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THERMO ACOUSTIC PARAMETERS OF BINARY MESOPHASE MIXTURES

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The dilatometric studies were performed on the nematic and isotropic phases of p-azoxyanisole (PAA), 4,4′-n-hexyloxyazoxy benzene (PHAB) and their mixtures. The coefficient of volume expansion α of these systems are estimated using a number of thermo-acoustic and anharmonic parameters such as the isochoric temperature coefficient of internal pressure, the reduced compressibility, the reduced volume, isothermal microsscopic Gruneisen parameter, fractional free volume and Sharma parameter. The temperature dependence of these parameters are also discussed.

1. Introduction

The properties of binary mesophase mixtures have not been studied extensively in erature because of their complex nature. The principal interest in a binary system ides in acquiring an additional degree of freedom relative to the thermodynamic iables ascribed to the phase stability. The dilatometric studies of the mixed system ps us in the understanding of the phase behaviour of the system. In the present dy the dilatometric properties of the p-azoxyanisole (PAA)/4,4′-di-n-hexyloxyazoxy nzene (PHAB) and their mixtures are investigated to obtain different thermo-acoustic d anharmonic parameters such as the isochoric temperature coefficient of internal essure x, isochoric temperature coefficient of volume expansivity x^1, the reduced mpressibility $\tilde{\beta}$, the reduced volume $\tilde{V}$, isothermal microscopic Gruneisen parameter fractional free volume f and Sharma parametr S_0. The temperature dependence of ese parameters are also discussed which will give a basic understanding about the olecular order and intermolecular interactions in the condensed phase.

2. Theory

The theoretical procedure for the estimation of the various thermoacoustic parameters using the coefficient of volume expannsion α is described below.

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The coefficient of volume expansion

$$\alpha = \frac{1}{V_m}\frac{\Delta V}{\Delta T} \quad (1)$$

where $\Delta V = (V_2 - V_1)$, $\Delta T = (T_2 - T_1)$ and $V_m = (V_1 + V_2)/2$. V_1 and V_2 are the molar volumes of temperatures T_1 and T_2 respectively.

Using the coefficient of thermal expansion, Haward and Parker [1] obtained an expression for the isochoric temperature coefficient of internal pressure x as

$$\begin{aligned} x &= \left[\frac{\mathrm{d}\ln P_i}{\mathrm{d}\ln T}\right]_V = \frac{2}{\beta}\left[\frac{\mathrm{d}\ln \alpha}{\mathrm{d}\ln T}\right]_V \\ &= \frac{-2(1+2\alpha T)}{V^{C_1}} \end{aligned} \quad (2)$$

where P_i is the internal pressure, $\tilde{\beta}$ is reduced compressibility and $\tilde{V}$ is reduced volume. The reduced volume and the reduced compressibility is obtained from α as

$$\tilde{V} = (V/V^*) = [1 + \alpha T/3(1+\alpha T)]^3 \quad (3)$$

$$\tilde{\beta} = (\beta/\beta^*) = \tilde{V}^{C_1} \quad (4)$$

Here V, V^* and β, β^* are the hardcore volumes and compressibilities at temperatures T and 0 K. The isochoric temperature coefficient of volume expansivity (x^1) can be given as

$$x^1 = \left[\frac{\mathrm{d}\ln \alpha}{\mathrm{d}\ln T}\right]_V = -(1+2\alpha T) \quad (5)$$

Moelwyn-Hughes [2] parameter (C_1) which is given as

$$C_1 = \left[\frac{\mathrm{d}\ln \beta}{\mathrm{d}\ln V}\right]_T = \frac{13}{3} + \frac{1}{\alpha T} + \frac{4\alpha T}{3} \quad (6)$$

The Sharma parameter [3] is given by the expression

$$S_0 = (-x/2)(3 + 4\alpha T) \quad (7)$$

Huggins parameter [4,5] (F) of a liquid crystal is reduced to S_0 as

$$\begin{aligned} F &= 1 + (2\alpha T/3) + (\mathrm{d}\ln\beta/\mathrm{d}\ln T)_V \\ F &= 2[1 + S_0/(3+4\alpha T)] - (3+4\alpha T)/3 \end{aligned} \quad (8)$$

