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STUDY OF ULTRASONIC INTERFEROMETER BY USING MALIC ACID ASCORBIC ACID, PECTIN AND CARBON DOTS

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ABSTRACT

The Ultrasonic instrument which is able to find out ultrasound produces by liquid interaction ,Ultrasonic sound refers to sound pressure with a frequency greater than the human audible range (20Hz to 20 KHz). When an ultrasonic wave propagates through a medium, the molecules in that medium vibrate over very short distance in a direction parallel to the longitudinal wave. During this vibration, momentum is transferred among molecules. This causes the wave to pass through the medium[5] measurement of ultrasonic velocity and the determination of acoustical parameters in the solution are of significant interest in understanding the intermolecular interactions in solute-solvent mixture. It also gives valuable information regarding the nature and strength of molecular interaction, formation of hydrogen bond etc..

INTRODUCTION

Now a day the measurement of ultrasonic velocity has been effectively used in understanding the nature of molecular interaction in pure liquids and in solutions. The intermolecular and intra molecular association, dipolar interactions, complex formations and related structural changes affect the compressibility of the system which in turn produces corresponding variations in the ultrasonic velocity, for that the acoustical parameters give valuable information regarding the behavior of liquid systems. The acoustical and thermo dynamical parameters obtained in ultrasonic study show that the ion solution accompanied by the destruction or enhancement of the solvent structure.

The study of ultrasonic velocity provides lots of information about the state of solution[1, 2].The measurement of ultrasonic velocity in a substance is now become a basic test to study the properties of the substance [3].The measurement of ultrasonic velocity and the determination of acoustical parameters in the solution are of significant interest in understanding the intermolecular interactions in solute-solvent mixture. It also gives valuable information regarding the nature and strength of molecular interaction, formation of hydrogen bond etc..[4]

Properties of Ultrasonic Waves

1. Highly energetic.
2. Ultrasonic waves are sound waves of short wavelength with very high frequency and have high energy content.
3. Just like ordinary sound waves, they get reflected and absorbed.
4. They can travel over long distance without much loss of energy.
5. They produce heat when they pass through a substance.
6. Due to smaller wavelength, they have a high penetrating power.
7. If an arrangement is made in a liquid to form stationary ultrasonic waves, it acts as diffraction grating. It is called as acoustic grating..

1.MALIC ACID :[22]

Malic acid is an organic compound and the cis-isomer form of the butenedioic acid. Hence, malic acid is a dicarboxylic acid which means that the malic acid structure consists of two carboxyl groups. The malic acid molecular formula is HOOCCH=CHCOOH, which clearly shows the presence of the double bond of carbon as depicted by the name butenedioic acid. This can also be seen in malic acid IUPAC name or nomenclature which identifies malic acid as (2Z) But-2-enedioic acid.

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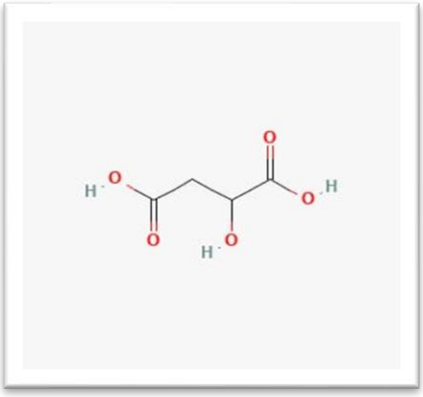
Molecular Structure of Malic Acid



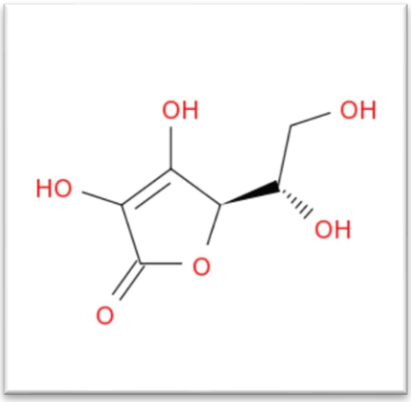
MOLECULAR FORMULA	$C_4H_6O_5$
IUPAC NAME	2-hydroxybutanedioic acid
DENSITY	1.61 gcm^{-3}
MELTING POINT	131.0 °C
MOLECULAR WEIGHT	134.087 $gmol^{-1}$

2. ASCORBIC ACID:[23]

Ascorbic acid is also known as vitamin C and is denoted by $C_6H_8O_6$. It is a natural water-soluble vitamin. Ascorbic acid is called as a potent reducing and antioxidant agent which functions to fight against the bacterial infections helps to detoxify the reactions and helps in the formation of collagen in the fibrous tissues, connective tissues, bones, capillaries, and skin. Ascorbic acid is found mostly in citrus fruits and vegetables. It cannot be produced or stored by humans and should be ingested in the diet.

