STUDY OF ISENTROPIC COMPRESSIBILITY OF CYCLOHEXANE WITH THE MOLE FRACTION OF DMSO

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ABSTRACT

Thermodynamic studies like density (σ), ultrasonic speed (u) and excess molar volume (V_m^E) of binary liquid mixture of Cyclohexane + DMSO have been carried out over the different range of composition at 308.15 K. Thermodynamic parameters like isentropic compressibility ΔK_s , interaction parameter, χ_{12} , Flory parameters, coefficients, A_i and standard deviations, σ (Y^E) have been computed from experimental findings. The excess thermodynamic functions have been fitted to the Redlich-Kister polynomial equation. The experimental ultrasonic speeds have been analyzed in terms of Jacobson Free Length Theory (FLT),Schaaff's Collision Factor Theory (CFT), Nomoto's relation, and Van Dael's ideal mixture relation. Intermolecular Free Length, L_f , and available volume, V_a , have been calculated from FLT, CFT and thermo acoustic approach.

Key Words: Ultrasonic Speed, Excess Molar Volume, Schaaff's Collision Factor Theory, C_6H_{12} and DMSO

INTRODUCTION

Physical properties of pure substance like density, ultrasonic speed at 308.15 K are reported. Speeds of sound, u, density, isentropic compressibility, k_s , and deviation in speed of sound of binary mixtures of Cyclohexane and DMSO over the different composition range at a temperature of 308.15 K are reported . Values of isentropic compressibility's, ΔK_s , intermolecular free length, L_f , and relative association, R_a , of the binary liquid mixtures of Cyclohexane and DMSO at 308.15 K are shown in Table 1 excess molar volumes of the binary liquid of DMSO and Cyclohexane at 308.15 K. Intermolecular Free Length, L_f , calculated from free length theory (FLT), Collision Factor Theory (CFT), and Thermo acoustic Approach (TAP) for Cyclohexane + DMSO binary liquid mixture at 308.15 K. Available volume,V_a , calculated from Free Length Theory (FLT), Collision Factor Theory (CFT), and Thermo acoustic Approach (TAP) for Cyclohexane+ DMSO binary liquid mixture at 308.15 K.

TABLE 1 = Values of deviation in isentropic compressibility ΔK_s , of binary liquid mixture Of C_6H_{12} and DMSO at 308.15K.

Mole Fraction (x_1)	**- ΔK_s (10^{-11} Pa^{-1})**
0.0000	00.00
0.0684	04.25
0.1364	05.78
0.1857	06.15
0.2437	07.23
0.3769	09.11
0.4638	09.24
0.5217	08.02
0.6746	06.47
0.8734	04.52
1.0000	00.00

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REVIEW OF LITERATURE

In the literature of physical chemistry, the thermodynamic properties of liquids and liquid mixtures constitute an important area of research. The study of liquids and liquid mixtures has been exhaustive since the pioneering work of Vander Waal`s around 1887, who suggested that the shape of the liquid molecules determine the intermolecular interactions. The first few issues of the "Zeitschrift Fur Physikalische Chemie" 90 years ago devoted a large fraction of their pages to the experimental and theoretical studies on the equilibrium properties of liquid mixtures. Since then, numerous research articles dealing with such studies have been published. This publication covered in textbooks, reviews and monographs.

MATERIAL AND METHOD

The values of the coefficients of Redlich-Kister polynomial equation for all the binary liquid mixtures of C_6H_{12} and DMSO at 308.15 K along with values of the standard deviation . Flory parameters of the pure compounds along with their physical properties are given for C_6H_{12} in DMSO binary liquid mixtures at 308.15 K. the estimated and experimental equimolar, u and k_s , values along with the interaction parameter, χ_{12} , for C_6H_{12} in DMSO

binary liquid mixtures at 308.15 K. Estimated values for speeds of sound and isentropic compressibility are almost identical to experimental results for C_6H_{12} mixtures. theoretical values of ultrasonic speed calculated from FLT, CFT, Nomotos and Van Dael and Vangeels ideal mixing relation and percentage error in calculated values for DMSO + C_6H_{12} at 308.15 K.

RESULT AND DISCUSSION

All the systems of DMSO with C_6H_{12} shows negative deviation through ΔK_s Isotherms over entire range of mole fraction (Figure 1). A clear minima at the mole fraction around x_1 = 0.3867, indicates that the maximum interactions are at This mole fraction range. It is observed that Δu values are positive while, ΔK_s values are negative, such trends of positive deviation in a speed of sound and negative deviation in isentropic compressibility is quite common.