The isothermal microscopic Gruneisen parameter (Γ) is a measure of volume dependence of the anharmonicity of the normal mode frequency (ν) of molecular vibrations of a liquid crystal is related to F and S_0 as

$$\begin{aligned} \Gamma &= -\left[\frac{\mathrm{d}\ln \nu}{\mathrm{d}\ln V}\right]_T \\ &= \frac{2}{3}\alpha T + (2 - F + 4\alpha T)/2\alpha T. \end{aligned} \quad (9)$$

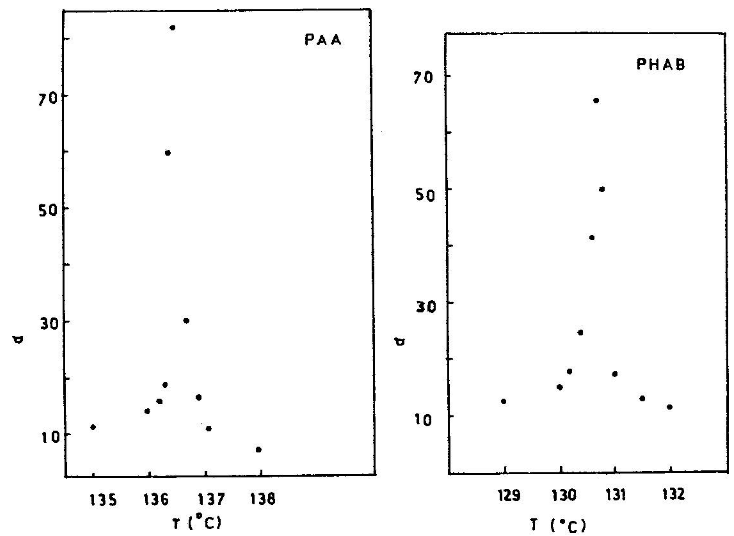


Fig.1 Variation of the cofficient of volume expansion of PAA and PHAB in the beighbourhood of the nematic isotropic phase transition temperature.

The fractional free volume f is a measure of disorder due to increased mobility of molecules in a liquid crystal and can be expressed in terms of isothermal microscopic Gruneisen parameter Γ as

$$f = V_a/V = 1/(\Gamma + 1) \quad (10)$$

where $V_a = V - V^*$ is the available volume of a liquid crystal. Thermal parameter (A^*), is a dimensionless parameter which shows that at low temperature, a liquid crystal tends to be ordered exhibiting a small fractional free volume, thereby making A^* equal to unity.

$$A^* = (1+f^2)/(1-f) = 1 + f/\Gamma \quad (11)$$

The isochoric acoustical parameter Δ is given as

$$\Delta = -XT/2 \quad (12)$$

The pressure coefficient of bulk modulus C_1^* as derived from α and V is given as

$$\begin{aligned} C_1^* &= 1 + (\delta/3)[1 + (1 + 1/\alpha T)/(1+\delta/3)] \\ &= -\left[\frac{\mathrm{d}\ln B}{\mathrm{d}\ln V}\right]_T \end{aligned} \quad (13)$$

where $\delta = \psi/(\psi - 1)$ and $\psi^3 = \tilde{V}$. B is the bulk modulus at T K.

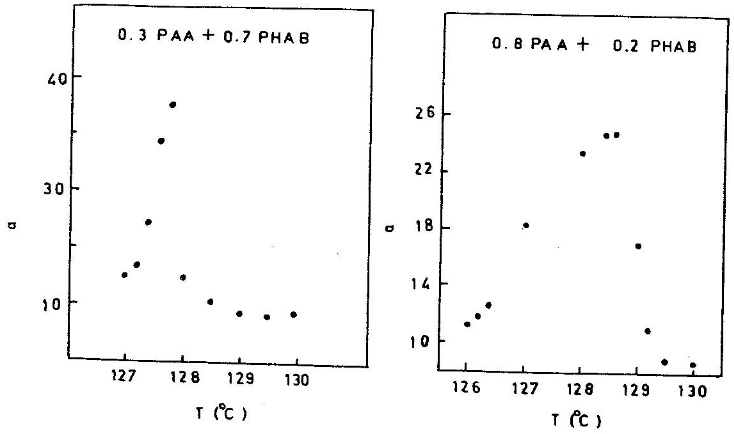


Fig.2 Variation of the coefficient of volume expansion of 0.3 PAA + 0.7 PHAB and PAA + 0.2 PHAB in the neighbourhood of the nematic isotropic phase transition temperature.