Ascorbic acid also called as vitamin C or ascorbate is a vitamin that is found in several food items and is also taken as a food supplement. It is used in the prevention and treatment of scurvy. Ascorbic acid is a vital nutrient which is involved in the repairing of tissue and the *enzymes in the body and is essential for the functioning of the immune system. It also acts as an antioxidant.* enzymatic *production of the neurotransmitters. It is needed for the functioning of several*

Molecular Structure of Ascorbic Acid



MOLECULAR FORMULA	$C_6H_8O_6$
IUPAC NAME	1,2-dihydroxyethyl
DENSITY	1.694 gcm^{-3}
MELTING POINT	190 °C
MOLECULAR WEIGHT	176.12 $gmol^{-1}$

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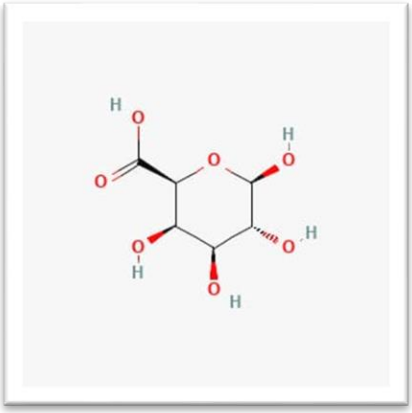
3. PECTIN[24]

Pectin is a high-molecular-weight carbohydrate polymer which is present in virtually all plants where it contributes to the cell structure. The term pectin covers a number of polymers which vary according to their molecular weight, chemical configuration, and content of neutral sugars, and different plant types produce pectin with different functional properties. The word 'pectin' comes from the Greek word pektos which means firm and hard, reflecting pectin's ability to form gels. The gelling properties of pectin have been known for centuries, but the isolation of commercial pectin only started at the beginning of the twentieth century. In this document we highlight the chemistry, origin and production, and the functional properties of pectin [25].

Molecular Structure of Pectin:



MOLECULAR FORMULA	$C_6H_{10}O_7$
IUPAC NAME	BETA-D-GALACTOPYRANURONIC ACID
DENSITY	1157.8 to 1500.4 kgm^{-3}
MELTING POINT	142-144 °C
MOLECULAR WEIGHT	194.14 $gmol^{-1}$

4.CARBON QUANTUM DOTS:[25]

Carbon quantum dots also commonly called Carbon dots (abbreviated as CQDs, C-dots or CDs) are carbon nanoparticles which are less than 10 nm in size and have some form of surface passivation. As a new class of fluorescent carbon nonmaterial's, CQDs possess the attractive properties of high stability, good conductivity, low toxicity, environmental friendliness, simple synthetic routes as well as comparable optical properties to quantum dots.Carbon quantum dots have been extensively investigated especially due to their strong and tunable fluorescence emission properties, which enable their applications in biomedicine, optronics, catalysis, and sensing.Here we have used microwave assisted technique for the synthesis of carbon quantum dots from urea and critic acid.

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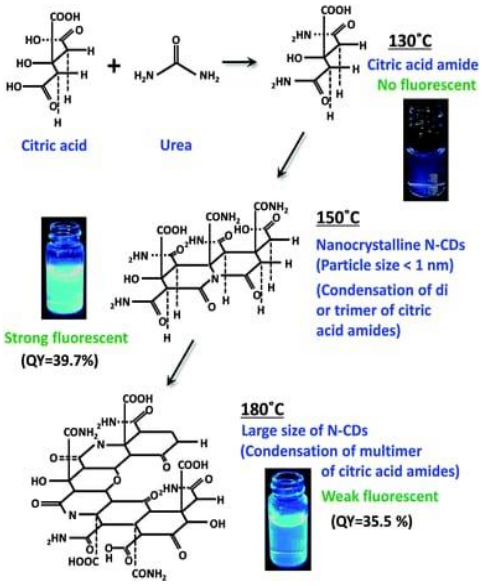
Molecular Structure of Carbon Quantum Dots



