

SIGNIFICANCE OF LIQUID MIXTURES OVER PURE LIQUID STATE FOR ACOUSTICAL PROPERTIES

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Abstract

Liquid state study of binary and ternary mixture shed more light on intermolecular interactions, leading to various applications in industry. Ultrasonic interferometer is used to measure the ultrasonic velocity, density and viscosity at various temperatures, concentrations and different frequencies. Further it can be used to calculate the acoustical and thermodynamic parameters. The method of calculating the acoustical parameters, variation of parameter with respect to frequency and its correlation to the intermolecular interactions are highlighted in this paper.

Introduction

For the better understanding of the molecular science, one needs to study the intermolecular interactions in binary mixture[1-6], ternary mixture and ionic interactions in electrolytic solutions. Several techniques are employed to study the intermolecular interactions. They are Nuclear Magnetic Resonance (NMR), ultraviolet (UV), Infrared (IR), dielectric constant and ultrasonic studies (ultrasonic interferometer). Ultrasound studies play a vital role in understanding the intermolecular interaction in mixture liquid state[7-10]. Earlier studies have shown that the ultrasonic velocity and acoustical parameters are related to molecular interactions and physico-chemical behaviour of the system[11-19].

1. Adiabatic Compressibility (β)

The electrostatic force of interaction is the key player to make the structural changes within the mixture of molecules[20-26]. The structural changes of molecules lead to significant changes in a adiabatic compressibility. The adiabatic compressibility is expressed as follows

$$\beta = 1/U^2 \rho \text{ Kg}^{-1} \text{ms}^2$$

Where U is the velocity of ultrasonic waves

ρ is the liquid mixture density.

2. Free Length (L_f)

The free length is the distance travelled by the ultrasound wave between the surfaces of the closest molecules and expressed in the equation form as follows

$$L_f = K / (\rho U)^{1/2} m$$

Where U is velocity of ultrasonic waves
 ρ is liquid mixture density

3. Acoustic Impedance (Z).

The specific acoustic impedance is the product of liquid mixture density and the velocity of ultrasonic waves. Z is expressed as

$$Z = \rho U \text{ Kg m}^{-2} \text{ s}^{-1}$$

4. Relaxation Time (τ).

Relaxation time (τ) is calculated using the following equation

$$\tau = 4\eta / 3 \rho U^2 \text{ sec}$$

where η is the adsorption coefficient

5. Attenuation coefficient (α/f^2)

Attenuation coefficient is expressed as

$$(\alpha/f^2) = 8\pi^2\eta/[3\rho U^3]. \text{ Npm}^{-1}\text{s}^2$$

but it depends on various parameters like pressure, frequency and temperature[27-35].

6. Free Volume

The free volume is defined as the average volume of free space in which the molecules can move inside the hypothetical cell due to the repulsion of the proximal molecules[36-50].

$$V_f = V(V_g/U)^3$$

$$V_g = (\gamma RT/M)^{3/2}$$

RESULTS AND DISCUSSION

The liquid state study of liquid systems using ultrasonic interferometer has gained lot of attention among researchers to explore the intermolecular interactions in the liquid state. More researchers are focused to elucidate the acoustic and thermodynamic parameters of different liquid systems, which throw more light on intermolecular interactions like hydrogen bonds, and dipole-dipole interaction present in the liquid system. In this paper, the recent ultrasonic velocity measurements in liquid mixtures (binary and ternary mixture) and in electrolyte solution are highlighted.

Binary mixture

In histidine-water binary system, the ultrasonic velocity, density and viscosity are measured at 35°C. The concentration plays a vital role in the histidine-water mixture. With the increase in concentration, the density, viscosity, specific acoustic impedance, ultrasonic attenuation, free volume and ultrasonic velocity also increase, but decrease in free length and adiabatic compressibility is observed. Here the increase in concentration enhances the molecular interaction and the dipole-dipole interaction. In N, N-dimethyle acetamide and benzonitrile binary system (Patil et al., 2013), the increasing concentration of binary mixture leads to decrease in density, viscosity and impedance. Higher the concentration, the ultrasonic velocity, free length, free volume and compressibility are observed to be increasing. These parameters show that the molecular interaction could be due to specific hydrogen bond and dipole-dipole interaction. A detailed investigation is done on Atropine sulphate – water mixture (Balakrishnan *et al.*, 2012), where the increasing concentration resulted high free length, compressibility and density but reduce in the ultrasound velocity. The acoustical behavior of polymer, polyvinyl acetate in acetic acid has been studied (Singh and Bhatt, 2010). The effect of temperature with different concentration have been studied.