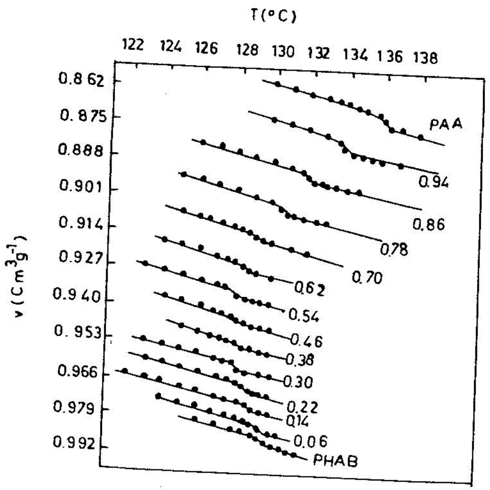


Fig.3 Variation of the specific volume with temperature for PAA, PHAB and their mixtures.

Rao's acoustical parameter [6] μ is calculated from the relation

$$\mu = -\left[\frac{\mathrm{d}\ln U}{\mathrm{d}\ln V}\right]_P = \frac{1}{2}(C_1^* - 1) \qquad (14)$$

where U is ultrasonic velocity.

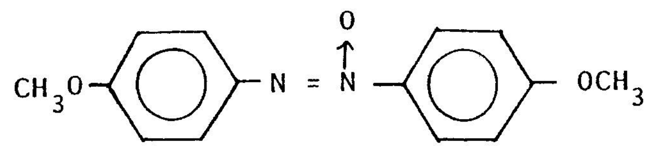
The Gruneisen parameter Γ_p for liquid crystals can be found from

$$\Gamma_P = (2/3)\alpha T + (1/2\alpha T) + 2 \qquad (15)$$

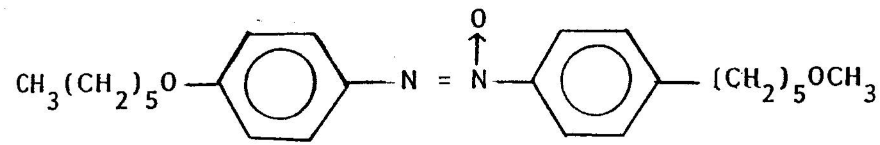
Using the above relations the Sharma parameter S_0 and other various thermoacoustic parameters of PAA, PHAB and their mixtures are evaluated at different temperatures.

3. Experimental

The structural formulas and the transition temperatures of the liquid crystals used in this study are presented below.



p-Azoxyanisole (PAA): Nematic $\xrightarrow{136.0^\circ\,C}$ Isotropic



4′4′-di-n-Hexyloxyazoxy benzene (PHAB): Nematic $\xrightarrow{130.1^\circ\,C}$ Isotropic

Mixture 1: 0.3 PAA + 0.7 PHAB: Nematic $\xrightarrow{127.9^\circ\,C}$ Isotropic

Mixture 2: 0.8 PAA + 0.2 PHAB: Nematic $\xrightarrow{129.0.1^\circ\,C}$ Isotropic

These samples were recrystallised from water-ethanol mixtures and dried under vacuum before their use. The mixtures were made by weighting desired amounts of each sample to an accuracy ±0.00005 gm and mixing them throughly while they were in the isotropic state. The transition temperatures of these samples were determined by using Olympus polarizing microscope model BHSP-751 with heating-stage [7] with an accuracy of ±0.1° C.

The micro heating stage consists of a high-conductivity copper block of about 10 cm diameter and about 2.5 cm thick. The block had a 3-4 mm central hold passing from top to the bottom for the passage of light, and two side slots, one for thermometer and the other for thermocouple, both coming in alongside of the central hole and just beneath the surface on which the sample slide rests. The block was electrically heated. Few crystals of the sample to be examined were placed on a glass slide that rests in the cavity of the heating block and a cover slip was then placed over the crystals.

