ISSN 0974 - 9373

Vol. 25 No. 3 (2021) **Journal of International Academy of Physical Sciences** pp. 421- 426

Assessment of Thermoacoustic Properties of the Refined Natural Oils

P. Johnson Babu

Jagruthi Degree and P.G College, Narayanaguda, Hyderabad, India
Email id: johnson.life@gmail.com

D. Linga Reddy

College of Science, Osmania University, Hyderabad, India- 500 007

(Received July 16, 2021)

Abstract: Utilizing the coefficient' of volume expansion. α, the thermoacoustic. parameters, such as the Sharma constant.S_0, the isochoric temperature coefficient of internal pressure (X) and the adiabatic temperature coefficient volume expansion (X'), the decreased volume, the reduced. Compressibility ($\tilde{\beta}$), and the "Huggins parameter" (F) have been assessed for the refined coconut and castor oils. The results show that the S_0, the Sharma's constant has the typical value of 1.11 ± 0.01 which establishes the Sharma parameter's' constancy. All the remaining parameters are in the anticipated order of magnitude.

Keywords: Sharma's constant, Huggins parameter, adiabatic temperature coefficient of volume expansion, Isochoric' temperature coefficient of internal pressure. Refined oils.

1. Introduction

In the previous two or three years, significant importance has been given to the analysis of physicochemical behaviour of liquid crystals in their mesophases', isotropic and crystalline phases because of various technological applications in science and industry. The fluid crystalline phase displays anisotropic and rheological properties of the fluid for of its unusual existence between' isotropic liquid states and the solid' crystalline[1].

Oil is a viscous liquid that is neutral and non-polar in nature at room temperature. In nature, oil is both hydrophobic and lipotropic. Oils have a significant hydrogen and carbon concentration, as seen by their chemical composition. The natural oils are oils that are derived from plant seed or fruit. Most edible oils are derived from plant seeds. Triglycerides are the building blocks of oils[2]. Edible oils are the most significant components of the human diet as they provide food with distinctive nutrients, flavour, and textures. As a result, ultrasonic studies in edible oils have been a field of study for many decades. For example, an implementation of ultrasonic technology in the high voltage' liquid insulation. sector to reduce the pour point of oilseed samples in order to use seed oils as fluid insulation on power transformers in cold climate zones was performed by Bakrutheen et.al.[3]. D. Julian Mc Clements et.al.[4,5], utilized the low intensity ultrasound technique for the characterisation of edible oils and fats, they found the dynamic rheology, composition of oils, emulsions droplet size.

Sharma established the worth of the coefficient of volume expansion (α) in assessing other thermoacoustic characteristics, such as the Sharma constant (S_0), in a variety of non-mesomorphic systems, such as polymers, rare earth alkali metals, polycrystalline solids, and so on. Sharma discovered that the Sharma constant, which is a characteristic constant, imparts a constant value of 1.11 ± 0.01 in all these systems. Understanding intermolecular interactions and the molecular arrangement in the condensed phase may be aided by S_0. Y. Narasimha Murthy et.al.[6], have determined the Sharma's constant and other acoustic characteristics of natural oils/fats such as Sal seed fat and Mango kernel fat using the coefficient of volume expansion and proved the Sharma parameter's constancy.

Inspired by these studies, an attempt is made in this research to estimate several thermoacoustic characteristics, including the Sharma constant. To understand the behaviour of the numerous thermoacoustic parameters in nematic and isotropic' states, as well as at and near the phase transition temperature, the coefficient of volume expansion (α), was used for the two natural refined oils namely coconut oil and castor oil.

2. Theory

A brief description of a theoretical approach for estimating various thermoacoustic' parameters using the coefficient of volume expansion (α) is as below, 2.1. The volume expansion coefficient (α) can be defined as

(2.1) $$\alpha = \frac{1}{V_n}\left(\frac{dV}{dT}\right),$$

where $dV = V_2 - V_1$, $dT = T_2 - T_1$ and $V_n = \left(\frac{V_1 + V_2}{2}\right)$, where V_1 and V_2 are the molar volumes at the temperatures T_1 and T_2 respectively.

