International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Some Acoustical Parameters of Ternary Liquid Mixture (Isopropyl Alcohol, Benzene and Cyclohexane)

H. K Semwal[1], S. C Bhatt[2]

Department of Physics, HNB Garhwal University Srinagar (Garhwal) Uttarakhand-246174, India

Abstract: ***The ultrasonic wave velocity in different composition of ternary liquid mixtures of Isopropyl alcohol, Benzene and Cyclohexane at frequencies 1MHZ to 7MHZ at room temperature has been measured with the help of ultrasonic interferometer and for whole composition range. Isentropic compressibility (Ks) and acoustic impedance (z) have been calculated for these ternary liquid mixtures.***

Keywords: Interferometer, Ultrasonic velocity, Isentropic compressibility, Acoustic impedance

1. Introduction

Acoustic sound velocity measurements are always of great interest since there are numerous applications, in particular for the chemical industry. Knowledge of the sound velocity and its variations are extremely useful in characterizing liquids such as electrolytes and organic solutions. Acoustical techniques to study oceanic behavior are the primary non invasive methods for geological, biological, physical and engineering aspects of oceans research as well as for resource location, evaluation and exploitation.

Acoustical methods are currently used for detection and to asses localized, regional and global problems especially and could become an extremely important tool for oceans research. As the speed of sound is dependent on the ocean structure, it enables studying the water column as well as the seabed and subsurface [1-2].

The technique of laser ultrasonic has immerged as a convenient method for non-destructive testing and physical characterization of materials. The technique involves generation of elastic waves in the ultrasonic frequency regime in a solid sample, irradiating with a high power pulse laser beam. Its principle, technique and applications are available in the literature [3].

It is known that the application of ultrasonic to mass transfer operation can enhance process yield. The extensive research performed in the area of solid liquid interaction is evidence to this effect [4-6]. Continuous liquid-liquid interaction is a counter-current flow process involving perceptional material transfer of a component between two immiscible or partially miscible liquids.

Ultrasonic in-service inspection is carried out to detect any unacceptable degradation in microstructure formation and extension of defects during the operation of components[7].

Measurement of ultrasonic velocity [8-13] has been adequately employed in understanding the molecular interactions in pure, binary, and higher order multi-component liquid mixtures. The propagation of ultrasonic velocity in a medium is a thermodynamic property and has come to be recognized as a very specific and unique tool for predicting and estimating various physio-chemical properties of the systems under consideration [14].

In present study ultrasonic velocity in ternary liquid mixture for different composition is measured. Using ultrasonic velocity in different composition in the frequency range 1MHZ to 7MHZ, isentropic compressibility and acoustic impedance for these liquid mixtures is calculated.

2. Experimental Measurements

The ultrasonic velocity measurements are extensively used to study physio – chemical behavior of liquids with the help of measured ultrasonic velocity , density and viscosity and using following formula, acoustic parameters Isentropic compressibility and Acoustic impedance have been determined and results are tabulated and discussed .

1. Ultrasonic velocity (U) calculated from the ultrasonic wavelength.

$$U = n\lambda$$

2. Isentropic compressibility

$$Ks = U^{-2}\,\rho^{-1}$$

3. Acoustic impedance

$$Z=\rho XU$$

Table 1: Ultrasonic velocity for ternary liquid mixture (Isopropyl alcohol + Benzene + Cyclohexane) at different frequencies and composition at room temperature

