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INTERMOLECULAR INTERACTIONS STUDIES IN BINARY MIXTURES OF CURCUMIN PARTICLES WITH PRIMARY ALCOHOLS

R.Soundar
Asst.Prof of physics, GFGC KGF.

ABSTRACT

Ultrasonic velocity, density, and viscosity for Curcumin with primary alcohols binary mixture viz, I-propanol is determined at 303k using Ultrasonic Interferometer. The result shows values for thermodynamic parameters such as adiabatic compressibility, intermolecular free length, free volume, acoustic impedance, and the molecular association have been calculated and tabulated. The data are used study to correlate the properties and relevant interaction parameters with the nature of intermolecular interaction between the binary mixture compounds. The results show a nonlinear variation of acoustical parameters which confirms the presence of molecular associative nature.

KEY WORDS: ***Intermolecular interaction, Curcumin, Ultrasonic velocity, Adiabaticcompressibility, intermolecular free length.***

INTRODUCTION

Curcumin (Diferuloymethane) is a natural yellow dye derived from the rhizome of Curcuma Longa Linn. Curcumin is a poly phenol di-ketone from extracted from turmeric [1]. It is yellow in color and is responsible for most of the therapeutic effects of turmeric used widely as a food coloring [2]. It has been known as an Ayurvedic medicine for centuries on the Indian subcontinents a pharmacological safety drug because of its antioxidant and anti-inflammatory effect; it has wide application in medical fields. Alcohols are industrially and scientifically important organic compounds and its property is largely depending on hydroxyl groups. Interaction between two or more molecules is called intermolecular interaction. Intermolecular interactions is particular important in terms of how molecules interact. Inter molecular forces are responsible intermolecular interaction [3].

To understand the intermolecular interaction, it is necessary to determine the various ultrasonic parameters, which are related to molecular associations.

I MATERIALS AND METHODS

Analytical research grade of Primary Alcohol werepurchased from SD fine chemicals Ltd, India and purified by the standard method [4,5,6]. Curcumin isolated from local turmeric rhizome.

The turmeric rhizomes are powered by sieved through a mesh of 0.5mm thickness mesh to obtain uniform size of sample. It is mixed with acetone to get mixture of oil and a resin. It mixed with solvent and kept overnight to get a yellow precipitate of curcumin. The precipitate is washed and purify for several times with solvent. Various concentrations of the binary liquid mixtures were prepared in terms of mole fractions varied from 0.1 to 0.7.

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

The density of pure liquids and liquid mixtures are determined using a 10 ml specific gravity bottle by relative measurement method with an accuracy of ±0.1mg. An Ostwald's viscometer which is 10 ml capacity is used for the viscosity measurement of pure liquids and experimental liquid mixtures,

Ultrasonic velocity is calculated for using relation

$$U = n\chi \ m/s \quad (1)$$

Adiabatic compressibility

$$\beta = 1/\rho U^2 \ ms^2 \ kg^{-1} \quad (2)$$

Intermolecular free length

$$L_f = \sqrt{\beta} \ k_T \ kg \ m^{-2} \ s^{-1} \quad (3)$$

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Acoustic impedance

$$Z = U\rho \quad (4)$$

Free volume

$$V_f = [MU/k\eta]^{3/2} \quad (5)$$

Where n, ρ, η, 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 361×10^{-6} and 4.28×10^{9} respectively.

II RESULT AND DISCUSSION

The experimentally determined values of density (ρ), viscosity (η) and ultrasonic velocity (U) of all the pure liquids and the mixture are tabulated in Table 1 at a temperature 303k. 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.

From the table 1, the results show value for density and viscosity is increases with the increasing the mole fraction of the binary mixture. But a reverse trend is observed for ultrasonic velocity that is with all the weight fraction the ultrasonic velocity decreases and reaches a minimum value. Similar result is reported by Pandey et al [7]. The nonlinear variation of ultrasonic velocity with mole concentration of primary alcohol indicates the existence of interaction between the curcumin with primary alcohols.

The data from table 1 shows adiabatic compressibility is increasing with the increasing the mole concentration of the primary alcohols. The result shows that a slightly steeper values for the binary mixture of curcumin with primary alcohols. The adiabatic compressibility shows a reverse trend as that of ultrasonic velocity. The structural geometry of molecules in themixture is depends on the adiabatic compressibility, the increasing in the adiabatic compressibility showing the progressive intermolecular interaction between the molecules [8].

The variation of ultrasonic velocity in a mixture depends upon the increase or decrease of intermolecular free length [9]. The results show 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. However, the increase in adiabatic compressibility and inter molecular length also be attributed to the internal interaction between the molecules of the binary mixtures [10].

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

Table 1
VALUE OF ULTRASONIC VELOCITY (U, DENSITY (p) AND VISCOSITY (H)

Mole fraction		For 1-proponol with Curcumin		
X1	X2	ρ in kg m^{-3}	$\eta\times10^{3}$ 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	1.1282	1014

Table 2
VALUES OF ADIABATIC COMPRESSIBILITY (B), INTERMOLECULAR FREE LENGTH (Lf), FREE VOLUME (Vf) AND SPECIFIC ASCOUSTIC IMPEDANCE (Z).

Mole fraction		For 1-Proponol with Curcumin			
X1	X2	$\beta\times10^{-10}$ N^{-1} m^{-2}	$L_f\times10^{-10}$m	$v_f\times10^{-7}$ ms^{-1}	$Z\times10^{3}$ N. s/m^{3}
0.1	0.7	6.2636	1.579	1.959	1098.7
0.2	0.6	7.0774	1.678	1.466	1041.9
0.3	0.5	7.5981	1739	1.229	1021.0
0.4	0.4	8.4357	1.832	0.096	1009.7
0.5	0.3	11.011	2.093	0.072	895.58

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III CONCLUSION

From measured ultrasonic velocity, density and viscosity, the related acoustical parameter for the binary mixture are calculated. It is noticed that ultrasonic 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 a intermolecular interaction present in the binary mixture.

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