Dielectric Constants and Molar Polarizations of 1,2-Dibromoethane in Cyclohexane, Benzene, Methylbenzene, 1,2-Dimethylbenzene, 1,3-Dimethylbenzene, and 1,4-Dimethylbenzene at 303.15 K

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The dielectric constants of the binary mixtures of 1,2-dibromoethane with cyclohexane, benzene, methylbenzene, 1,2-dimethylbenzene 1,3-dimethylbenzene, and 1,4-dimethylbenzene have been measured at 303.15 K as a function of composition. The molar polarizations of the mixtures were calculated from dielectric constant measurements at 303.15 K.

Introduction

Excess volumes (*1*), viscosities (*2*), surface tensions (*3*), and refractive indices (*4*) of the above mentioned mixtures were reported earlier. In this paper we report the dielectric constants and molar polarizations of the same mixtures. Molar polarizations may provide information about complexes in liquid mixtures (*5*).

Experimental Section

Cyclohexane, benzene, methylbenzene, 1,2-dimethylbenzene, 1,3-dimethylbenzene, and 1,4-dimethylbenzene (all B.D.H.) were purified as described earlier (*1*). The samples were made thiophene free, dried over anhydrous calcium chloride, refluxed over sodium wire, and fractionally distilled. 1,2-Dibromoethane (Reidel) was dried over anhydrous calcium chloride and fractionally distilled. The purities of the samples were checked by density measurements, which agree to within 0.000 02 g cm^{-3} with the corresponding literature values (*7–9*).

Dielectric constants of the pure components and mixtures were determined from capacity measurements using a Universal impedance bridge (Type EE 01.02a, Toshniwal) at 303.15 K. The samples were placed in a cell containing a coaxial brass cylinder at 303.15 K. The temperature of the thermostat was kept constant within 0.01 K. The instrument was calibrated before hand with several samples of pure liquids of known dielectric constants (*7–9*). The dielectric constants of cyclohexane, benzene, methylbenzene, 1,2-dimethylbenzene, 1,3-dimethylbenzene, and 1,4-dimethylbenzene were measured at 293.15 K and are recorded in Table I, along with the literature values (*7–9*). The experimental values were found to agree within 0.0004 with the corresponding literature values (*7–9*).

Results and Discussion

The values of dielectric constants of mixtures are recorded in Table II and have been plotted in Figures 1–6. The lines in the figures are drawn to make the best fit of the experimental points.

It is now evident from Figures 1–6 that dielectric constant plots against mole fraction are not linear. The mixtures are not ideal at the temperature of measurements. The molar polarization P of the pure component is given by:

$$P = [(\epsilon - 1)/(\epsilon + 2)][M/d] \quad (1)$$

where ϵ is the dielectric constant, M is the molecular weight, and d is the density of the liquid.

The molar polarization P_{12} of the mixture is given by

$$P_{12} = [(\epsilon_{mix} - 1)/(\epsilon_{mix} + 2)][(X_1M_1 + X_2M_2)/d_{mix}] \quad (2)$$

where ϵ_{mix} is the dielectric constant of the mixture, d_{mix} the density, and X_1, X_2, M_1, and M_2 are the mole fractions and molecular weights of components 1 and 2.

Table I. Dielectric Constants of Pure Components at 293.15 K

	dielectric constant	
	this work	lit. value (*7–9*)
cyclohexane	2.0232	2.0230
benzene	2.2822	2.2825
methylbenzene	2.3795	2.3799
1,2-dimethylbenzene	2.5680	2.5680
1,3-dimethylbenzene	2.3742	2.3740
1,4-dimethylbenzene	2.2704	2.2700

