ISSN 0974 - 9373

Vol. 20 No. 3 (2016) **Journal of International Academy of Physical Sciences** pp. 197- 202

Acoustic Non-linearity Parameter of Binary Liquid Mixtures

Vandana Pathak and Sunil

Department of Physical Sciences
Faculty of Science and Environment
Mahatma Gandhi Chitrakoot Gramodaya Vishvavidyalaya
Chitrakoot, Satna (M.P.)

Email:chemsunilshukla@gmail.com

(Received March 24, 2016)

Abstract: Non-linearity parameter (B/A) for four binary mixtures namely DPGDME+methanol, +propanol, +pentanol, +heptanol, has been computed at 298.15K. A simple method for calculating (B/A) has been employed. In this method only the values of thermal expansion coefficient (α), isothermal compressibility (β_T), sound velocity (u), and heat capacity ratio (Υ) are required. B/A for the afrosaid systems has been calculated from the knowledge of α, β_T, u and Υ which has been taken from literature. From the knowledge of (B/A) of mixture, its excess values (B/A^E) were obtained. The results are discussed in terms of interactions operating in binary mixtures.

Keywords: Adiabatic compressibility, sound velocity, non-linearity parameter.

1. Introduction

The non-linearity represented by symbol B/A, is used to describe the non-linearity of the medium. It can be obtained from the distortion of finite amplitude sound waves and the variation of sound velocity with temperature and pressure. This parameter, also called the Beyer's non-linearity parameter, plays significant role in non-linear acoustics. From the knowledge of the parameter, one can gain information about some physical properties of liquids such as internal pressure, intermolecular spacing, acoustic scattering, structural behaviour and interactions in liquid and solutions. There are several methods of determining this parameter which involve a number of input data. In the present work we have employed a simple method which involves only limited input data.

2. Formulation

B/A is defined as

$$\frac{B}{A} = 2\rho u\left(\frac{\partial u}{\partial \rho}\right)_S, \tag{1}$$

where ρ, u and S are respectively the density, sound velocity and entropy of the medium. Here we have used a entirely different method developed by Sharma[1, 2, 3] and Pandey et al[4]. According to this method B/A is given by

$$\frac{B}{A} = 2K + 2\gamma - K'', \tag{2}$$

where $\gamma = C_P / C_V$ and K'', K are given by

$$K'' = \left(\frac{\partial \ln \beta_T}{\partial \ln T}\right)_V \sqrt{2\alpha T}, \tag{3}$$

$$K = -\frac{1}{\alpha}\left(\frac{\partial \ln u}{\partial T}\right)_P, \tag{4}$$

where

$\beta_T =$ isothermal compressibility

$\alpha =$ thermal expansivity

$u =$ velocity of sound/ ultrasonic speed.

3. Results and Discussion

In the present study, Eq (2) is used to obtain B/A of following binary mixtures:

(I) DPGDME+methanol

(II) DPGDME+propanol

(III) DPGDME+pentanol

(IV) DPGDME+heptanol

The input data desired for the computation of B/A of the binary mixtures (I), (II), (III) and (IV) are taken from the literature[5,6]. Calculated values of B/A from Eqs (2) to (4) are recorded in Table-1 at 298.15K.

Table 1: Nonliearity Paramter of DPGDME+Methanol-I, DPGDME+Propanol-II DPGDME+Pentanol-III, DPGDME+Heptanol- IV

