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Interaction Study of Curcumin with 1-Butanol Binary Mixture

Manjunath M S[1] and J Sannappa[2]

[1]Department of Physics, Government First Grade College, Chamarajanagara, Karnataka, India.
[2]Department of Post-Graduate Studies and Research in Physics, Kuvempu University, Jnanasahyadri, Shankaraghatta, Karnataka, India.

ABSTRACT

Ultrasonic velocity, density and viscosity of binary mixtures of Curcumin and 1-Butanol have been measured at room temperature 303K. Using the measured ultrasonic velocity, thermodynamic parameters such as adiabatic compressibility (β), inter molecular free length (Lf), Acoustic impedance (Z), free volume (VE) have been calculated. It is observed from the result for 1-butanol in curcumin systems as the concentration increases the ultrasonic velocity decreases which indicate the intermolecular interaction exist between them. Further value of acoustic parameter shows non linear variation which confirms presence of molecular interaction between curcumin molecules with 1-butanol systems.

Keywords: Molecular interaction, Hydrogen bond, Ultrasonic velocity.

**Corresponding author:*

INTRODUCTION

Measurement of ultrasonic velocity and acoustical parameters in the fluid systems is one of the powerful methods to known different Physico-chemical character of the fluid systems. Alcohols are one of the most important organic compounds which are used in clinically as well as in many scientific and industrial purposes [1]. Curcumin (Di-feruloyl methane) is one of the natural polyphenolic components of turmeric which is a yellow pigment, isolated from the rhizomes of plant Curcuma longa [2]. Curcumin is known for biological and pharmaceutical application in many fields and useful for the prevention, treatment of several diseases like cancer [3]. Curcumin has been used extensively in Ayurvedic medicine for centuries, as it is nontoxic and has a variety of therapeutic properties including anti-oxidant, analgesic, anti-inflammatory and antiseptic activity. [4-9]

MATERIALS AND METHODS

The experimental procedure and other details of the equipment procedure and other details of the equipment were basically the same as reported earlier [10].The alcohols used in the present work were analytical reagent (AR) grades obtained from Sd fine chemicals India and used without further purification. In all systems, the various concentrations of the binary liquid mixtures were prepared in terms of mole fraction varied from 0.1 to 0.7. A Curcumin sample is isolated in our lab by using Indian turmeric. The density of pure liquids and liquid mixtures are determined using a specific gravity bottle by relative measurement method with an accuracy of ± 0.1mg. An Ostwald's viscometer which is 10ml capacity is used for the viscosity measurement of pure liquids and liquid mixtures.

Ultrasonic velocity is calculated for using relation $U = n\,\chi$ m/s

Adiabatic compressibility $$\beta = \frac{1}{\rho U^2} \ ms^2\,kg^{-1}$$

Intermolecular free length $$L_f = \sqrt{\beta}\ K_T \quad Kg\,m^{-2}\,s^{-1}$$

Acoustic impedance $$Z = U\rho$$

Free volume $$V_f = \left[\frac{MU}{K\eta}\right]^{\frac{3}{2}}$$

Where n, $\rho, \eta,$ M is the frequency of the ultrasonic wave, density, viscosity and molecular weight of the mixtures. K and K_T are the constant. They are temperature dependent and the values are 361X 10^{-6} and 4.28 x 10^{9} respectively.

RESULT AND DISCUSSION

Values of Ultrasonic velocity (U), Density (ρ) and Viscosity (η) are measured for the binary mixture of curcumin with 1-butanol systems at 303K are presented in Table-1. The values of adiabatic compressibility (β), inter molecular free length (Lf), free volume (Vf) and acoustical impedance (Z) at the temperatures of 303k are reported in Table-2.

Result from table-1 shows the ultrasonic velocity is decreases with increasing mole fraction and viscosity and density are increases as the concentration of 1-butanol increases, this clearly indicates the intermolecular interaction in the binary fluid systems. Result shows there is moderate attraction between molecules. The decreasing velocity shows molecules of components are attracted by hydrogen bond. Figure-1 shows the decreasing variation of ultrasonic velocity with mole fraction of the 1-butanol. The magnitude of the density is increases and viscosity is also increases clearly indicate the increases of frictional resistance force. This is due to change in molecular area or cohesive or adhesive force between the molecules.

Adiabatic compressibility, intermolecular free length values are calculated by measured values of ultrasonic velocity, viscosity and density. The Adiabatic compressibility, intermolecular free length values shows increases trends with increases concentration of the 1-butanol. The data in table-2 shows adiabatic compressibility increases with decreasing the ultrasonic velocity clearly shows the presence of molecular interaction between the molecules of 1-butanol with curcumin binary mixtures. Intermolecular free length increases shows the distance between inter molecules decreases with increasing the concentration of the 1-butanol. This conform the association in the binary systems [11]. This can be observed from Figure -2, which shows the variation of adiabatic compressibility with 1-buatnol binary mixture.

Values for free volume and acoustical impedance are calculated by measured values of ultrasonic velocity, viscosity and density. The data from the table -2 shows a reverse trend is observed that is decreases trends for free volume and acoustical impedance values with increasing the mole fraction of the 1-buatanol. This shows presence of interaction between curcumin with 1-butanol molecules.

The figure 2 shows that a slightly steeper curve for the binary mixture of curcumin with 1-butanol. The adiabatic compressibility shows a reverse trend that of ultrasonic velocity. The structural geometry of molecules in the mixture is depends on the adiabatic compressibility, the increasing in the adiabatic compressibility showing the progressive intermolecular interaction between the molecules [12].