The specific volumes of the samples were measured using a specially construced dilatometer having two uniformly bored capillary arms of length around 30 cm above

Temp. °C	$\alpha \times 10^4$ °C^{-1}	C_1	V	β	x	x^1
129.0	8.02	14.14	1.09	3.69	-0.65	-1.21
131.0	8.51	13.45	1.10	3.77	-0.65	-1.22
133.0	9.54	12.38	1.12	3.93	-0.64	-1.25
134.0	10.53	11.98	1.13	4.27	-0.60	-1.28
134.5	11.02	11.28	1.13	4.15	-0.62	-1.30
135.0	11.53	10.97	1.14	4.24	-0.62	-1.31
136.0	14.24	9.76	1.17	4.67	-0.59	-1.39
136.2	16.08	9.19	1.19	4.97	-0.58	-1.44
136.3	19.09	8.52	1.22	5.49	-0.55	-1.52
136.4	60.21	6.64	1.52	16.31	-0.32	-2.64
136.5	82.02	6.72	1.63	26.29	-0.25	-3.24
136.7	30.34	7.30	1.32	7.70	-0.48	-1.83
136.9	16.54	9.05	1.20	5.06	-0.57	-1.45
137.1	11.56	10.85	1.14	4.27	-0.62	-1.32
138.0	7.52	14.11	1.10	3.69	-0.65	-1.21
139.0	6.58	15.39	1.09	3.57	-0.66	-1.18
140.0	7.51	13.98	1.10	3.71	-0.63	-1.21
141.0	8.51	12.83	1.11	3.86	-0.64	-1.24
142.0	9.02	12.31	1.12	3.94	-0.64	-1.26

Table 1. Coefficient of volume expansion α and other Thermoacoustic parameters of PAA

Table 2. Sharma parameter S_0 and other related Thermoacoustic parameters of PAA

Temp °C	S_0	F	Γ	f	A^*	C^*	μ	Γ_P	Δ
129.0	1.117	1.52	4.41	0.185	1.042	22.76	10.83	6.90	42.21
131.0	1.118	1.50	4.32	0.188	1.043	21.27	10.14	6.56	42.49
133.0	1.119	1.47	4.09	0.196	1.048	19.10	9.05	6.03	42.40
134.0	1.070	1.41	4.18	0.193	1.046	17.51	8.25	5.64	40.21
134.5	1.123	1.42	4.03	0.199	1.049	16.83	7.91	5.47	42.03
135.0	1.120	1.41	4.00	0.200	1.050	16.18	7.59	5.32	41.75
136.0	1.121	1.34	3.84	0.206	1.054	13.66	6.33	4.71	40.39
136.2	1.121	1.29	3.78	0.209	1.055	12.47	5.73	4.43	39.39
136.3	1.120	1.21	3.70	0.213	1.057	11.02	5.01	7.13	37.76
136.4	1.018	0.23	3.63	0.216	1.060	5.77	2.38	3.16	22.10
136.5	0.921	-0.25	3.75	0.211	1.056	5.12	2.06	3.19	16.82
136.7	1.107	0.92	3.58	0.219	1.061	8.16	3.58	3.48	32.48
136.9	1.121	1.27	3.76	0.210	1.056	12.17	5.58	6.57	39.39
137.1	1.120	1.41	3.98	0.201	1.050	15.95	7.48	8.42	42.26
138.0	1.117	1.52	4.40	0.185	1.041	22.61	10.80	6.89	45.14
139.0	1.116	1.54	4.58	0.179	1.039	25.20	12.10	7.47	46.09
140.0	1.117	1.51	4.39	0.186	1.042	22.36	10.68	6.83	44.27
141.0	1.118	1.48	4.24	0.191	1.045	20.00	9.50	6.25	45.31
142.0	1.119	1.47	4.17	0.194	1.046	18.95	8.97	5.99	45.23

the bulb. The volume of the dilatometer bulb and the volume of the capillary bore per cm were determined by calibrating it with triple distilled water, benzene and mercury and were found to be 3.12916 cc and 0.00951 cc/cm respectively. The level of the fluid in both capillary arms was recorded by using two travelling microscopes of least count 0.001 cm. The temperature variation of the volume of the dilatometer was recorded

Temp. °C	$\alpha \times 10^4$ °C^{-1}	C_1	V	β	x	x^1
120.0	9.36	13.39	1.10	3.78	-0.65	-1.23
122.0	10.10	12.61	1.11	3.89	-0.64	-1.25
124.0	10.53	12.17	1.12	3.93	-0.64	-1.26
126.0	11.01	11.73	1.13	4.06	-0.63	-1.28
128.0	12.21	10.94	1.14	4.25	-0.62	-1.31
129.0	12.56	10.72	1.15	4.31	-0.61	-1.32
130.0	15.12	9.68	1.17	4.70	-0.59	-1.39
130.2	18.10	8.89	1.20	5.18	-0.57	-1.47
130.4	24.51	7.89	1.26	6.28	-0.52	-1.64
130.6	41.50	6.90	1.39	9.91	-0.42	-2.08
130.7	66.00	6.64	1.54	17.48	-0.31	-2.73
130.8	50.21	6.73	1.45	12.26	-0.38	-2.31
131.0	17.52	8.99	1.20	5.10	-0.57	-1.46
131.5	13.06	10.39	1.15	4.42	-0.61	-1.34
132.0	11.56	11.09	1.14	4.21	-0.62	-1.31
132.5	9.05	12.83	1.11	3.86	-0.64	-1.24
133.0	7.59	14.24	1.09	3.62	-0.66	-1.20
134.0	7.58	14.31	1.10	3.67	-0.65	-1.20