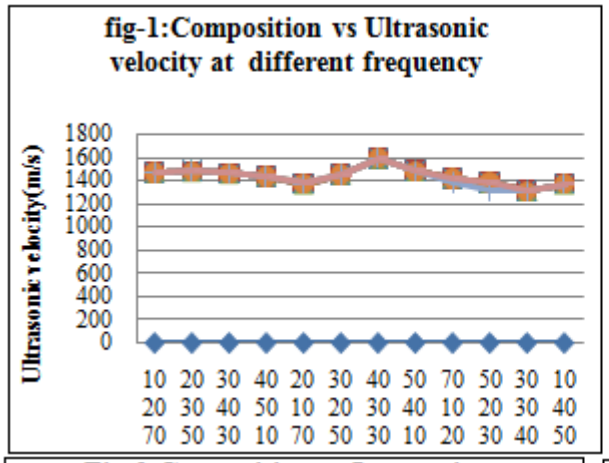
Ternary liquid mixture composition (volume)	Density	Ultrasonic velocity (m/s) at different frequencies						
Isopropylalcohol%+Benzene%+yclohexane %	(g/cc)x10^{-3}	1MHZ	2MHZ	3MHZ	4MHZ	5MHZ	6MHZ	7MHZ
10 20 70	0.703	1468	1468	1469	1470	1471	1472	1473
20 30 50	0.697	1476	1477	1479	1480	1481	1482	1482
30 40 30	0.702	1459	1458	1460	1460	1461	1462	1464
40 50 10	0.723	1435	1436	1436	1437	1438	1438	1440
20 10 70	0.702	1369	1370	1370	1371	1372	1374	1375
30 20 50	0.708	1449	1450	1450	1451	1452	1452	1454
40 30 30	0.712	1587	1588	1589	1590	1592	1593	1594
50 40 10	0.712	1478	1479	1479	1480	1481	1481	1482
70 10 20	0.703	1418	1419	1419	1420	1421	1382	1422
50 20 30	0.700	1378	1379	1380	1381	1382	1312	1383
30 30 40	0.686	1308	1308	1309	1310	1311	1312	1313
10 40 50	0.686	1369	1369	1370	1370	1371	1372	1374

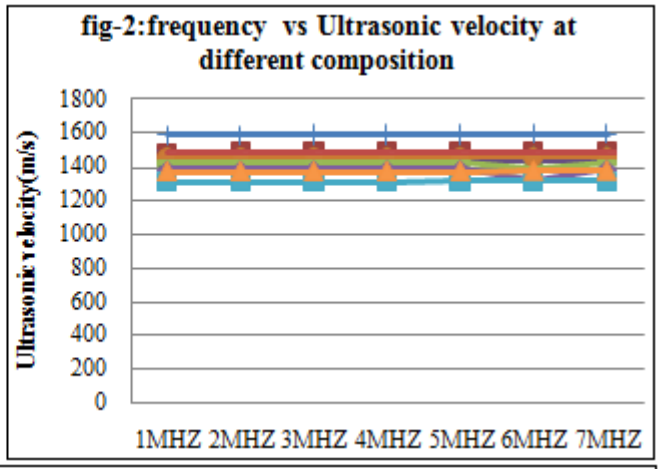
Table 2: Isentropic compressibility for ternary liquid mixture (Isopropyl alcohol + Benzene + Cyclohexane) at different frequencies and composition at room temperature

