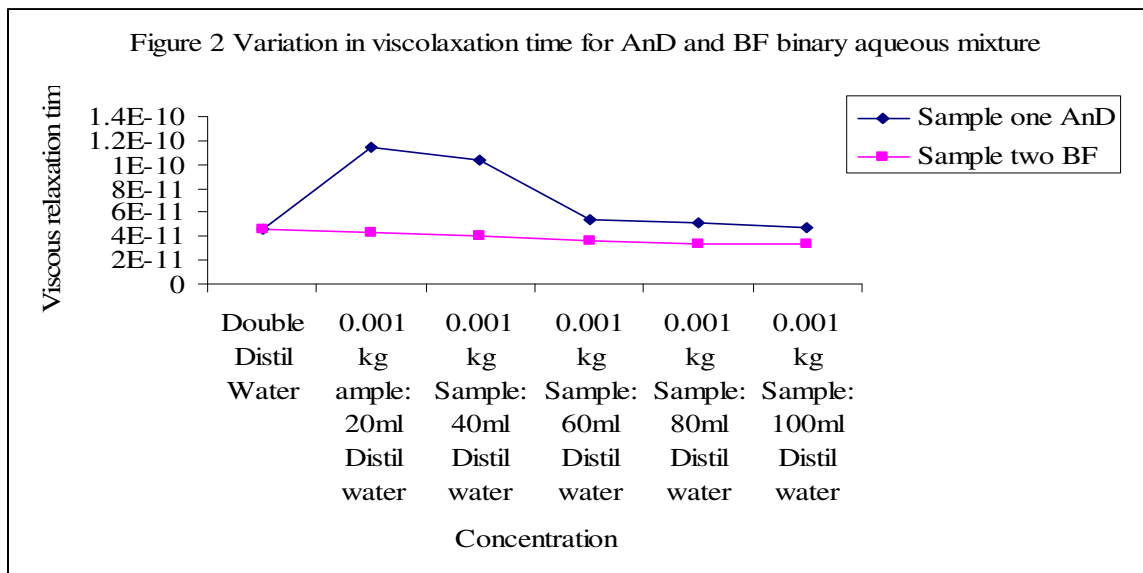
III. RESULT AND DISCUSSION

Our focus herein is on the time scale of molecular motions, the central importance of which is seen in the correlation of τ with other properties. For example, the shape of the relaxation function (or equivalently, the breadth of the absorption peak in the spectrum) is uniquely determined by viscous relaxation time. Viscosity and viscous relaxation time first increase and then decreases with the concentration double distil water in both the binary mixture of BF and AnD fruit pulp. The viscosity and viscous relaxation time shows similarity in both the binary liquid mixture of AnD and BF Table 1 and figure 1&2. Our focus herein is on the time scale of molecular motions, the central importance of which is seen in the correlation of τ with other properties. For example, the shape of the relaxation function (or equivalently, the breadth of the absorption peak in the spectrum) is uniquely determined by viscous relaxation time.

Table: 1- Density, ultrasonic velocity, surface tension, viscosity and viscous relaxation time

Concentration	Density ρ x 10^3	Ultrasonic Velocity U	Surface tension	Viscosity	Viscous relaxation time τ
Double Distil Water	0.9937	1517	0.071	0.079	4.63E-11
0.001 kg ample: 20ml Distil water	0.9998	1529.67	8.890	0.201	1.15E-10
0.001 kg Sample: 40ml Distil water	0.9993	1527.84	8.680	0.181	1.03E-10
0.001 kg Sample: 60ml Distil water	0.9987	1525.13	8.400	0.093	5.34E-11
0.001 kg Sample: 80ml Distil water	0.9962	1524.53	7.600	0.089	5.13E-11
0.001 kg Sample: 100ml Distil water	0.9951	1523.64	7.400	0.081	4.68E-11
Double Distil Water	0.9937	1517	0.071	0.079	4.63E-11
0.001 kg ample: 20ml Distil water	1.008	1526.66	0.058	0.075	4.26E-11
0.001 kg Sample: 40ml Distil water	1.0042	1525.33	0.060	0.070	3.99E-11
0.001 kg Sample: 60ml Distil water	1.0025	1522.1	0.061	0.064	3.67E-11
0.001 kg Sample: 80ml Distil water	1.0011	1521.54	0.063	0.058	3.34E-11
0.001 kg Sample: 100ml Distil water	0.9983	1517.12	0.064	0.057	3.31E-11

Figure 1 Variation in density with concentration for AnD and BF binary aqueous mixture

Figure 2 Variation in viscolaxation time for AnD and BF binary aqueous mixture

IV. CONCLUSION

We show that there is a particular magnitude of the relaxation time associated with the transition of a given liquid from one dynamic regime to another. The orientation of molecules to form a liquid, or the change from one phase to another, represents the final characteristic of liquid behaviour considered herein. From the above study it is seen that there exists molecular association between the components of the binary mixture due to dipole-dipole, dipole-induced dipole, charge transfer and hydrogen bonding interactions, which varies with density and the change in the frequency of the ultrasonic wave.

V. ACKNOWLEDGEMENT

VI. REFERENCE

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