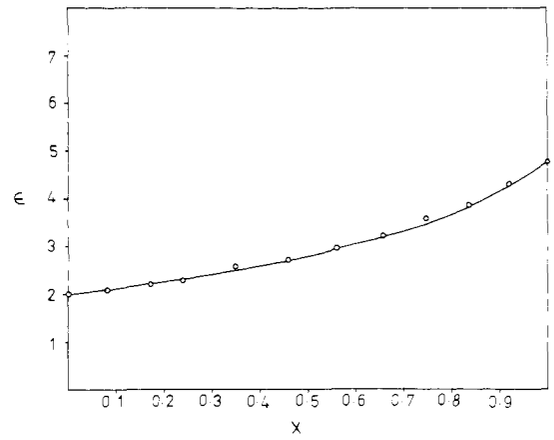

Figure 1. Plot of dielectric constant ϵ against mole fraction x of (x)1,2-dibromoethane + $(1 - x)$cyclohexane.

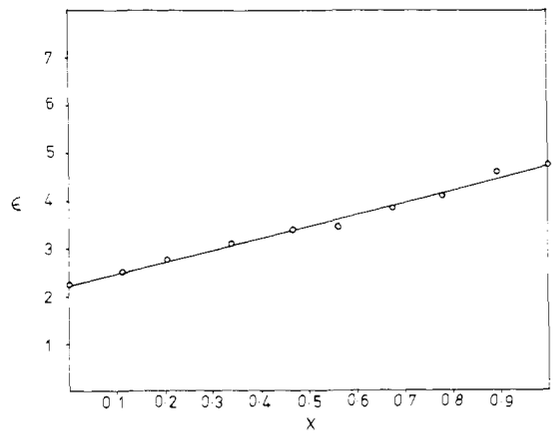

Figure 2. Plot of dielectric constant ϵ against mole fraction x of (x)1,2-dibromoethane + $(1 - x)$benzene.

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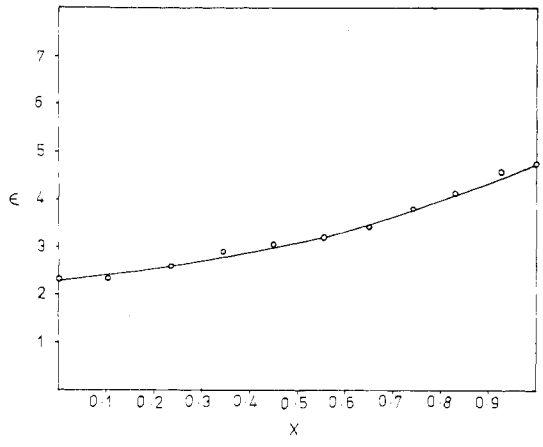

Figure 3. Plot of dielectric constant ϵ against mole fraction x of (x)1,2-dibromoethane + $(1 - x)$methylbenzene.

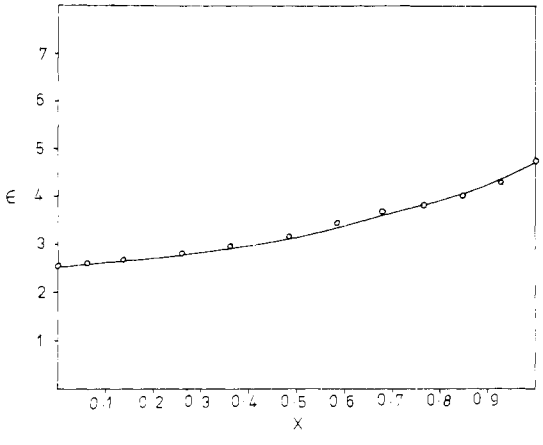

Figure 4. Plot of dielectric constant ϵ against mole fraction x of (x)1,2-dibromoethane + $(1 - x)$1,2-dimethylbenzene.