Ternary mixture

The liquid state study of ternary mixture N-Ndimethylformamide, nitrobenzene, and cyclohexane is performed (Praharaj et al., 2013) at 45°C which revealed that the concentration variation of liquid mixture leads to decrease in density and viscosity but the velocity of ultrasonic waves are

increasing. The adiabatic compressibility is measured at different frequency in which the decrease in adiabatic compressibility resulting decrease in free length and free volume. Here the ternary liquid mixture is mainly stabilized by weak interactions, dipole-dipole moments, dipole-induced dipole and hydrogen bonding. In addition, $\pi - \pi$ interactions are observed.

CONCLUSION

Enlarged data set of molecular interaction is a must for molecular science. The expansion of liquid state study of various liquid systems, pure and mixture, will deduce the molecular interaction in a precise manner.

REFERENCES

1. Ramamoorthy, R., Kanagasabai, V., Kausalya, R., Impact of celebrities' image on brand, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-251-253, 2017
2. Ramamoorthy, R., Kanagasabai, V., Vignesh, M., Quality assurance in operation theatre with reference to Fortis Malar Hospital, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-87-93, 2017
3. Ramya, N., Arthy, J., Honey comb graphs and its energy, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-83-86, 2017
4. Ramya, N., Jagadeeswari, P., Proper coloring of regular graphs, International Journal of Pure and Applied Mathematics, V-116, I-16 Special Issue, PP-531-533, 2017
5. Ramya, N., Karunakaran, K., Proper, star and acyclic coloring of some graphs, International Journal of Pure and Applied Mathematics, V-116, I-16 Special Issue, PP-43-44, 2017
6. Ramya, N., Muthukumar, M., On coloring of 4-regular graphs, International Journal of Pure and Applied Mathematics, V-116, I-16 Special Issue, PP-491-494, 2017
7. Ramya, N., Muthukumar, M., On star and acyclic coloring of graphs, International Journal of Pure and Applied Mathematics, V-116, I-16 Special Issue, PP-467-469, 2017
8. Ramya, N., Pavi, J., Coloring of book and gear graphs, International Journal of Pure and Applied Mathematics, V-116, I-17 Special Issue, PP-401-402, 2017
9. Ramya, P., Hameed Hussain, J., Alteration framework for integrating quality of service in internet real-time network, International Journal of Pure and Applied Mathematics, V-116, I-8 Special Issue, PP-57-61, 2017
10. Ramya, P., Sriram, M., Tweet sarcasm: Peep, International Journal of Pure and Applied Mathematics, V-116, I-10 Special Issue, PP-231-235, 2017

11. Sabarish, R., Meenakshi, C.M., Comparision of beryllium and CI connecting rod using ansys, International Journal of Pure and Applied Mathematics, V-116, I-17 Special Issue, PP-127-132, 2017
12. Sabarish, R., Rakesh, N.L., Outcome of inserts for enhancing the heat exchangers, International Journal of Pure and Applied Mathematics, V-116, I-17 Special Issue, PP-419-422, 2017
13. Sangeetha, M., Gokul, N., Aruls, S., Estimator for control logic in high level synthesis, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-425-428, 2017
14. Sangeetha, M., Gokul, N., Aruls, S., Image steganography using a curvelet transformation, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-417-422, 2017
15. Saraswathi, P., Srinivasan, V., Peter, M., Research on financial supply chain from view of stability, International Journal of Pure and Applied Mathematics, V-116, I-17 Special Issue, PP-211-213, 2017
16. Saravana Kumar, A., Hameed Hussain, J., Expanding the pass percentage in semester examination, International Journal of Pure and Applied Mathematics, V-116, I-15 Special Issue, PP-45-48, 2017
17. Saravana, S., Arulselvi, S., AdaBoost SVM based brain tumour image segmentation and classification, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-399-403, 2017
18. Saravana, S., Arulselvi, S., Dynamic power management monitoring and controlling system using wireless sensor network, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-405-408, 2017
19. Saravana, S., Arulselvi, S., Clustered morphic algorithm based medical image analysis, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-411-415, 2017
20. Saravana, S., Arulselvi, S., Networks, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-393-396, 2017
21. Saritha, B., Chockalingam, M.P., Adsorptive removal of heavy metal chromium from aqueous medium using modified natural adsorbent, International Journal of Civil Engineering and Technology, V-8, I-8, PP-1382-1387, 2017
22. Saritha, B., Chockalingam, M.P., Adsorptive removal of brilliant green dye by modified coconut shell adsorbent, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-211-215, 2017
23. Saritha, B., Chockalingam, M.P., Photodegradation of eriochrome black-T dye from aqueous medium by photocatalysis, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-183-187, 2017
24. Saritha, B., Chockalingam, M.P., Photodradation of malachite green DYE using TIO_2 /activated carbon composite, International Journal of Civil Engineering and Technology, V-8, I-8, PP-156-163, 2017