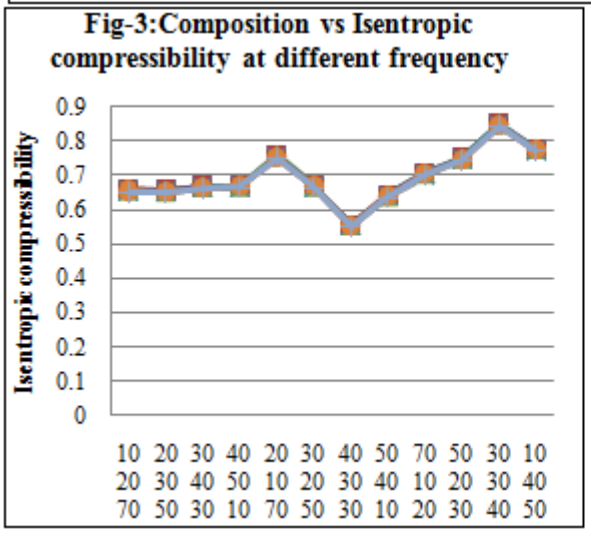
Ternary liquid mixture composition (volume)	Isentropic compressibility(Kg-^{1}ms-^{2}) at different frequencies (x10-^{3})						
Isopropyl alcohol% + Benzene % + Cyclohexane %	1MHZ	2MHZ	3MHZ	4MHZ	5MHZ	6MHZ	7MHZ
10 20 70	0.660	0.660	0.659	0.658	0.657	0.656	0.652
20 30 50	0.658	0.657	0.655	0.655	0.654	0.653	0.653
30 40 30	0.671	0.670	0.668	0.668	0.667	0.666	0.664
40 50 10	0.671	0.670	0.669	0.669	0.668	0.668	0.667
20 10 70	0.760	0.758	0.758	0.757	0.756	0.754	0.753
30 20 50	0.672	0.671	0.670	0.670	0.669	0.669	0.668
40 30 30	0.557	0.556	0.555	0.555	0.554	0.553	0.552
50 40 10	0.642	0.642	0.641	0.641	0.640	0.640	0.639
70 10 20	0.707	0.706	0.705	0.705	0.704	0.704	0.703
50 20 30	0.752	0.752	0.749	.749	0.748	0.747	0.746
30 30 40	0.852	0.852	0.849	0.849	0.848	0.846	0.845
10 40 50	0.777	0.777	0.776	0.776	0.775	0.774	0.772

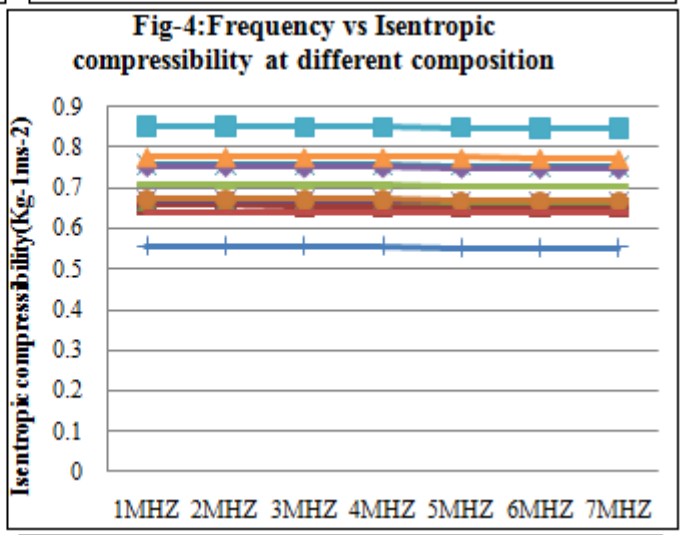
Table 3: Acoustic impedance for ternary liquid mixture (Isopropyl alcohol+Benzene+Cyclohexane) at different frequencies and composition

