

## Excess volumes of the binary mixtures 1,2-dichloroethane + *n*-alkanols [C<sub>2</sub>-C<sub>6</sub>]

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**Abstract.** Volume changes on mixing of binary systems formed by 1,2-dichloroethane and *n*-alcohols, namely, ethanol, *n*-propanol, *n*-butanol, *n*-pentanol and *n*-hexanol were measured as a function of composition at 30, 35, 40 and 45° C. At all compositions the  $V^E$  values are all positive for all systems. The molar excess volumes of mixing for equimolar mixtures increase as the length of carbon chain increases.  $V^E$  becomes more positive on increasing temperature. The positive value of the excess volume has been attributed to breaking of hydrogen bonds of associated species of alcohol by dilution with 1,2-dichloroethane.

**Keywords.** Excess volumes ; volume ; mixing ; 1,2-dichloroethane-*n*-alcohols.

### 1. Introduction

We report the excess volumes of mixtures,  $V^E$ , for the binary systems formed by 1,2-dichloroethane + ethanol, + *n*-propanol, + *n*-butanol, + *n*-pentanol and + *n*-hexanol measured at 30, 35, 40 and 45° C over the entire composition range.

### 2. Experimental

Ethanol (Bengal Chemicals, Calcutta) and other chemicals (BDH) were further purified by the methods described by Vogel (1975). Volume changes on mixing had been calculated from precision density values of pure liquids and liquid mixtures obtained by pycnometric method. The temperature of the thermostatic bath was controlled to within  $\pm 0.01^\circ\text{C}$ .

The overall working of the experimental set-up was standardized by studying the volume change on mixing of iso-butyl alcohol and *n*-heptane system at 25° C. The excess volume for equimolar mixture obtained by us for this system (0.33 cm<sup>3</sup>/mole) agreed fairly well with the value (0.322 cm<sup>3</sup>/mole) reported by Anil Kumar *et al* (1979).

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### 3. Results and discussion

Excess volumes of mixing covering the complete range of mole fraction of 1,2-dichloroethane were measured at temperatures 30, 35, 40 and 45°C. The excess volumes are accurate to  $\pm 0.02 \text{ cm}^3/\text{mole}$ . Column three of table 1 presents the excess volumes for equimolar mixtures.

Volume change on mixing of 1,2-dichloroethane + *n*-butanol had already been studied at 40°C by Subramanian *et al* (1969). It is found that their value of  $V^E$  for equimolar mixture ( $0.36 \text{ cm}^3/\text{mole}$ ) is considerably lower than our value ( $0.44 \text{ cm}^3/\text{mole}$ ).

The experimental data were fitted by the least squares method to the equation (Ram K Nigam and K C Singh 1979)

$$V^E/X_1X_2 = A + B(X_1 - X_2) + C(X_1 - X_2)^2 \quad (1)$$

where  $X_1$  and  $X_2$  are mole fractions of 1,2-dichloroethane and *n*-alcohols respectively. The values of  $A$ ,  $B$  and  $C$  along with their standard deviations ( $\sigma$ ) are reported in table 1.

These mixtures have positive values of  $V^E$  with maxima occurring from 0.5 to 0.6 mole fraction of 1,2-dichloroethane. The  $V^E$  versus composition curves are skewed towards higher mole fractions of 1,2-dichloroethane (figure 1). Alcohols are strongly associated by hydrogen bonding. When alcohols are diluted with solvents like 1,2-dichloroethane the changes in the thermodynamic functions can be due to the breaking up of hydrogen bonds. The positive excess volume on mixing is therefore attributed to the dissociation of associated species of alcohol

Table 1.  $V^E$  values at  $X_1 = X_2 = 0.5$  and parameters  $A$ ,  $B$ , and  $C$  of equation (1) along with the standard deviation  $\sigma$ .