Table 3. Coefficient of volume expansion α and other Thermoacoustic parameters of PHAB

Table 4. Sharma parameter S_0 and other related Thermoacoustic parameters of PHAB

Temp. °C	S_0	F	Γ	f	A^*	C_1^*	μ	Γ_P	Δ
120.0	1.118	1.50	1.80	0.357	1.198	21.14	10.07	6.53	38.89
122.0	1.119	1.48	1.85	0.351	1.189	19.56	9.28	6.14	39.07
124.0	1.131	1.47	4.12	0.195	1.047	18.65	8.83	5.92	39.82
126.0	1.119	1.45	4.09	0.196	1.048	17.75	8.38	4.80	39.18
128.0	1.120	1.41	3.99	0.200	1.050	16.13	7.57	5.30	39.55
129.0	1.120	1.40	3.97	0.201	1.051	15.68	7.34	5.19	39.62
130.0	1.121	1.33	3.85	0.206	1.054	13.51	6.50	4.68	38.49
130.2	1.121	1.25	3.74	0.211	1.056	11.82	5.41	4.28	37.01
130.4	1.117	1.09	3.63	0.216	1.060	9.59	4.30	3.78	34.05
130.6	1.087	0.70	3.56	0.219	1.062	7.02	3.01	3.28	27.46
130.7	1.006	0.16	3.64	0.216	1.059	5.65	2.33	3.16	20.38
130.8	1.062	0.50	3.58	0.218	1.061	6.38	2.69	3.20	24.68
131.0	1.021	1.27	3.75	0.211	1.056	12.05	5.52	4.23	37.19
131.5	1.121	1.38	3.92	0.203	1.052	14.98	6.99	5.02	39.97
132.0	1.121	1.42	4.01	0.200	1.050	16.44	7.72	5.38	40.95
132.5	1.118	1.48	4.24	0.191	1.045	20.01	9.51	6.25	42.58
133.0	1.131	1.53	4.40	0.185	1.042	23.15	11.07	7.02	44.17
134.0	1.117	1.52	4.43	0.184	1.042	23.02	11.01	6.99	43.94

and corrections were made for it. All the weighings were done on sensitive K. Roy Analytical Single Pan Balance of sensitivity 0.00005 gm. The dilatometer was placed inside the INSREF solid state temperature bath and the temperature was controlled to an accuracy of ± 0.1 K for making measurements at various temperatures. Using the specific volume data the coefficient of volume expansion α of the liquid crystals are estimated.

Temp. °C	$\alpha \times 10^4$ °C^{-1}	C_1	V	β	x	x^1
121.0	9.40	13.35	1.11	3.78	-0.65	-1.23
122.0	9.80	12.86	1.11	3.67	-0.68	-1.24
123.0	10.20	12.47	1.12	3.92	-0.64	-1.25
124.0	10.40	12.26	1.12	3.95	-0.64	-1.26
125.0	10.60	12.06	1.12	3.99	-0.63	-1.27
126.0	11.20	11.61	1.13	4.08	-0.63	-1.28
126.2	11.80	11.25	1.14	4.17	-0.62	-1.30
126.4	12.60	10.83	1.14	4.28	-0.62	-1.32
126.8	16.20	9.48	1.18	4.18	-0.58	-1.41
127.0	18.40	8.92	1.20	5.15	-0.57	-1.47
128.0	23.40	8.07	1.25	6.00	-0.53	-1.60
128.2	24.20	7.97	1.26	6.15	-0.53	-1.62
128.4	24.80	7.90	1.26	6.26	-0.52	-1.64
128.6	24.80	7.89	1.26	6.27	-0.52	-1.64
129.0	17.00	9.19	1.19	4.98	-0.57	-1.43
129.2	9.00	13.09	1.11	3.82	-0.65	-1.23
129.5	8.80	13.26	1.11	3.79	-0.65	-1.23
130.0	8.70	13.33	1.11	3.79	-0.65	-1.23
131.0	8.40	13.57	1.10	3.76	-0.65	-1.22
132.0	8.00	13.94	1.10	3.71	-0.65	-1.21
133.0	7.40	14.63	1.09	3.64	-0.66	-1.20
134.0	6.20	16.48	1.08	3.48	-0.67	-1.17
135.0	5.00	19.24	1.07	3.33	-0.68	-1.14