(2.2) The isochoric temperature coefficient of internal pressure (ITIP) as derived by Harward and Parker[6] and denoted by $\tilde{X}$ can be calculated using α as

(2.2) $$\tilde{X} = \left[\frac{d\,ln\,Pi}{d\,ln\,T}\right]_V = \frac{-2\left[1+2\,\alpha\,T\right]}{\tilde{V}^{C_1}},$$

where Pi is the internal pressure, $\tilde{V}$ is the reduced volume, $\tilde{\beta}$ is the reduced compressibility, C_1 is the dimensionless coefficient of bulk modulus as introduced by Moelwyn-Hughes[6]. These values can be obtained from α as follows

(2.3) $$\tilde{V} = \left(\frac{V}{V*}\right) = \left[1 + \frac{\alpha T}{3(1+\alpha T)}\right]^3,$$

(2.4) $$\tilde{\beta} = \left(\frac{\beta}{\beta *}\right) = \left(\tilde{V}\right)^{C_1},$$

(2.5) $$C_1 = \frac{13}{3} + \frac{1}{\alpha T} + \frac{4\alpha T}{3}.$$

Here V, V^*, β, β^* are the hard-core volumes[6] and compressibilities at absolute zero and temperature T.

(2.3) The isochoric temperature coefficient of volume expansivity (X') can be given[1,7],

(2.6) $$X' = -\left[1 + 2\alpha T\right].$$

(2.4) The Sharma's constant (S_0) by means of the coefficient of volume expansion (α) ac be expressed as

$$(2.7) \qquad S_0 = \frac{-X'}{\tilde{\beta}}\left[3+4\alpha T\right] = \frac{-S^* S_0^*}{\tilde{\beta}}\left[3+4\alpha T\right],$$

where S^* and S_0^* are the Sharma's parameters[1] given by

$$(2.8) \qquad S^* = 1+\frac{4}{3}\alpha T \text{ and } S_0^* = \frac{1+2\alpha T}{1+\frac{4}{3}\alpha T}$$

(2.5) The Huggin's Parameter (F) is stated in terms of the Sharma's constant as

$$(2.9) \qquad F = 2\left[1+\frac{S_0}{(3+4\alpha T)}\right] - \frac{(3+4\alpha T)}{3}.$$

Thus, from the above expressions of the thermoacoustic parameters imply the importance of the coefficient of volume expansion (α).

3. Materials Used

3.1. Coconut, well-known as Cocos Nucifera, a tree known for its numerous nutritional and medicinal properties has recently sparked interest in western medicine. Coconut oil is very regularly used as a tropical' edible oil in several Asian cultures and is comprised of almost 90- 95% saturated fatty acids. Coconut oil contains no cholesterol, sodium, or sugar. It includes an uncommon composition of saturated fats, primarily lauric acid and muriatic acids, which have been found to have many health benefits. This also makes it an admirable source of energy, as it is the type of fat which is burned straight away rather than stored[8].

3.2**.** Castor oil's scientific name is "Ricinuscommunis". The seeds of castor oil plants are extracted and used for medicinal purposes. It is a colourless to dark pale yellow liquid with a distinct taste and odour. It has a boiling point of 3130 ^{0}C and a density (ρ) of 0.961 x103 kgm^{-3}. Castor oil is a triglyceride that contains 90 percent fatty acids such as ricinolate. Castor oil and its derivatives are used in the production of lubricants such as brake fluids, as well as paints, coatings, and soaps[8].

4. Results

The Sharma constant narrates the adiabatic volume derivative of the intermolecular constant to the Gruneisen thermodynamic parameter and other numerous physical parameters, and as such it is a significant parameter in examining the physicochemical behaviour of any system. According to the descriptions of Sharma , the value of the Sharma constant" is a constant for any type of system, either in a solid or in a liquid[1]. The observation of this study reveals that, when the system transitions from an isotropic liquid state to a mesomorphic state, S_0 takes on a lower value than the characteristic value only at the transition temperatures. S_0 drops to a lower value at the transition temperature than at any other temperature. Table.1 and Table.2 give the investigation results of the thermo acoustic properties of the refined coconut and castor oils and from the tables it is evident that S_0 is solely dependent on α, but not on temperature. For refined coconut oils the transition temperature is 308^0K and for castor oil it is 303^0K.

The other parameters display atypical behaviour at the transition temperature, as well as pre-transitional effects on both sides of the transition.

Table1 Thermoacoustic properties of the refined coconut and refined castor oil[9].