MOLECULAR FORMULA	C
IUPAC NAME	Carbon
DENSITY	1.0032 gml^{-1}
MELTING POINT	N/A
MOLECULAR WEIGHT	12.011 $gmol^{-1}$

RESULT AND DISCUSSION: VISCOSITY AND DENSITY MEASUREMENTS

a) VISCOSITY MEASUREMENTS: [26]

Ostwald viscometer is used to measure the viscosity. The viscometer is filled with the experimental solution. This instrument consists of U-shaped glass tube held vertically in a controlled temperature bath in one arm of the U is a vertical section of precise narrow bore (the capillary). Above there is a bulb, with it is another bulb lower down on the other arm. In use, liquid is drawn into the upper bulb by suction, and then allowed to flow down through the capillary into the lower bulb. Two marks (one above and one below the upper bulb) indicate a known volume

SAMPLE	CONCENTRATION				
	0.02 M	0.04 M	0.06 M	0.08 M	0.10 M
Malic Acid	1.0868	1.0942	1.0985	1.1017	1.1051
Ascorbic Acid	0.9166	0.9328	0.9439	0.9541	0.9699
Pectin	1.7460	2.8700	4.2070	6.0410	9.4050
CQD	0.7140	0.7962	1.0750	1.1392	1.2095

TABLE 1 : Variation of viscosity with concentration of different liquids

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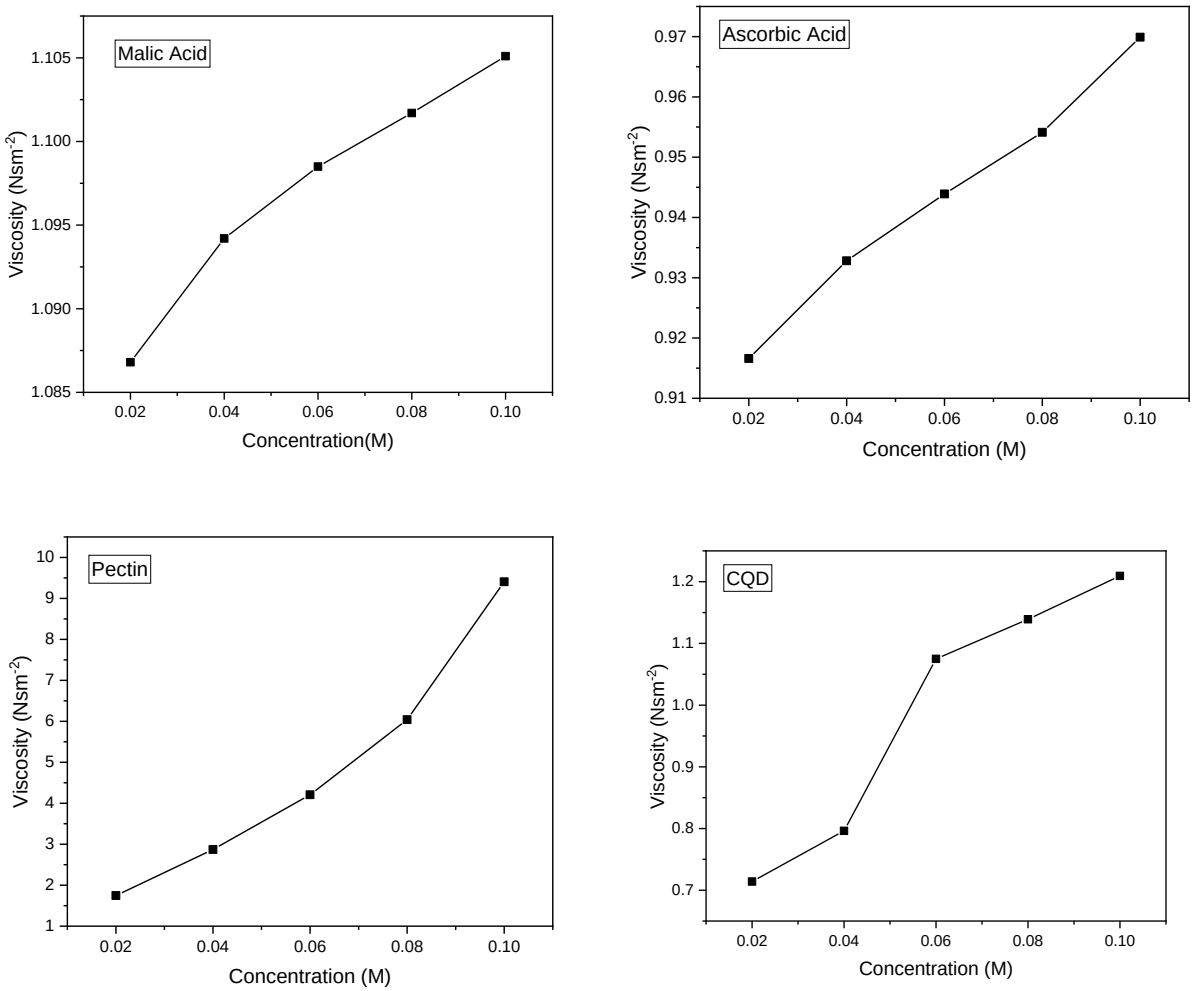
FIGURE 19: Graphs of Viscosity With different Concentration of Different Liquids