The variation of ultrasonic velocity in a mixture depends upon the increase or decrease of intermolecular free length [13]. Figure-3 shows the variation of intermolecular free length for different value concentration. Since the free length Lf is proportional to the adiabatic compressibility β the same trend of variation similar to the variation of adiabatic compressibility has observed in the graph. However, the increase in adiabatic compressibility and inter molecular length also be attributed to the internal interaction between the molecules of the binary mixtures [14]. Data for specific acoustic impedance (Z) are tabulated in the table-2. The values in table-2 show a gradually decreasing of impedance with increasing mole concentration of the 1-butanol. This trend of result shows presence of interaction between the curcumin and 1-butanol. Table-2 shows the value of free volume with variable concentration of 1-butnaol. The free volume is decreases with increasing the mole concentration of the 1-butnaol with curcumin as observed from the table-2. This result confirms interaction between the curcumin with 1-butnaol.

CONCLUSION

From measured ultrasonic velocity, density and viscosity, the related acoustical parameter for the binary mixture are calculated. It is noticed that sound velocity is decreases with increasing mole concentration and adiabatic compressibility is increases with increasing mole concentration. Inter molecular free length is increases and free volume decreases with concentration. This result shows existences a interaction and it can be conclude that there is a intermolecular interaction present in the binary mixture.

Table 1: Value of ultrasonic velocity (U), Density (ρ) and Viscosity (η)

Mole Fraction		For 1-Butanol with Curcumin		
X_1	X_2	ρ in Kg m^{-3}	η x 10^3 in Ns m^{-2}	U in ms^{-1}
0.1	0.7	786.81	0.7822	1218
0.2	0.6	815.21	0.8321	1151
0.3	0.5	856.58	0.9562	1126
0.4	0.4	895.21	1.1356	1000
0.5	0.3	923.63	1.2761	981
0.6	0.2	968.21	1.3521	956
0.7	0.1	986.65	1.3842	910

Table 2: Values of Adiabatic compressibility (β), Intermolecular free length (L_f), Free volume (V_f) and Specific acoustic impedance (Z).

Mole Fraction		*For 1-Butanol with Curcumin*			
X_1	X_2	$\beta \times 10^{-10}$ in $N^{-1} m^{-2}$	$L_f \times 10^{-10}$ in m	$V_f \times 10^{-7}$ in ms^{-1}	$Z \times 10^3$ in $N{\cdot}s/m^3$
0.1	0.7	8.5671	1.8469	1.4235	958.33
0.2	0.6	9.2593	1.9200	1.1909	938.30
0.3	0.5	9.2401	1.9180	1.1473	961.13
0.4	0.4	11.1709	2.1089	0.0969	895.21
0.5	0.3	11.2503	2.1164	0.0833	906.08
0.6	0.2	11.3029	2.1213	0.0603	925.52
0.7	0.1	12.2442	2.2079	0.0353	897.48

Figure 1: Variation of ultrasonic velocity with mole fraction.

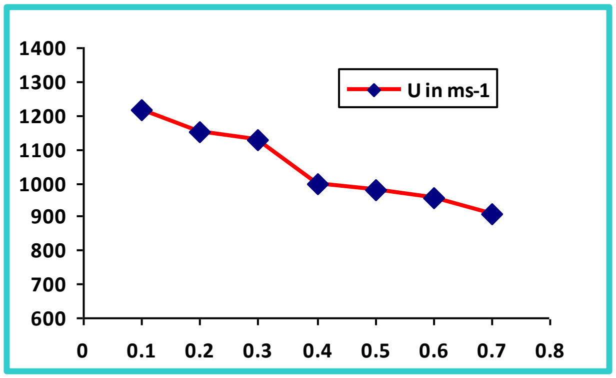


Figure 2: Variation of Adiabatic compressibility with mole fraction.

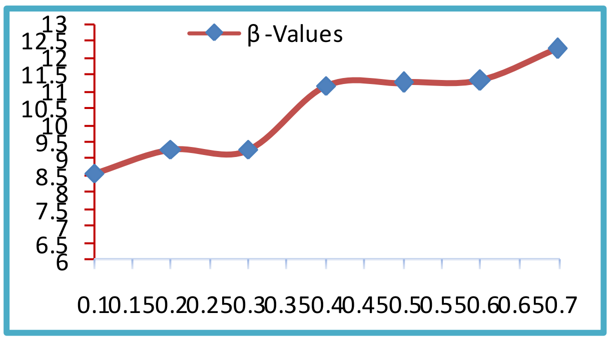
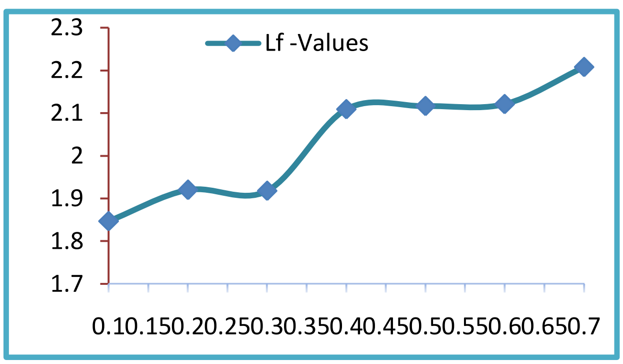


Figure 3: Variation of intermolecular free length for different value concentration.



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