I		II		III		IV	
x_1	B/A	x_1	B/A	x_1	B/A	x_1	B/A
0.0705	7.331	0.1089	7.333	0.0441	7.358	0.1164	7.369
0.1312	7.335	0.1451	7.333	0.1045	7.351	0.1570	7.365
0.1632	7.337	0.2124	7.334	0.1523	7.347	0.2117	7.360
0.2094	7.339	0.2694	7.336	0.2149	7.344	0.2590	7.357
0.2514	7.341	0.3041	7.336	0.2431	7.342	0.3132	7.353
0.3018	7.342	0.3359	7.337	0.2986	7.341	0.3539	7.351
0.3598	7.343	0.3913	7.338	0.3419	7.340	0.4060	7.349
0.4036	7.344	0.4561	7.340	0.3740	7.339	0.4533	7.347
0.4549	7.345	0.5020	7.341	0.4018	7.339	0.5056	7.346
0.5022	7.345	0.5464	7.342	0.4549	7.339	0.5520	7.345
0.5449	7.346	0.6139	7.343	0.5038	7.339	0.5935	7.344
0.6169	7.347	0.6513	7.344	0.5334	7.339	0.6316	7.344
0.6494	7.347	0.7080	7.345	0.6034	7.340	0.7137	7.344
0.7083	7.347	0.7572	7.345	0.6553	7.341	0.7666	7.344
0.7560	7.347	0.8098	7.346	0.6968	7.342	0.8059	7.344
0.8114	7.348	0.8457	7.347	0.7505	7.343	0.8495	7.345
0.8537	7.348	0.9067	7.347	0.7962	7.344	0.9026	7.346
0.9047	7.348	0.9576	7.348	0.8509	7.345	0.9293	7.347
0.9364	7.348	0.9746	7.348	0.9071	7.346	0.9527	7.347
0.9511	7.348			0.9476	7.347		
				0.9600	7.348		

Since B/A is a thermodynamic property of a system, it would be worthwhile to obtain the excess value $(B/A)^E$ to get qualitative information about the interactions occurring in solutions. $(B/A)^E$ is defined as

(5) $$\left(\frac{B}{A}\right)^E = \left(\frac{B}{A}\right)_{mix} - \left[x_1\left(\frac{B}{A}\right)^1 + x_2\left(\frac{B}{A}\right)^2\right].$$

From the inspection of values of (B/A) mixtures from Table-1, it is clear that in the case of system (I) and (II) an increase is observed with increasing the mole fraction x,(DPGDME) of component one. For the system (III) and (IV), the values of non linearity parameter of mixture have decreasing trend with the increase of mole fraction of DPGDME (x_1). This unusual behaviour of (B/A) of mixtures is due to the different types of interactions occurring in the systems. Similar is the behaviour of $(B/A)^E$ recorded in Table-2 and shown graphically in the figure-1.

Table 2: Excess nonliearity paramter of DPGDME+methanol-I, DPGDME+propanol-II DPGDME+pentanol-III, DPGDME+heptanol-IV

L		**II**		**III**		**IV**	
$\mathbf{x_1}$	$\mathbf{B/A^E}$	$\mathbf{x_1}$	$\mathbf{B/A^E}$	$\mathbf{x_1}$	$\mathbf{B/A^E}$	$\mathbf{x_1}$	$\mathbf{B/A^E}$
0.023	-0.19648	0.0653	-0.15827	0.0143	-0.11235	0.0609	-0.08484
0.0705	-0.1879	0.1089	-0.15585	0.0441	-0.11554	0.1164	-0.09023
0.1312	-0.17861	0.1451	-0.15358	0.1045	-0.12025	0.157	-0.09359
0.1632	-0.17426	0.2124	-0.14899	0.1523	-0.12263	0.2117	-0.09742
0.2094	-0.16847	0.2694	-0.1449	0.2149	-0.12432	0.259	-0.10013
0.2514	-0.16357	0.3041	-0.14237	0.2431	-0.12466	0.3132	-0.10262
0.3018	-0.15805	0.3359	-0.14003	0.2986	-0.12468	0.3539	-0.10408
0.3598	-0.15204	0.3913	-0.13597	0.3419	-0.1242	0.406	-0.10548
0.4036	-0.14769	0.4561	-0.13126	0.3740	-0.12362	0.4533	-0.10632
0.4549	-0.14274	0.5020	-0.12796	0.4018	-0.12298	0.5056	-0.10683
0.5022	-0.1383	0.5464	-0.1248	0.4549	-0.12144	0.552	-0.10692
0.5449	-0.13437	0.6139	-0.12008	0.5038	-0.11973	0.5935	-0.10675
0.6169	-0.12786	0.6513	-0.1175	0.5334	-0.11858	0.6316	-0.10638
0.6494	-0.12496	0.7080	-0.11365	0.6034	-0.11558	0.7137	-0.10498
0.7083	-0.11977	0.7572	-0.11035	0.6553	-0.11315	0.7666	-0.10368
0.756	-0.11561	0.8098	-0.10688	0.6968	-0.11111	0.8059	-0.10252
0.8114	-0.11082	0.8457	-0.10454	0.7505	-0.10837	0.8495	-0.10105
0.8537	-0.10718	0.9067	-0.10062	0.7962	-0.10596	0.9026	-0.09904
0.9047	-0.10282	0.9576	-0.09739	0.8509	-0.103	0.9293	-0.09793
0.9364	-0.10012	0.9746	-0.09631	0.9071	-0.09991	0.9527	-0.09691
0.9511	-0.09887			0.9476	-0.09766		
				0.9600	-0.09697		