Table 5. Coefficient of volume expansion α and Thermoacoustic parameters of 0.8 PAA + 0.2 PHAB

Table 6. Sharma parameter S_0 and other related Thermoacoustic parameters of 0.8 PAA + 0.2 PHAB

Temp. °C	S_0	F	Γ	f	A^*	C_1^*	μ	Γ_P	Δ
121.0	1.118	1.50	4.30	0.189	1.044	21.06	10.03	6.51	39.19
122.0	1.118	1.52	4.10	0.196	1.048	20.06	9.53	6.26	41.21
123.0	1.119	1.47	4.19	0.193	1.046	19.28	9.14	6.07	39.29
124.0	1.119	1.47	4.16	0.194	1.047	18.84	8.92	5.96	39.46
125.0	1.119	1.46	4.14	0.195	1.047	18.43	8.71	5.86	39.63
126.0	1.120	1.44	4.08	0.197	1.048	17.51	8.25	5.64	39.58
126.2	1.120	1.42	4.03	0.199	1.049	16.76	7.88	5.46	39.31
126.4	1.120	1.40	4.00	0.201	1.051	15.89	7.45	5.25	38.94
126.8	1.121	1.31	3.81	0.208	1.055	13.07	6.04	4.57	37.20
127.0	1.121	1.26	3.74	0.211	1.056	11.89	5.45	6.44	36.18
128.0	1.118	1.13	3.65	0.215	1.059	10.01	4.51	3.87	34.15
128.2	1.118	1.11	3.64	0.216	1.059	9.78	4.39	3.82	33.78
128.4	1.117	1.10	3.63	0.216	1.060	9.61	4.31	3.78	33.61
128.6	1.117	1.10	3.63	0.216	1.060	9.60	4.30	3.78	33.59
129.0	1.121	1.29	3.77	0.210	1.055	12.45	5.73	4.43	37.30
129.2	1.118	1.49	4.27	0.190	1.045	20.53	9.77	6.38	41.69
129.5	1.121	1.50	4.28	0.189	1.044	21.00	10.00	6.46	42.00
130.0	1.118	1.50	4.30	0.189	1.044	21.02	10.01	6.50	42.09
131.0	1.118	1.50	4.33	0.188	1.043	21.51	10.25	6.62	42.56
132.0	1.117	1.51	4.38	0.186	1.042	22.27	10.64	6.81	43.09
133.0	1.117	1.53	4.47	0.183	1.041	23.65	11.33	7.15	43.76
134.0	1.115	1.56	4.47	0.175	1.037	27.41	13.20	8.07	44.85
135.0	1.113	1.59	5.07	0.165	1.033	32.96	15.98	9.45	46.00

Temp °C	$\alpha \times 10^4$ °C^{-1}	C_1	V	β	x	x^1
122.0	9.50	13.12	1.11	3.79	-0.65	-1.23
123.0	10.00	12.63	1.11	3.91	-0.64	-1.25
124.0	10.50	12.14	1.12	3.98	-0.63	-1.26
125.0	11.50	11.48	1.13	4.11	-0.63	-1.29
126.0	12.50	10.89	1.14	4.25	-0.62	-1.32
126.5	13.00	10.63	1.15	4.34	-0.61	-1.39
127.0	15.00	9.84	1.17	4.65	-0.59	-1.38
127.2	16.50	9.59	1.18	5.05	-0.56	-1.42
127.4	24.00	8.01	1.25	6.09	-0.52	-1.61
127.6	38.50	7.02	1.37	8.99	-0.44	-1.98
127.8	45.00	6.84	1.41	10.52	-0.41	-2.15
128.0	14.50	9.97	1.17	4.58	-0.60	-1.37
128.5	10.50	11.93	1.12	4.03	-0.63	-1.27
129.0	8.50	13.60	1.10	3.75	-0.65	-1.22
129.5	8.00	14.12	1.10	3.69	-0.66	-1.21
130.0	8.00	14.09	1.10	3.69	-0.65	-1.21
131.0	8.50	13.46	1.10	3.79	-0.65	-1.22

