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A Comparison Study Of Ultrasonic Velocities Binary Mixtures EG, DEG And TEG With Glycerol

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Abstract
The speed of sound, of binary mixtures of ethylene glycol, diethylene glycol and triethylene glycol are measured at different temperatures and at frequency of 2 MHz over entire range of mole fraction. The variation of the speed of sound with the molality of solute in the solvent depicts the nature of the intermolecular interactions taking place inside the mixture. The deviation of the experimental values with the increase in the molar mass of glycols is interpreted in terms of molecular interactions among the components of the binary mixtures.

Introduction

For determination of physicochemical behavior of liquid mixtures, the measurement of ultrasonic velocities plays a major role [1, 2]. An ultrasonic velocity propagating in a medium is related to the binding force of among the molecules of the mixture. As per liquid model's concept, the molecules in liquid state are loosely packed, leaving free space among the molecules. The intermolecular free space and its derived properties, reveal some information regarding the interaction occurring in the mixture as consequence of mixing of liquids together [3-5].

The theoretical evaluation of ultrasonic velocity in liquids and liquid mixtures as a function of composition is of great interest. A comparison of theoretically obtained velocity with those of experimentally obtained velocity data has been found to be beneficial in understanding the thermodynamics of liquid mixtures and gives the better means to check the validity of various empirical relations [6-9]. Liquid mixtures containing polar and non-polar group are of significance importance in understanding intermolecular interactions among the molecules of the mixture and find extensive applications in several industrial and technological processes. The aim of the present study is to obtain the speed of sound experimentally in the binary liquid mixtures of Ethylene Glycol (EG), Diethylene Glycol (DEG) and Triethylene Glycol (TEG) with glycerol and discuss the intermolecular interactions occurring in studied binary mixtures [10-16].

Materials and Methods

Ethylene Glycol (EG), Triethylene Glycol (TEG), Glycerol attained from Loba Chemie Pvt. Ltd. and Diethylene Glycol (DEG) acquired from SD Fine Chem. Ltd, India have been used in the present investigation. All the chemicals are having mass fraction purity greater than 0.99. The speed of sound for liquid mixtures has been measured with Mittal enterprises ultrasonic interferometer at frequency of 2 MHz.

Results and Discussion

The ultrasonic velocities for three binary systems EG + Glycerol, DEG + Glycerol and TEG + Glycerol has been measured experimentally at different temperatures T=(298.15, 303.15, 308.15, 313.15) K, are given in **Table 2** and are graphically represented in **Figure 1**, **Figure 2** and **Figure 3** respectively.

Table 2: Ultrasonic velocities for binary liquid mixtures of Glycols and Glycerol at different temperatures.

Mole fraction of EGs	C_{EXP} ($m \cdot s^{-1}$)			
	T= 298.15 K	*T*= 303.15 K	*T*= 308.15 K	*T*= 313.15 K
EG + G*lycerol*				
0.0000	1920.0	1885.2	1851.0	1836.4
0.0958	1911.6	1875.6	1840.8	1823.7
0.1858	1902.3	1866.1	1830.7	1812.4
0.4259	1872.6	1837.3	1802.1	1780.4
0.4973	1856.7	1823.6	1790.6	1767.3
0.6290	1812.3	1780.8	1752.8	1730.3
0.6900	1787.4	1758.1	1732.9	1712.2
0.8558	1717.6	1695.1	1678.6	1661.3
0.9061	1695.9	1676.9	1662.5	1646.1
1.0000	1656.2	1643.8	1632.6	1616.8
DEG + G*lycerol*				
0.0000	1920.0	1885.2	1851.0	1836.4
0.1178	1892.3	1857.3	1824.9	1807.8
0.1783	1877.5	1843.6	1811.2	1793.6
0.4316	1816	1784.6	1751.8	1731.2
0.4979	1797	1766.2	1733.7	1713.1
0.6345	1740.8	1714.6	1686.7	1667.8
0.7047	1709.5	1686.3	1661.5	1643.7
0.8494	1645.3	1627.7	1609.2	1593.7
0.9240	1612.8	1597.5	1582.3	1567.8
1.0000	1579.8	1567.2	1555.1	1541.9
TEG + G*lycerol*				
0.0000	1920.0	1885.2	1851.0	1836.4
0.1178	1897.2	1862.9	1829.7	1814.6
0.1783	1884.8	1850.9	1818.1	1802.8
0.4316	1828.6	1795.6	1765.2	1747.3
0.4979	1812.2	1779.6	1749.9	1730.9