b) DENSITY MEASUREMENTS : [27]

The density of the pure liquids, liquid mixtures solutions can be determined by relative measurement method. Specific gravity bottle was standardized using distilled water. Take the gravity bottle and measure its mass, in grams. Fill the specific gravity bottle with water either by pouring carefully or with pipette until the level is as close to 10ml mark put the gravity bottle back on **the** balance. Measure & note down the new mass. Repeat the same procedure for liquid. The density of liquid and liquid mixtures can be calculated using the formula.

$$\rho_l = \frac{M_l \rho_w}{M_w} g cm^{-3}$$

Where,

M_l is the mass of the liquid or liquid mixtures.

M_w is the mass of water.

SPECIFIC GRAVITY BOTTLE

A small bottle or flask used to measure the specific gravities of liquids; the bottle is weighed when it is filled with the liquid whose specific gravity is to be determined, when filled with a reference liquid, and when empty Also known as density bottle, relative-density bottle.

METHODS OF DETERMINING SPECIFIC GRAVITY

A number of experimental methods for determining the specific gravities of solids, liquids, and gases have been devised. A solid is weighed first in air, then while immersed in water; the difference in the two weights, according to Archimedes' principle, is the weight of the water displaced by the volume of the solid. If the solid is less dense than water, some means must be adopted to fully submerge it, e.g., a system of pulleys or a sinker of known mass and volume. The specific gravity of the solid is the ratio of its weight in air to the difference between its weight in air and its weight immersed in water.

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SAMPLE	CONCENTRATION				
	0.02 M	0.04 M	0.06 M	0.08 M	0.10 M
Malic Acid	1.005	1.007	1.008	1.009	1.010
Ascorbic Acid	1.005	1.006	1.009	1.011	1.012
Pectin	1.004	1.007	1.009	1.012	1.017
CQD	1.000	1.002	1.003	1.004	1.009