Table 7. Coefficient of volume expansion α and other thermoacoustic parameters of 0.3 PAA + 0.7 PHAB

Table 8. Sharma parameter S_0 and other related Thermoacoustic parameter of 0.3 PAA + 0.7 PHAB

Temp. °C	S_0	F	Γ	f	A^*	C_1^*	μ	Γ_P	Δ
122.0	1.124	1.49	4.26	0.190	1.045	20.77	9.89	6.39	39.59
123.0	1.114	1.47	4.22	0.192	1.046	19.47	9.24	6.15	39.24
124.0	1.116	1.46	4.16	0.194	1.047	18.74	8.90	5.93	39.31
125.0	1.121	1.44	4.06	0.196	1.048	17.42	8.21	5.58	39.19
126.0	1.123	1.41	3.98	0.201	1.050	16.09	7.35	6.42	39.00
126.5	1.121	1.39	3.95	0.202	1.051	15.51	7.26	5.15	38.77
127.0	1.117	1.34	3.86	0.206	1.053	13.87	6.44	4.75	37.72
127.2	1.079	1.28	3.85	0.206	1.054	12.84	5.92	4.52	35.74
127.4	1.117	1.12	3.62	0.216	1.059	9.88	4.44	3.84	33.70
127.6	1.095	0.79	3.56	0.219	1.061	7.40	3.20	3.35	28.14
127.8	1.084	0.64	3.56	0.219	1.062	6.83	2.92	3.25	26.14
128.0	1.119	1.35	3.87	0.205	1.053	14.13	6.57	4.82	38.27
128.5	1.115	1.45	4.13	0.195	1.047	18.08	8.54	5.80	40.48
129.0	1.117	1.50	4.34	0.187	1.043	21.55	10.28	6.63	41.99
129.5	1.118	1.52	4.40	0.185	1.042	22.74	10.87	6.89	42.41
130.0	1.117	1.52	4.40	0.185	1.042	22.56	10.78	6.88	42.51
131.0	1.113	1.50	4.33	0.188	1.043	21.41	10.21	6.56	42.31

4. Results and discussion

The temperature dependence of the coefficient of volume expansion of the liquid crystals, PAA, PHAB and their mixtures are presented in Fig. 1 and 2. The specific volumes at various temperatures for PAA, PHAB and their mixtures are presented in Fig. 3. The thermoacoustic and anharmonic parameters estimated from the coefficient of volume expansion are presented in Tables 1 to 8. An examination of the data presented above reveals the following points.

As per the reports of Sharma [8,9,10]; Sharma and Reddy [11,12], the value of

Sharma parameter S is a constant for any system existing either in a liquid or in a solid state. It can be seen from the present investigations that even in the liquid crystalline state, where the substance simultaneously exhibits the anisotropic properties of crystals as well as rheological properties of liquids, the value of the Sharma parameter is also a constant 1.11 ± 0.01 as was reported by Sharma for certain non-mesomorphic systems. For the binary mixtures also the Sharma parameter remains the same characteristic value. Only at and in the immediate vicinity of the nematic-istropic transition temperature the value of S changes to a lower value which is less than the characteristic value. It can be seen that all the thermoacoustic parameters evaluated above shows the transitional effects at and in the immediate vicinity of the phase transition temperature. The parameters Γ, f and A^* shows a little change compared to other parameters Δ, μ and C_1^* at the transition temperature.

The sharp discontinuity in the expansion coefficients and sudden raise in the specific volumes at the nematic-istropic transition temperature clearly shows that the transitions are all of the first order. The sudden increase of the specific volumes with temperature near the transition point can be attributed to the sudden change from the ordered nematic phase to the disordered isotropic phase, since the two phases differ mainly in the degree of molecular orientations. It was observed by microscopic studies that the nematic-isotropic phase transition was not sharp because the phase transition began with the formation of clusters which increased in size to give nematic droplets, then they finally coalesced to complete the transition. For the pure PAA and PHAB samples, the two phase regions occurred over a 0.1° C range while for the mixtures, the two phase regions ranged from 0.2° to 1.2° C. The results are well supported by the behaviour of all the above thermoacoustic and anharmonic paramters at the vicinity of the nematic-isotropic phase transition temperature.

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