0.6345	1768.5	1739.8	1712.8	1693.2
0.7047	1741.2	1715.5	1690.5	1671.6
0.8494	1680.8	1660.4	1640.4	1622.8
0.9240	1647.3	1629.6	1612.1	1595.4
1.0000	1611.3	1596.7	1581.4	1565.8

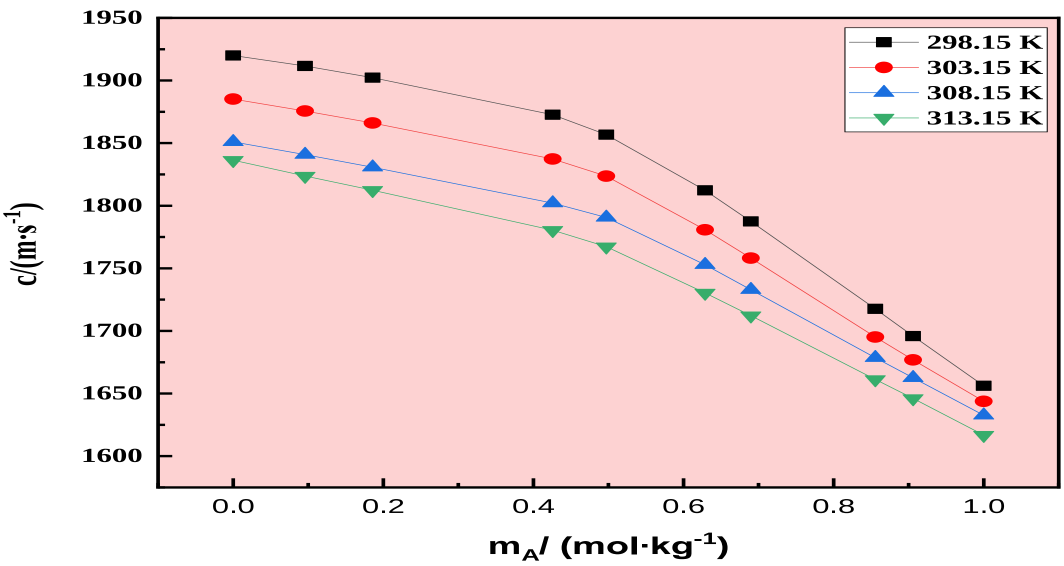

Figure1 : Variation of experimental speed of sound with molality for (Ethylene glycol + Glycerol) at T= (298.15 - 313.15) K.

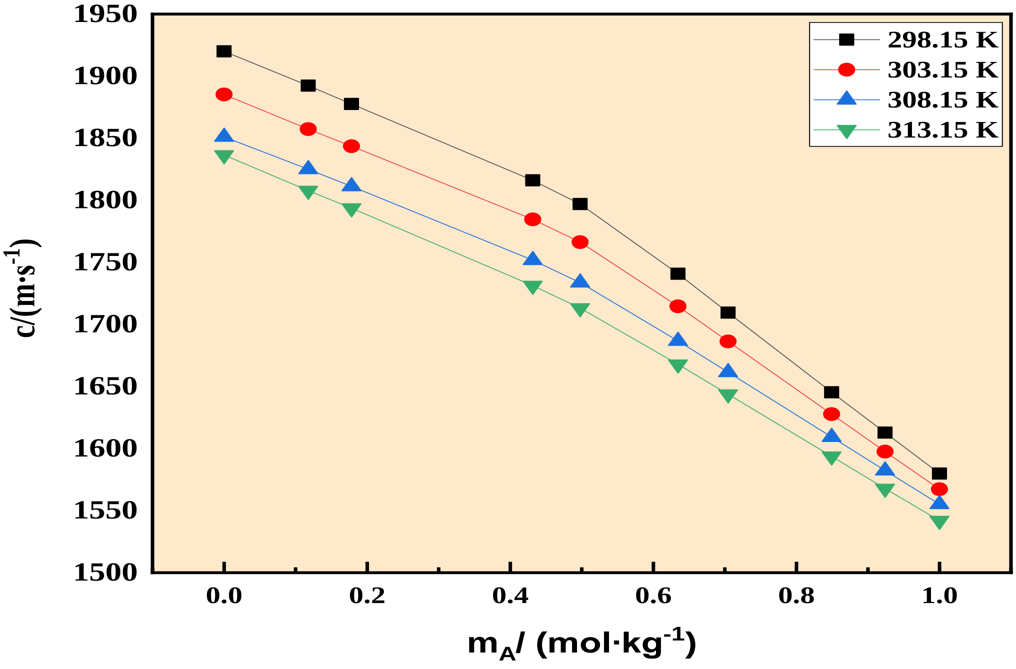

Figure 2: Variation of experimental speed of sound with molality for (Diethylene glycol + Glycerol) at T= (298.15 - 313.15) K.