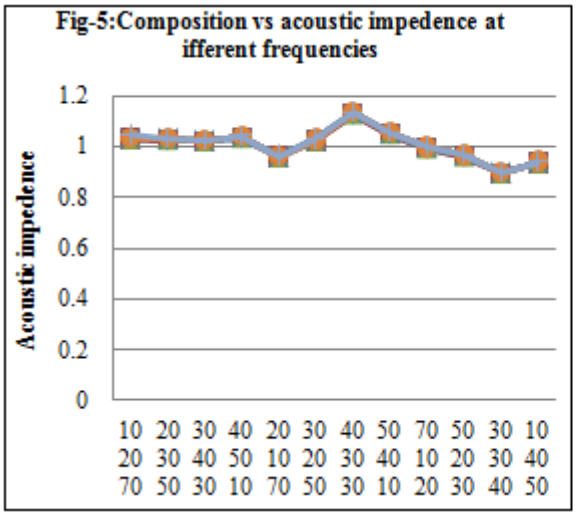
Ternary liquid mixture composition (volume)	Acoustic impedance(Kgm^{-2}s^{-1}) at different frequencies						
Isopropyl alcohol% + Benzene % + Cyclohexane %	1MHZ	2MHZ	3MHZ	4MHZ	5MHZ	6MHZ	7MHZ
10 20 70	1.032	1.032	1.032	1.033	1.034	1.034	1.246
20 30 50	1.028	1.029	1.030	1.031	1.032	1.032	1.032
30 40 30	1.022	1.023	1.024	1.024	1.025	1.026	1.027
40 50 10	1.037	1.038	1.038	1.038	1.039	1.039	1.041
20 10 70	1.962	.961	.961	.962	.963	.964	.965
30 20 50	1.025	1.026	1.026	1.027	1.028	1.028	1.029
40 30 30	1.129	1.130	1.131	1.132	1.133	1.134	1.134
50 40 10	1.052	1.053	1.053	1.053	1.054	1.054	1.055
70 10 20	0.996	0.997	0.997	0.998	0.994	0.998	0.999
50 20 30	0.964	0.964	0.965	0.966	0.966	0.967	0.968
30 30 40	0.897	0.897	0.897	0.898	0.899	0.900	0.900
10 40 50	0.939	0.939	0.939	0.939	0.940	0.941	0.942

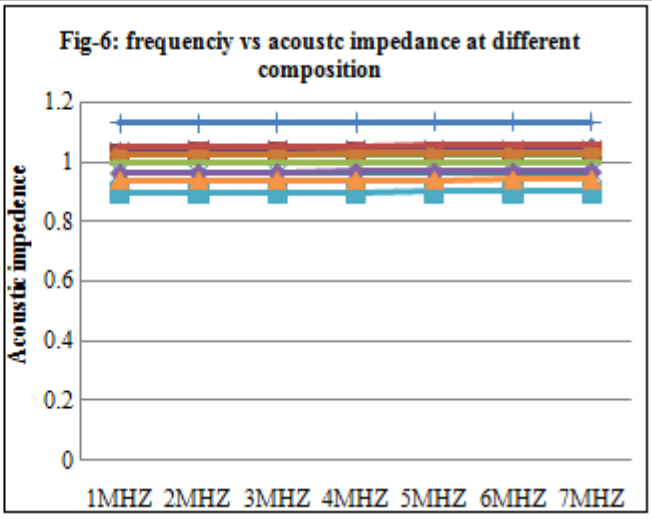












3. Result and Discussion

Ultrasonic velocity has been measured by variable path interferometer at different frequencies from 1MHZ to 7MHZ at room temperature in ternary liquid mixture (Isopropyl alcohol + Benzene + Cyclohexane). Ultrasonic velocity in ternary liquid mixtures (Isopropyl alcohol+ Benzene+ Cyclohexane) presented in table-1,fig-1 and fig-2. From the table and fig, it is observed that in ternary liquid mixture ultrasonic velocity increases with increasing frequency, while with composition the ultrasonic velocity changes, and depend upon the composition percentage of particular liquid in the ternary liquid mixture.

Isentropic compressibility of ternary liquid mixture have been calculated using formula $Ks=U^{-2}\rho^{-1}$and acoustic impedance is calculated by the equation $Z=\rho xU$. From the table-2 ,fig-3 and fig-4 the isentropic compressibility of ternary liquid mixture is decreases with increasing frequency. isentropic compressibility is also changing with composition of particular liquid in liquid mixture.

In ternary liquid mixture table-3 ,fig-5 and fig-6 shows that acoustic impedance is slightly increases with increasing frequency while acoustic impedance changes with composition, depend upon the composition percentage of particular liquid in liquid mixture.

4. Conclusion

The ultrasonic velocity determined in the table-1,fig-1 and fig-2 It is concluded that value of ultrasonic velocity in liquid mixtures is increases with increasing frequency slightly, It is almost remains constant, while ultrasonic velocity depends on the percentage of particular liquid in liquid mixture, i.e., it strongly depends on composition.