System	Temp., °C	$V^E$ at $X_1 = X_2 = 0.5$ ( $\text{cm}^3 \text{ mol}^{-1}$ )	$A$ ( $\text{cm}^3 \text{ mol}^{-1}$ )	$B$ ( $\text{cm}^3 \text{ mol}^{-1}$ )	$C$ ( $\text{cm}^3 \text{ mol}^{-1}$ )	$\sigma$
1,2-dichloroethane + ethanol	30	0.23	0.916	0.464	0.209	0.008
	35	0.25	0.987	0.444	0.247	0.005
	40	0.27	1.097	0.493	0.346	0.008
	45	0.31	1.239	0.557	0.357	0.009
1,2-dichloroethane + <i>n</i> -propanol	30	0.26	1.058	0.397	0.073	0.005
	35	0.31	1.229	0.463	0.150	0.007
	40	0.33	1.299	0.540	0.285	0.006
	45	0.35	1.415	0.542	0.326	0.008
1,2-dichloroethane + <i>n</i> -butanol	30	0.36	1.422	0.629	0.154	0.005
	35	0.39	1.567	0.618	0.077	0.003
	40	0.44	1.755	0.614	0.088	0.009
	45	0.47	1.874	0.673	0.214	0.009
1,2-dichloroethane + <i>n</i> -pentanol	30	0.47	1.899	0.511	-0.068	0.008
	35	0.49	1.971	0.525	-0.073	0.007
	40	0.52	2.093	0.646	0.088	0.004
	45	0.56	2.231	0.642	0.042	0.006
1,2-dichloroethane + <i>n</i> -hexanol	30	0.66	2.646	0.421	0.324	0.009
	35	0.68	2.746	0.421	0.317	0.007
	40	0.70	2.814	0.517	0.572	0.008
	45	0.75	3.013	0.520	0.518	0.009

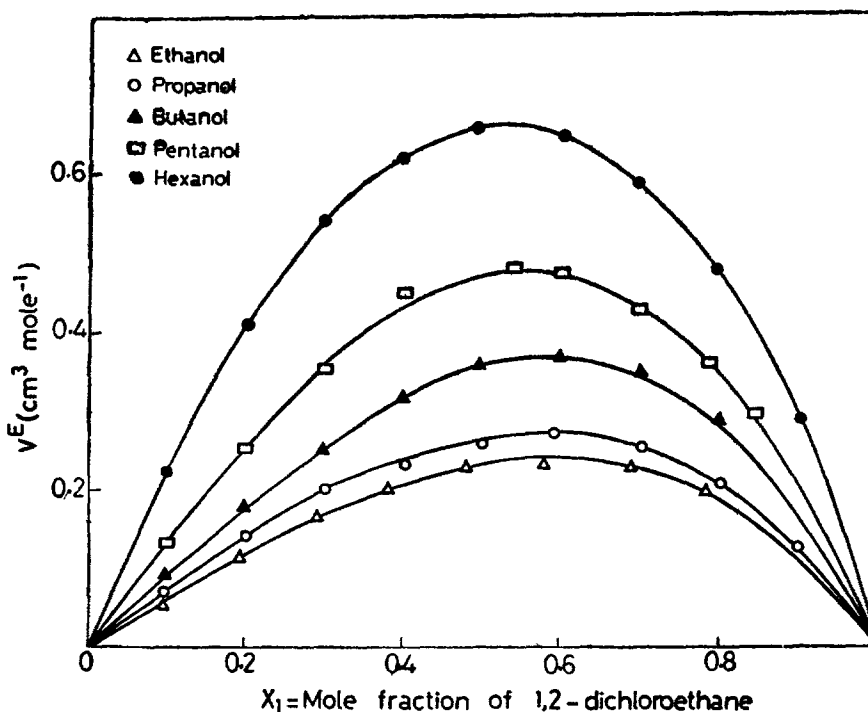


Figure 1.  $V^E$  versus  $X_1$  plots for 1,2-dichloroethane(1)— $n$ -alcohol (2) systems at 30° C.

by dilution with 1,2-dichloroethane (Pimentel and McClellan 1960). The molar excess volumes of equimolar mixtures lie in the following increasing sequence :

1,2-dichloroethane + ethanol, <  $n$ -propanol, <  $n$ -butanol, <  $n$ -pentanol,  
<  $n$ -hexanol.

$V^E$  values become more positive on increasing temperature for all the five systems.

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