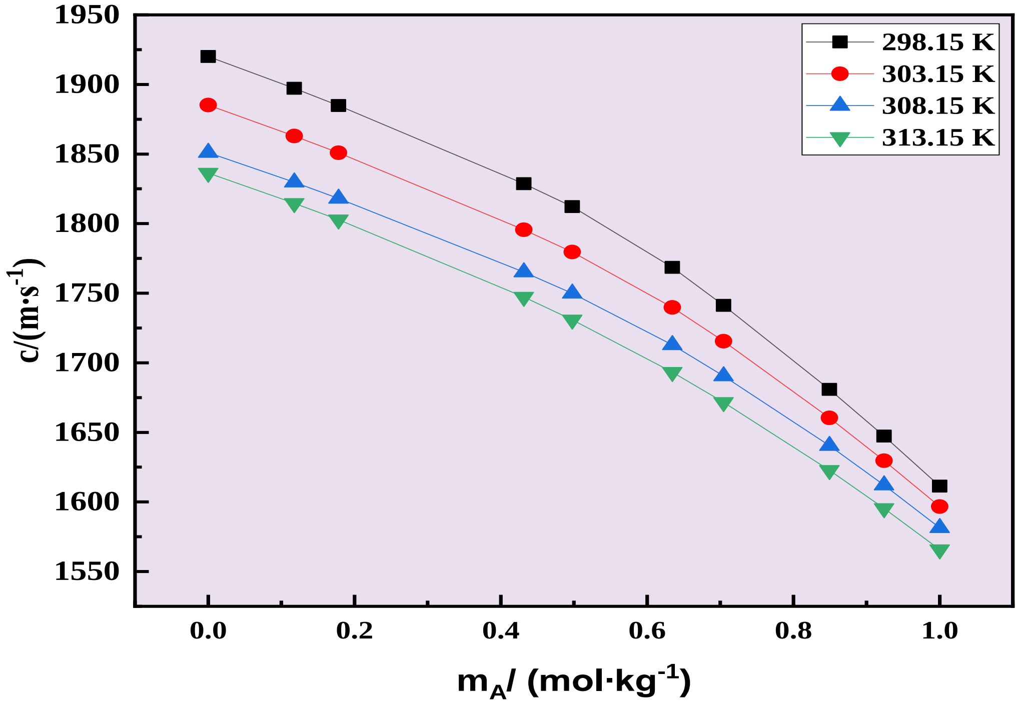

Figure 3: Variation of experimental speed of sound with molality for (Triethylene glycol + Glycerol) at T= (298.15 - 313.15) K.

The experimental values are decreasing along with the temperatures and the molar mass of glycols in Glycerol. This occurs due to 3-D network of the intermoleculer H-bonds in solute – solvent molecules and intramoleculer hydrogen bonding in solute molecules, thus indicates the high combination rate of the molecules inside the solutions. Also, the upsurge in the values of speed of sound along with the molality of glycols attributes the hydrogen bond network in solvent with aqueous Glycerol molecule [17-23].

Conclusions

From the values of experimental speed of sound values, it is observed that there exists strong intermolecular hydrogen bond among the molecules of aqueous glycerol with three different glycols i.e. Ethylene glycol, Diethylene glycol and Triethylene glycol. Due to this the solute-solvent interaction inside the solution increases with the increase in the molar mass of glycols. The molecular interaction upsurges from ethylene glycol to diethylene glycol to triethylene glycol but decreases with the temperature.

