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Excess Molar Volumes for Benzyl Alcohol ($C_6H_5CH_2OH$) with Methyl Ethyl Ketone ($CH_3CH_2COCH_3$) at Different Temperatures

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ABSTRACT

Measurements of excess volume (V^E) have been undertaken for the mixtures of Benzyl Alcohol ($C_6H_5CH_2OH$) with Methyl Ethyl Ketone ($CH_3CH_2COCH_3$) at the temperature 298.15, 308.15 and 318.15 K and under atmospheric pressure in the liquid state by using dilatometer. The data obtained have been fitted by means of Redlich – Kister euation. The results show negative values of V^E at all temperatures and the values of negativity of V^E increases with rise in temperature. The results were discussed from the viewpoint of specific interaction between these components.

Keywords: Benzyl Alcohol, Methyl Ethyl Ketone, Redlich-Kister Equation, Dilatometer, Excess Volume

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INTRODUCTION

Benzyl Alcohol possess self-association properties by means of hydrogen bonding and used as a polar solvent, whereas Methyl Ethyl Ketone acts as n-donor solvent due to existence of nonbonding electrons present on O atom. Both compounds are extensively used as solvent in the liquid state. Since we are interested in getting physicochemical properties of those compounds, which are used as solvent [1,2,3,4] excess molar volume of the mixtures of whole range composition were obtained at the temperature 298.15,308.15 and 318.15K, respectively, in the present work and data collected have been deciphered.

EXPERIMENTAL

Benzyl Alcohol (Obtained from Aldrich, purity 0.99 mass fraction) and Methyl Ethyl Ketone (Source Aldrich, purity >0.99 mass fraction) were used without additional treatment. Density of pure components have been measured with the help of vibrating tube densimeter and compared with the best accessible literature data and found in good harmony. All compounds were dried in activated molecular sieves before use.

Excess volumes were determined by means of a two-limbed pyrex made dilatometer at the temperature 298.15, 308.15 and 318.15K and under atmospheric pressure. Details of the working and precision of the dilatometer is given elsewhere [5]. Mole fraction of components were made by using digital electronic balance (Bosch, Germany, reproducibility ±0.0001gm). Accuracy in preparing mole fraction was ±0.0001. The results

were taken in the absence of air bubble formed in the components present over mercury in the dilatometer.

RESULTS AND DISCUSSION

The excess molar volume values are negative in sign for mixture of benzyl alcohol and methyl ethyl ketone at the temperature 298.15, 308.15 and 318.15K over the whole mole fraction range, and are tabulated in Table 1, and a plot of measured values of experimental V^E data against mole fractions(x1) of benzyl alcohol are plotted in Fig. 1.

The experimental data were fitted by means of a polynomial Redlich kister equation as shown below:

$$\frac{V^E}{cm^3.mol^{-1}} = x_1 x_2 \sum_{i=0}^{m} A_i \qquad (1)$$

In this case x1 represents the mole fraction of benzyl alcohol and x2 refers for methyl ethyl ketone. The different coefficients, alongwith standard deviations, σ, are collected in Table 2. The values of standard deviation of the fit, σ, are obtained by means of eq.2

$$\sigma = \left[\frac{\Sigma\left(V^E - V^E_{calc}\right)^2}{(m^* - n^*)}\right]^{1/2} \qquad (2)$$

Where V^E is experimental values and V^E_{calc} refers to calculated excess volume with the help of eq. (1), m* represents no. of data measured experimentally & n* is no. of constants which are distinctive of a binary system.

Table 1: Excess Molar Volumes, V^E for the Mixtures of Benzyl Alcohol (1) with Methyl Ethyl Ketone (2) at the temperature 298.15, 308.15, and 318.15K

298.15K	
X_1	V^E/ cm^3mol^{-1}
0.0991	-0.412
0.1987	-0.662
0.2962	-0.803
0.3881	-0.856
0.4976	-0.862
0.5995	-0.795
0.6874	-0.667
0.7965	-0.434
0.9003	-0.196

308.15K	
X_1	V^E/ cm^3mol^{-1}
0.0999	-0.452
0.2003	-0.763
0.3004	-0.885
0.4041	-0.945
0.5005	-0.934
0.6008	-0.862
0.6994	-0.716
0.8003	-0.489
0.9112	-0.215

318.15K	
X_1	V^E/ cm^3mol^{-1}
0.1002	-0.512
0.2012	-0.854
0.3112	-1.071
0.3994	-1.131
0.5113	-1.126
0.6234	-1.016
0.7098	-0.858
0.8212	-0.571
0.9244	-0.254

Table 2: Least Squares Coefficients of Eq 1 for the Excess Molar Volumes, and the standard deviations, σ, of Benzyl Alcohol (1) with Methyl Ethyl Ketone (2) at the temperature 298.15, 308.15, and 318.15K

	Temp.		
	298.15K	**308.15K**	**318.15K**
A0	-3.453	-3.762	-4.539
A1	0.7458	0.7716	0.9472
A2	0.0919	-0.5242	-0.2688
A3	1.268	1.6	0.4919
σ/ (cm^3 mol^{-1})	0.005	0.005	0.005

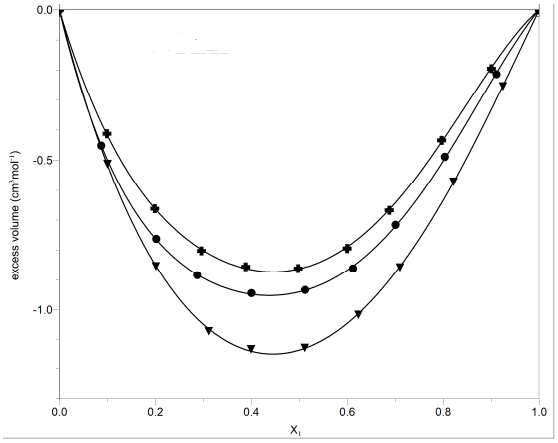

Figure 1: Excess volumes,V^E, for various mixtures against mole fraction x1 of $C_6H_5CH_2OH$. Benzyl Alcohol (1) with Methyl Ethyl Ketone (2) at the temperature 298.15K (✦); 308.15K (●) and 318.15K (▲)

The minimum value occurs at the mole fraction, $x_1 \approx 0.5$.The graph at different temperatures is parabolic in nature. There are two types of interactions are believed to be present between these components; (1) O=C< group in methyl ethyl ketone interacts with the hydrogen of benzyl alcohol and thus H-bonding takes place between these two components, it is donor-acceptor interaction (2) delocalized π– electrons of the benzene ring of benzyl alcohol interacts with O=C< group in methyl ethyl ketone, thus change in orientation of the molecules occurs. There is also possibility that there is limited interstitial adjustment of ketone molecules into the group of benzyl alcohol at those places where composition of alcohol is more. The sign of excess volume is net effect of all type of interactions present in the binary system, thus the values of V^E becomes negative. Temperature coefficient $(V^E/\partial T) < 0$, which explains higher intermolecular complex formation within the system.

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