TABLE 2: Variation of Density With Concentration of Different Liquids

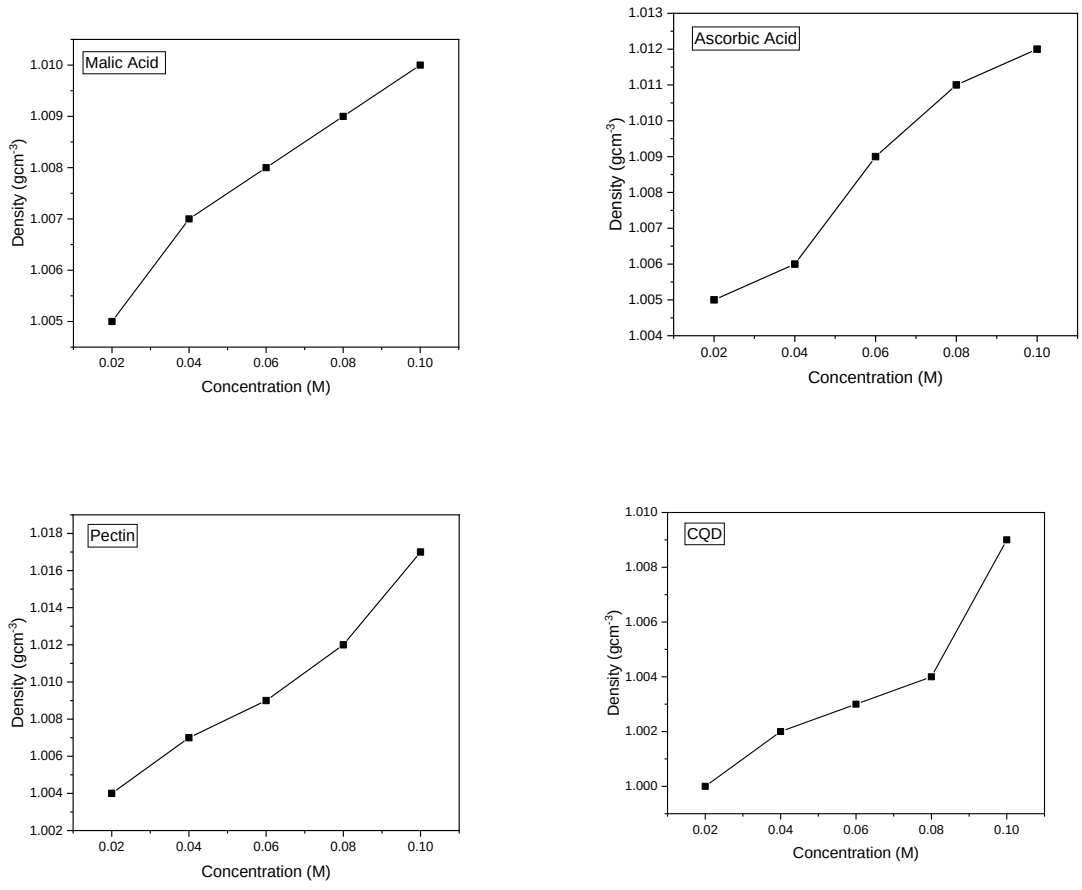

FIGURE 21 : Graphs of Density with different Concentration of Different Liquids

ACOUSTIC PARAMETERS:[28]

1. Ultrasonic Velocity (υ):

Ultrasonic velocity is the speed in which sound travels through a given material. Velocity remains constant in a given material. It is given by

$$v = \lambda f sec$$

SAMPLE	CONCENTRATION				
	0.02 M	0.04 M	0.06 M	0.08 M	0.10 M
Malic Acid	1508	1532	1557.6	1578.9	1621
Ascorbic Acid	1480	1520	1540	1548	1560
Pectin	1508	1536	1553.6	1566.4	1600
CQD	1512	1528	1544	1555.78	1564

TABLE 3: Variation of Ultrasonic Velocity With Concentration of Different Liquids

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2. Adiabatic Compressibility (β)

TABLE 4: Variation of adiabatic compressibility with Concentration of Different Liquids

SAMPLE	CONCENTRATION				
	0.02 M$\times 10^{-10}$	**0.04M** $\times 10^{-10}$	**0.06M** $\times 10^{-10}$	**0.08M** $\times 10^{-10}$	**0.10 M** $\times 10^{-10}$
Malic Acid	4.4194	4.29054	4.15479	4.04745	3.84375
Ascorbic Acid	4.5882	4.35422	4.25451	4.219	4.15845
Pectin	4.415	4.26822	4.1803	4.12454	3.97266
CQD	4.37418	4.29162	4.20733	4.14799	4.12494