Temperature T^0K	α x 10^{-3} K^{-1}	-X	-X´	$\tilde{V}$	$\tilde{\beta}$	S_0	S^*	S_0^*	F
1.**Refined Coconut oil**									
298	0.330063	0.65814	1.1967	1.09225	3.63668	1.117	1.1311	1.05797	1.526992
303	0.9687	0.53595	1.5870	1.244509	5.92233	1.119	1.3914	1.140638	1.144594
308	0.0911	0.71225	1.0561	1.027555	2.96567	1.108	1.0374	1.01804	1.674817
313	0.1468	0.61965	1.3077	1.139333	4.22062	1.120	1.2051	1.085099	1.414546
318	0.94314	0.53250	1.5998	1.24892	6.00882	1.118	1.3999	1.142829	1.132605
323	0.180865	0.68809	1.1168	1.056217	3.24619	1.113	1.0779	1.036132	1.610199
328	0.487519	0.61564	1.3198	1.144294	4.28762	1.120	1.2132	1.08787	1.40243
333	0.234308	0.67314	1.1560	1.074138	3.43481	1.115	1.1040	1.047115	1.569104
2.**Refined Castor oil**									
298	0.327	0.65888	1.1946	1.091	3.626	1.1	1.12	1.05	1.5291

		1	68	349	36	17	98	74	02
303	0.058	0.72101	1.0348 96	1.017 247	2.870 68	1.1 07	1.02 33	1.01 14	1.6977 46
308	0.556	0.60828 7	1.3423 7	1.153 401	4.413 61	1.1 21	1.22 82	1.09 29	1.3800 4
313	0.23	0.67779 8	1.1436 88	1.068 537	3.374 71	1.1 14	1.09 58	1.04 37	1.5820 06
318	0.248	0.67242 1	1.1579 6	1.074 999	3.444 15	1.1 15	1.10 53	1.04 76	1.5671 15
323	0.324	0.65352 2	1.2095 1	1.097 851	3.701 51	1.1 17	1.13 97	1.06 13	1.5138 48
328	0.191	0.68494 2	1.1249 88	1.059 979	3.284 91	1.1 13	1.08 33	1.03 85	1.6016 17
333	0.969	0.52047 8	1.6452 81	1.264 309	6.322 19	1.1 17	1.43 02	1.15 04	1.0902 91

References

1. M. S. R. Subrahmanyam, H. S. Vedanayagam, and P. Venkatacharyulu, Estimation of the Sharma Constant and Thermoacoustic Properties of Vegetable Oils, *J. Am. Oil Chem. Soc.*, **71(8)** (1994), 901-905.

2. H. Noureddini, B. C. Teoh and L. Davis Clements, Viscosities of Vegetable Oils and Fatty Acids, *J. Am. Oil Chem. Soc.*, **69(12)** (1992), 1189-1191.

3. M. Bakrutheen and W. Siluvairaj, Impact of Ultrasonic Treatment Process on Pour Point of Vegetable Oils Based Liquid Insulation, *Ultrason. Sonochem.*, **71** (2021), 105380.

4. D. J. McClements and M. J. W. Povey, Ultrasonic Analysis of Edible Fats and Oils, *Ultrasonics*, **30(6)** (1992), 383-388.

5. R. Chanamai and D. Julian McClements, Ultrasonic Attenuation of Edible Oils, *JAOCS, J. Am. Oil Chem. Soc.*, **75(10)** (1998), 1447-1448.

6. R. N. V. R. R. Y. Narasimiia Murthy and V. Rama Murthy, Coefficient of Volume Expansion and Thermoacoustic Parameters in Two Natural Oils, *Cryst. Res. Technol*, **13** (1996), 921-927.

7. B. K. Sharma, Nonlinearity Parameter and its Relationship with Thermo-Acoustic Parameters of Polymers, *J. Phys. D. Appl. Phys.*, **16(10)** (1983), 1959-1965.

8. I. R. Jeevankumar and E.Rekha, Densities, Ultrasonic Studies and a Few Acoustic Parmeters in Some Edible Oils, *J. Interdiscipl. Cycle Res.*, **12(7)** (2020), 43-54.

9. T. Sankarappa, M. Prashant Kumar and A. Ahmad, Ultrasound Velocity and Density Studies in Some Refined and Unrefined Edible Oils, *Phys. Chem. Liq.*, **43(6)** (2005), 507-514.