In pure DMSO, there is dipole–dipole as well as the usual dispersive interaction. The effect of adding a non polar second component is primarily to disrupt the dipolar interaction of the first component, but when the second component is also polar, the dipole-dipole interaction between unlike molecule is most likely which result in contraction of volume and the mixture becomes the less compressible.

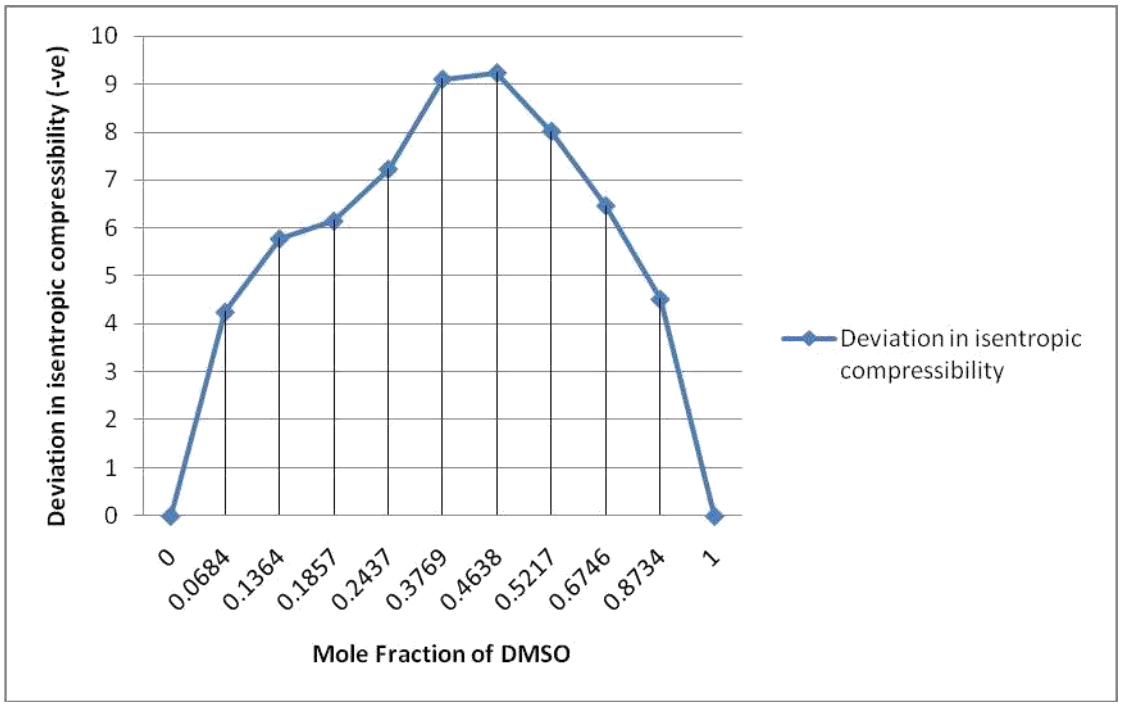

Figure 1 Deviation in isentropic compressibility (- ΔK_s) of C_6H_{12} with the mole fraction of DMSO.

CONCLUSION

The behavior of binary liquid mixtures can be explained in term of physical forces -dispersion chemical forces – dipole-dipole interaction. The former factor increases the intermolecular

free length as described by Jacobson. This is turn, causes negative deviation in sound speed and positive deviation in compressibility. On the other hand, the latter factor decreases the intermolecular path lengths leading to a positive deviation in sound speed and negative Deviation in compressibility and excess molar volume, V_m^E . The actual values depend upon the relative strength of two opposing effects. The observed negative values of ΔK_s and excess molar volume and positive values of Δu for these mixtures imply that the specific interaction dominate over the dispersive interaction between unlike molecules. the negative value of deviation in the molecular free length parameter substantive the above argument undoubtedly and undeniably unveils the fact the specific interaction are being operative between the molecules of solvent and co-solvents in the mixture.

Table 2 Interaction Parameters, χ_{12} , calculated and experimental equimolar speed of sound, and isentropic compressibility's, Δk_s , of the binary systems at 308.15K.

□ ($J\,cm^{-3}$)	u_{cal} ($m\,s^{-1}$)	u_{expt} ($m\,s^{-1}$)	k_s (TPa^{-1})	$k_{s,expt}$ (TPa^{-1})
12				
	C_6H_{12} + DMSO			
80.4	1501.70	1502.40	13.43	13.58

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