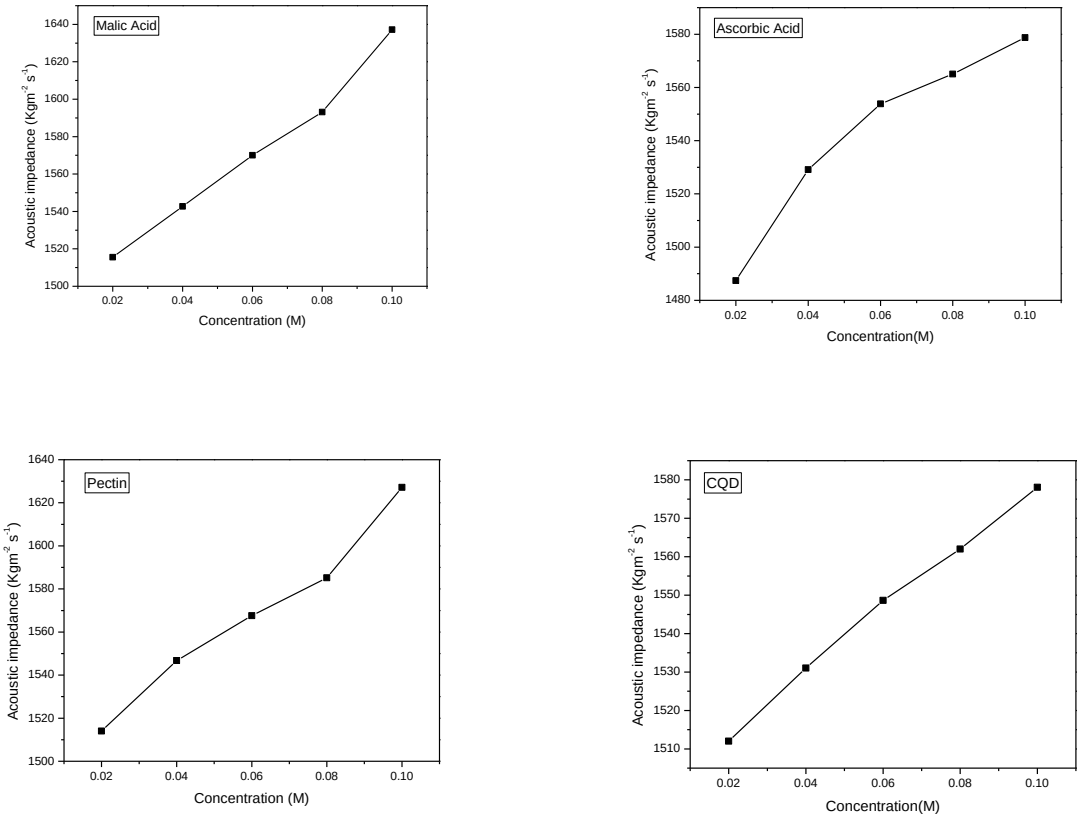

FIGURE 23 : Graphs of adiabatic compressibility with different Concentration of Different Liquids

3.Acoustic impedance (Z)

The acoustic impedance is the measure of the opposition that a system presents to the acoustic flow resulting of an acoustic pressure applied to the system.The acoustic impedance is related to the density (ρ) and velocity (v) .It is given by

$$Z = \rho v \quad \mathrm{Kgm^{-2}S^{-1}}$$

SAMPLE	CONCENTRATION				
	0.02 M	**0.04M**	**0.06M**	**0.08M**	**0.10 M**
Malic Acid	1515.54	1542.72	1570.06	1593.11	1637.21
Ascorbic Acid	1487.40	1529.12	1553.86	1565.02	1578.72
Pectin	1514.03	1546.73	1567.58	1585.19	1627.20
CQD	1512.00	1531.05	1548.63	1562.00	1578.07

TABLE 5 : Variation of Acoustic impedance with Concentration of Different Liquids

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CONCLUSION

- With increase in concentration the density and hence the velocity of ultrasonic waves increases in the solutions.
- The viscosity of the solution and hence the velocity of ultrasonic waves increases with increase in concentration of the solute in solution. This increase appears to be associated with an overall increase in the cohesion in the solution.
- With increase in concentration the velocity of ultrasonic waves increase but it shows non linearity. The increase in concentration weakens the molecular forces and hence change in velocity is observed.
- The values of viscosity increases with increase in concentration of compound in solvent. This increasing trend indicates the existence of molecular interaction occurring in these systems.
- The adiabatic compresability decreases with increase in concentration of the solution. This is due to the enhancement of the bond strength with the concentration.
- The acoustic impedance increases with increase in concentration. This is due to increase in density, viscosity of the solution and also effective due to solute solvent interactions.
- Free length decreases non-linearly with increase in concentration.