From the table-2, fig-3 and fig-4 it is revealed that the isentropic compressibility of liquid mixtures decreases with increasing ultrasonic velocity, it means that there is a significant interaction between the molecules due to which structural arrangement is affected of the constituent ion. From the table-3,fig-5 and fig-6 it is also observed that the acoustic impedance slightly increases with increasing frequency while acoustic impedance depends on the composition percentage of particular liquid in liquid mixture ,which shows that the constituent ions of structural arrangement are considerably affected in solute-solvent interaction of molecules.

References

[1] B.Chakraborty and Ehrlich Desa, J, Acous.Soc.Ind.,Vol.28 No.1-4,2000,pp19-24.
[2] The ATOC consortium "Oceanclimate change: comparision of acoustic tomography satellite oltimetry and modeling"Science 281(1998)1327-32.
[3] J.Philip," Laser Ultrasonics:Principles,techniques and applications" J.Acous.Soc.Ind,Vol.28(2000)pp49-54.
[4] H.S.Fogler,Recent advances in sonochemical engineering,CEP Symposium Series,67(1971)109.
[5] W,F.Head,H.M.Beal, W.M.Lauter,'Ultrasonic extraction of sinchona succerubra,J.Amer Pharm Assoc XL Vol 4(1956)239.
[6] M.E.Ovedi,D.M.Skauem,'Effect of ultrasonic waves on the extraction of alkaloids. Pharms Sci, 54,7(1948)68.
[7] D.R. Godhani, Y.V. Patel and P.H. Parsonia., 2001:, J. Pure and Appl.Ultrason.23,pp58-62.
[8] Ana B. López, Alicia García-Abuín, Diego Gómez-Díaz, M. Dolores La Rubia and José M. Navaza.,2013:, "Density, speed of sound, viscosity, refractive index and surface tension of N-methyl- 2- pyrrolidene+ diethanolamine (or triethanolamine) from T = (293.15 to 323.15)K," Journal of Chemical Thermodynamics,vol. 61, pp. 1-6.
[9] M.M. Papari, H. Ghodrati, F. Fadaei, R. Sadeghi, S. Behrouz, M. N. Soltani Rad and J. Moghadasi., 2013:,"Volumetric and ultrasonic study of mixtures of 2- phenyl ethanol with 1-butanol and 2-methyl-1-butanol at T=(298.15 – 323.15)K and atmospheric pressure: Measurement and prediction," Journal of Molecular Liquids, vol. 180, pp. 121-128.
[10] M. V. Rathnam, Kavita R. Bhanushali, Reema T. Sayed, and M. S. S. Kumar.,2012:,"Acoustic, thermodynamics and transport properties of binary liquid mixtures of isopentyl acetate with aryl halides at 303.15 K and 313.15 K," Journal of Molecular Liquids, vol. 173, pp. 35- 41.
[11] M. Sahin, and E. Ayranci.,2011:, "Volumetric properties of (ascorbic acid + polyethylene glycol 3350 + water) systems at T= (288.15, 298.15 and 308.15) K," J. Chem. Thermodynamics, vol. 43, pp.177-185.
[12] S.C Bhatt, Harikrishna Semwal, Vijendra Lingwal, Kuldeep Singh and B.S.Semwal., 2000:,"Relaxation Time and Ultrasonic Attenuation in Some Binary and Ternary Liquid Systems" J.Acous.Soc. Ind., Vol. 28 No.1-4, pp 275-278.
[13] H.K.Semwal, S.C.Bhatt and B.S.Semwal, 2003, "Acoustical study of binary liquid mixture of Acetic acid & Isopropyl-sulphide", J. Pure and Appl. Ultrason.25, pp.6-12.
[14] Ranjan Dey, Aditya Harshvardhan., Jan 2014:,"A Comperative study of Ultrasonic velocities of Binary and Multicomponent Liquid mixture at 298.15K.",Journal of Energy and Chemical Engineering,Vol 2 Iss.I,pp1-7.