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Molecular Interaction study of Curcumin with 1-Propanol binary mixture

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ABSTRACT

Ultrasonic velocity, density and viscosity of binary mixtures of Curcumin and 1-Propanol have been measured at room temperature 303K. Using the measured velocity the thermodynamic parameters such as adiabatic compressibility (β), inter molecular free length (L_f), Acoustic impedance (Z), free volume (V_E) have been calculated. It has been established that ultrasonic velocity decreases with increasing the mole fraction. The results show a nonlinear variation of acoustical parameters confirms the presence of molecular associative nature in this binary mixture.
Keywords: Ultrasonic velocity, Binary mixtures, Molecular interaction.

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INTRODUCTION

Ultrasonic technique is a one of the power now a day in all the fields. The ultrasonic study plays an important role in the study of physic chemical properties of the liquids. The interaction of molecule in the liquid mixture can be predicts by measuring the thermodynamic properties like velocity, density and viscosity. The variation of this parameter gives the vital information of the intermolecular interaction [1]. Curcumin is known for his biological and pharmaceutical application in many fields [2]. Curcumin is useful for the prevention and treatment of several diseases like cancer. Many studies have suggested a wide range of potential therapeutic or preventive effects associated with curcumin like antitumor, antioxidant, antiarthritic, antiamvloid and anti-inflammatory [3-8]. Alcohols are one of the important organic chemical and plays significant role in many chemical reactions of bio-molecules. Many drugs can be prepared by the using the alcohols example Benadryl and also it is used as common solvent for paints, glues and nail varnish [9].

MATERIALS AND METHODS

An ultrasonic interferometer supplied by M/s. Mittal Enterprises, New Delhi, having the frequency 2MHz with an overall accuracy of ± 2 ms^{-1} has been used for ultrasonic velocity measurement. The chemicals 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 Crucumin 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 χ m/s

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

Intermolecular free length $L_f = \sqrt{\beta}\ K_T$ 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, $\boldsymbol{\rho}, \boldsymbol{\eta}$, 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

The experimentally determined values of density (ρ), viscosity (η) and ultrasonic velocity (U) of all the pure liquids at 303K for the binary mixture are presented in Table 1. The values of adiabatic compressibility (β), inter molecular free length (L_f), free volume (V_f) and acoustical impedance (Z) at the temperatures of 303k are reported in Table 2. The Figure-1 represents the variation of ultrasonic velocity of binary mixture with their corresponding mole fraction. Figure-2 shows the adiabatic compressibility variation with mole fraction of the curcumin with 1-propanol binary mixture.

From the table 1, it was observed that the value for density and viscosity is increases with the increasing the mole fraction of the binary mixture. But a reverse trend is observed for the sound velocity, that is with all the weight fraction the sound ultrasonic velocity decreases and reaches a minimum values. Similar result is reported by Pandey et al [10]. Figure 1 shows the nonlinear variation of the velocity with increasing the mole fraction. The nonlinear variation of sound velocity with mole concentration of 1-alcohol indicates the existence of interaction between the curcumin with 1-propanol.

The data from table 2 shows the adiabatic compressibility is increasing with the increasing the mole concentration of the 1-propanol. The figure 2 shows that a slightly steeper curve for the binary mixture of curcumin with 1-propanol. 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 [11].

The variation of ultrasonic velocity in a mixture depends upon the increase or decrease of intermolecular free length [12]. Figure 3 shows the variation of intermolecular free length for different value concentration. Since the free length L_f 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 [13].

The value for specific acoustic impedance (Z) from table 2 shows, it is gradually decreasing with increasing the mole concentration of the 1-propnaol. This result shows the presence of interaction between the curcumin and 1-propanol. Table 2 shows the value of free volume with variable concentration of 1-propanol. The free volume is decreases with increasing the mole concentration of the alcohols with curcumin is observed from the table 2. This result confirms inter molecular interaction between the curcumin with 1-propanol.