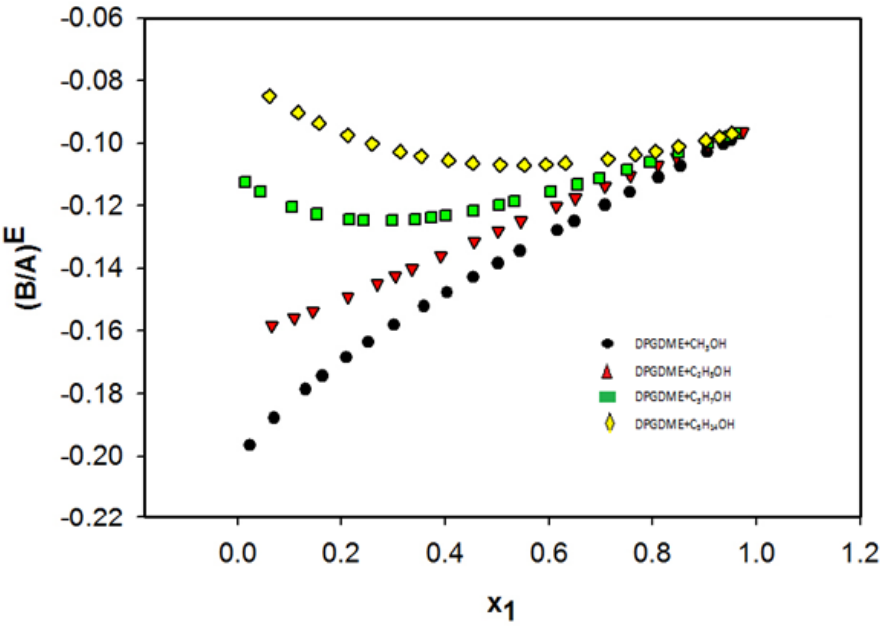

Figure 1: Variation of excess non-linearity parameter(B/A^E) with mole fraction of DPGDME(x_1)

$(B/A)^E$ measures directly the nature of interactions qualitatively, and its change is related to such interactions, however we can predict quantitatively the exact nature of interactions from the study of non-linearity acoustic parameter.

References

1. B. K. Sharma, Nonlinearity acoustical parameter and its relation with Rao's acoustical parameter of liquid state, *J. Acoust. Soc. Am.*, **73(1)** (1983) 106.

2. B. K. Sharma, Isochoric temperature coefficient of surface tension andS_o-parameter of quasi-spherical molecular liquids, *Pramana- J. Phys.*, **26(3)** (1986) 223.

3. B. K. Sharma and R R Reddy, Temperature invariance of S_0-parameter of polymers, *Pramana- J. Phys.*, **28(2)** (1987) 195.

4. J. D. Pandey, N. Tripathi and G. P. Dubey, Thermoacoustic and nonlinear parameters of pure liquids under varying physical conditions, *Ind. J. Pure and Appl. Phys.*, **33(1)** (1995) 7-11.

5. A. Pal and R. Gaba, Densities, excess molar volumes, speeds of sound and isothermal compressibilities for {2-(2-hexyloxyethoxy)ethanol+*n*-alkanol} systems at temperatures between (288.15 and 308.15) K, *J. Chem. Themodyn.,* **40(5)** (2008) 818-828.

6. R. T. Beyer, Parameter of Nonlinearity in Fluids, *J. Acoust. Soc. Am.,* **32(6)** (1960) 719-721.