25. Saritha, B., Chockalingam, M.P., Synthesis of photocatalytic composite Fe-C/TiO₂ for degradation of malachite green dye from aqueous medium, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-177-181, 2017
26. Saritha, B., Chockalingam, M.P., Removal of heavy X`X`l from aqueous medium using modified natural adsorbent, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-205-210, 2017
27. Saritha, B., Chockalingam, M.P., Degradation of malachite green dye using a semiconductor composite, International Journal of Pure and Applied Mathematics, V-116, I-13 Special Issue, PP-195-199, 2017
28. Sartiha, B., Chockalingam, M.P., Photocatalytic decolourisation of textile industry wastewater by TiO₂, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-221-224, 2017
29. Sartiha, B., Chockalingam, M.P., Study on photocatalytic degradation of Crystal Violet dye using a semiconductor, International Journal of Pure and Applied Mathematics, V-116, I-18 Special Issue, PP-209-212, 2017
30. Shanthi, E., Nalini, C., Rama, A., The effect of highly-available epistemologies on hardware and architecture, International Journal of Pharmacy and Technology, V-8, I-3, PP-17082-17086, 2016
31. Shanthi, E., Nalini, C., Rama, A., Drith: Autonomous, random communication, International Journal of Pharmacy and Technology, V-8, I-3, PP-17002-17006, 2016
32. Shanthi, E., Nalini, C., Rama, A., A case for replication, International Journal of Pharmacy and Technology, V-8, I-3, PP-17234-17238, 2016
33. Shanthi, E., Nalini, C., Rama, A., Elve: A methodology for the emulation of robots, International Journal of Pharmacy and Technology, V-8, I-3, PP-17182-17187, 2016
34. Shanthi, E., Nalini, C., Rama, A., Autonomous epistemologies for 802.11 mesh networks, International Journal of Pharmacy and Technology, V-8, I-3, PP-17087-17093, 2016
35. Sharavanan, R., Golden Renjith, R.J., Design and analysis of fuel flow in bend pipes, International Journal of Pure and Applied Mathematics, V-116, I-15 Special Issue, PP-59-64, 2017
36. Sharavanan, R., Jose Ananth Vino, V., Emission analysis of C.I engine run by diesel, sunflower oil, 2 ethyl hexyl nitrate blends, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-403-408, 2017
37. Sharavanan, R., Sabarish, R., Design of built-in hydraulic jack for light motor vehicles, International Journal of Pure and Applied Mathematics, V-116, I-17 Special Issue, PP-457-460, 2017
38. Sharavanan, R., Sabarish, R., Design and fabrication of aqua silencer using charcoal and lime stone, International Journal of Pure and Applied Mathematics, V-116, I-14 Special Issue, PP-513-516, 2017
39. Sharmila, G., Thooyamani, K.P., Kausalya, R., A schoolwork on customer relationship management with special reference to domain 2 host, International Journal of Pure and Applied Mathematics, V-116, I-20 Special Issue, PP-199-203, 2017

40. Sharmila, S., Jeyanthi Rebecca, L., Anbuselvi, S., Kowsalya, E., Kripanand, N.R., Tanty, D.S., Choudhary, P., Swathy Priya, L., GC-MS analysis of biofuel extracted from marine algae, *Der Pharmacia Lettre*, V-8, I-3, PP-204-214, 2016
41. Sidharth Raj, R.S., Sangeetha, M., Data embedding method using adaptive pixel pair matching method, *International Journal of Pure and Applied Mathematics*, V-116, I-15 Special Issue, PP-417-421, 2017
42. Sidharth Raj, R.S., Sangeetha, M., Android based industrial fault monitoring, *International Journal of Pure and Applied Mathematics*, V-116, I-15 Special Issue, PP-423-427, 2017
43. Sidharth Raj, R.S., Sangeetha, M., Mobile robot system control through an brain computer interface, *International Journal of Pure and Applied Mathematics*, V-116, I-15 Special Issue, PP-413-415, 2017
44. Sivaraman, K., Sundarraj, B., Decisive lesion detection in digital fundus image, *International Journal of Pure and Applied Mathematics*, V-116, I-10 Special Issue, PP-161-164, 2017
45. Sridhar, J., Sriram, M., Cloud privacy preserving for dynamic groups, *International Journal of Pure and Applied Mathematics*, V-116, I-8 Special Issue, PP-117-120, 2017