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

Mole Fraction		For 1-Propanol 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	756.21	0.7835	1453
0.2	0.6	768.43	0.8116	1356
0.3	0.5	792.11	0.8745	1289
0.4	0.4	860.08	0.9612	1174
0.5	0.3	883.22	1.1281	1014
0.6	0.2	929.21	1.2009	986
0.7	0.1	941.65	1.2102	928

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-Propanol with Curcumin			
X_1	X_2	β x 10^{-10} in N^{-1} m^{-2}	L_f x 10^{-10} in m	V_f x 10^{-7} in ms^{-1}	Z x 10^3 in N·s/m^3
0.1	0.7	6.2636	1.5792	1.8594	1098.77
0.2	0.6	7.0774	1.6786	1.4669	1041.99
0.3	0.5	7.5981	1.7393	1.2291	1021.03
0.4	0.4	8.4357	1.8327	0.096	1009.73
0.5	0.3	11.0110	2.0939	0.0728	895.585
0.6	0.2	11.0696	2.0994	0.0528	916.20
0.7	0.1	12.8785	2.2644	0.0297	836.73

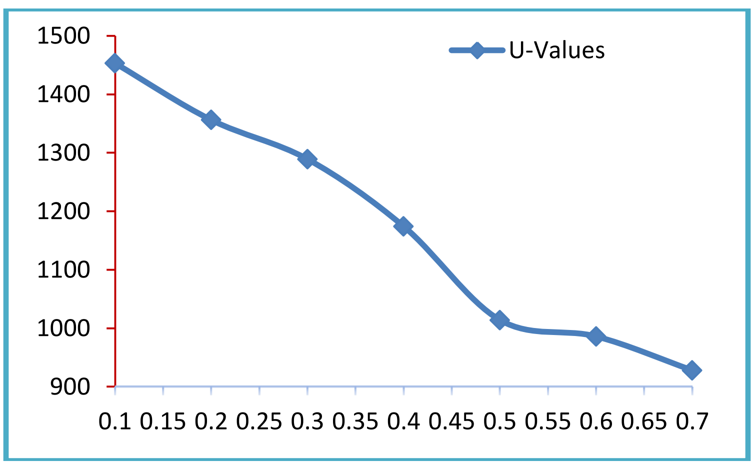

Figure 1: Variation of ultrasonic velocity with mole fraction

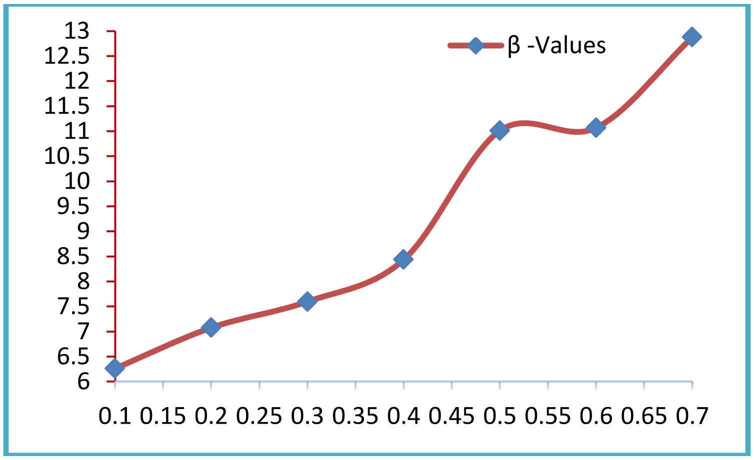

Figure 2: Variation of Adiabatic compressibility with mole fraction

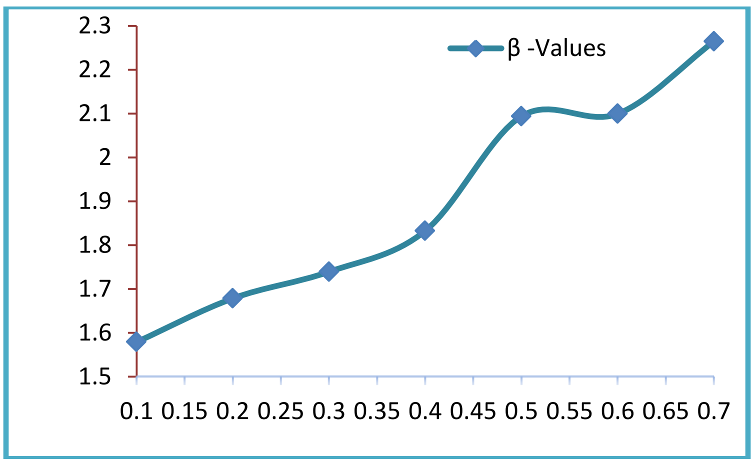

Figure 3: Variation of intermolecular free length for different value concentration

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 increases with concentration. This result shows existences a molecular association and it can be conclude that there is an intermolecular interaction present in the binary mixture.

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