References

1. G. V. Rama Rao, A. Viswanatha Sarma, J. Siva Rama Krishna, and C. Rambabu, “Theoretical evaluation of ultrasonic velocities in binary liquid mixtures of o-chlorophenol at different temperatures,” Indian Journal of Pure and Applied Physics, vol. 43, no. 5, pp. 345–354, 2005.
2. P. Vasantharani, S. Muthu Shailaja, A. N. Kannappan, and R. Ezhil Pavai, “Theoretical evaluation of ultrasonic velocity in organic liquid mixtures,” Journal of Applied Sciences, vol. 8, no. 12, pp. 2329–2332, 2008.
3. J. D. Pandey, A. K. Singh, and R. Dey, “Novel approach for prediction of ultrasonic velocity in quaternary liquid mixtures,” Pramana, vol. 64, no. 1, pp. 135–139, 2005.
4. J. D. Pandey, R. Dey, and D. K. Dwivedi, “Ultrasonic velocity of binary systems at elevated pressures,” Pramana, vol. 52, no. 2, pp. 187–193, 1999.
5. T. Sumathi and J. U. Maheswari, “Ultrasonic and theoretical studies of some ternary liquid mixtures at Various temperatures,” Indian Journal of Pure and Applied Physics, vol. 47, no. 11, pp. 782–786, 2009.
6. Rao GVR, Samantha K, Sarma AV (2004) A comparative study of ultrasonic velocity and allied parameters of binary mixtures at different temperatures. J Acoust Soc Ind 32: 213.
7. Dubey GP, Monika Sharma (2008) Acoustical and excess properties of {1-hexanol + n-hexane, or n-octane, or n-decane} at (298.15, 303.15, and 308.15) K. Journal of Molecular Liquids 142: 124-129.
8. Artigas HI Bandrés, B Giner, C & A.L afuenteVillares, J Mol Liq, 139(2008): 138.
9. Radhamma M, Venkatesu P, PrabhakaraRao MV, Lee MJ, Lin HM (2008) Excess molar volumes and ultrasonic studies of dimethylsulphoxide with ketones at T = 303.15 K. The Journal of Chemical Thermodynamics 40: 492-497.
10. Fakruddin Sk, Srinivasu Ch, Narendra K (2012) Theoretical Studies of Ultrasonic Velocities in Binary Liquid Mixtures of Quinoline at Different Temperatures. Journal of Chemical and Pharmaceutical Research 4: 1799-1806.
11. Rita Mehra, Avneesh K Gaur (2008) Study of a Binary Liquid Mixture of Diethylamine and 1-Decanol and Validation of Theoretical Approaches of Sound Speed at Different Temperatures. J Chem Eng Data 53: 863-866.

12. Al-Kandary JA, Al-Jimaz AS, Abdul-Haq M, Abdul-Latif (2006) Viscosities, Densities, and Speeds of Sound of Binary Mixtures of Benzene, Toluene, o-Xylene, m-Xylene, p-Xylene, and Mesitylene with Anisole at (288.15, 293.15, 298.15, and 303.15) K. J Chem Eng Data 51: 2074-2082.

13. WB Bunger JA Reddick, & TK Sankano, Organic Solvents, VolII (4thedn), Weissberger A Ed, Wiley Interscience, New York, (1986).

14. Mukherjee, R. (2020). Electrical, thermal and elastic properties of methylammonium lead bromide single crystal. Bulletin of Materials Science, *43*(1), 1-5.

15. Mukherjee, R., Huang, Z. F., & Nadgorny, B. (2014). Multiple percolation tunneling staircase in metal-semiconductor nanoparticle composites. Applied Physics Letters, *105*(17), 173104.

16. Laha, S. S., Mukherjee, R., & Lawes, G. (2014). Interactions and magnetic relaxation in boron doped Mn3O4 nanoparticles. *Materials Research Express*, *1*(2), 025032.

17. Weissberger, Proskaner ES, Riddick & E .E. Jr, Toops.Organic Solvents, Vol II (2ndedn), Weissberger A Ed, Wiley Interscience, New York (1955).

18. Rama Rao M (1941) Velocity of Sound in Liquids and Chemical Constitution J Chem Phys 9: 682.

19. Mukherjee, R., Lawes, G., & Nadgorny, B. (2014). Enhancement of high dielectric permittivity in CaCu3Ti4O12/RuO2 composites in the vicinity of the percolation threshold. Applied Physics Letters, *105*(7), 072901.

20. Mukherjee, R., Chuang, H. J., Koehler, M. R., Combs, N., Patchen, A., Zhou, Z. X., & Mandrus, D. (2017). Substitutional Electron and Hole Doping of WSe 2: Synthesis, Electrical Characterization, and Observation of Band-to-Band Tunneling. Physical Review Applied, *7*(3), 034011.

21. Nomoto O (1958) Empirical Formula for Sound Velocity in Liquid Mixtures J Phys Soc 13: 1528-1532.

22. Van Dael W, Vangael E, Pro Int Conf on Calorimetric and Thermodynamics, Warsaw (1955) 555.

23. Junjie Z (1984) J China Univ Sci Techn 14: 298.