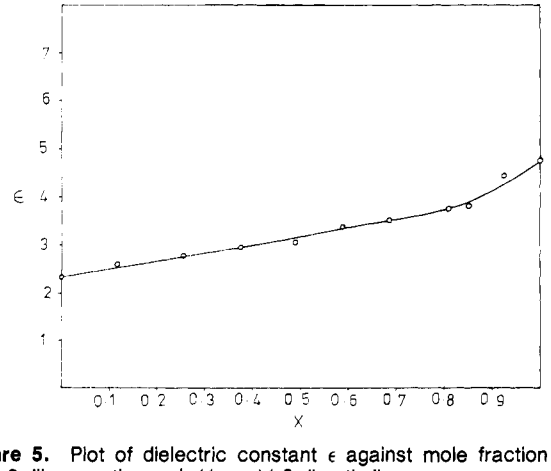

Figure 5. Plot of dielectric constant ϵ against mole fraction x of (x)1,2-dibromoethane + $(1 - x)$1,3-dimethylbenzene.

The molar polarizations of the mixtures were calculated from eq 2. The densities of the mixtures were taken from excess volume measurements (*1*). The molar polarizations of the mixtures are recorded in Table II and are plotted against mole fraction in Figures 7–12.

From Figures 7–12 it is clear that the plots of P_{12} against mole fraction are linear within experimental error. These systems do not possess a complexing nature. The deviations from linearity in the plots of dielectric constant against mole fraction in Figures 1–6 are the expected behavior of the systems. The region of nonlinearity occurs in the high concentration region of the polar components. The deviations from linearity in these

Table II. Dielectric Constants and Dielectric Polarizations of Mixtures Containing 1,2-Dibromoethane at 303.15 K

x	e	P_{12}/cm^3
(x)1,2-dibromoethane + $(1-x)$cyclohexane		
1.0000	4.7503	48.15
0.9172	4.2814	46.32
0.8321	3.8601	43.95
0.7448	3.6020	42.90
0.6528	3.2396	40.18
0.5594	2.9790	38.36
0.4539	2.7214	36.31
0.3471	2.5806	34.83
0.2380	2.2800	31.21
0.1226	2.1816	29.86
0.0785	2.1189	28.90
0.0000	2.0107	27.44
(x)1,2-dibromoethane + $(1-x)$benzene		
1.0000	4.7503	48.15
0.8905	4.6011	47.18
0.7791	4.0823	44.29
0.6740	3.8246	42.54
0.5631	3.4607	39.75
0.4681	3.4009	39.34
0.3387	3.1398	37.05
0.2069	2.7806	33.33
0.1138	2.5397	30.40
0.0000	2.2626	26.58
(x)1,2-dibromoethane + $(1-x)$methylbenzene		
1.0000	4.7503	48.15
0.9141	4.6018	48.10
0.8299	4.1406	46.46
0.7391	3.8212	44.47
0.6494	3.4409	41.92
0.5540	3.2188	40.64
0.4506	3.0799	40.06
0.3468	2.9206	39.14
0.2378	2.6000	35.65
0.1033	2.3431	32.47
0.0000	2.3522	33.66
(x)1,2-dibromoethane + $(1-x)$1,2-dimethylbenzene		
1.0000	4.7503	48.15
0.9239	4.2806	46.51
0.8474	0.0214	46.08
0.7679	3.8220	46.07
0.6787	3.7007	46.51
0.5860	3.4413	45.43
0.4817	3.1816	44.12
0.3639	2.9810	43.52
0.2596	2.8224	42.53
0.1362	2.6818	41.55
0.0585	2.6204	41.52
0.000	2.5403	41.23
(x)1,2-dibromoethane + $(1-x)$1,3-dimethylbenzene		
1.0000	4.7503	48.15
0.9230	4.4424	47.39
0.8522	3.8221	46.75
0.8102	3.7628	45.37
0.6845	3.5006	44.71
0.5884	3.3794	43.07
0.4886	3.0400	41.81
0.3771	2.9414	43.12
0.2566	2.7198	42.24
0.1184	2.6011	41.23
0.0000	2.3502	38.45
(x)1,2-dibromoethane + $(1-x)$1,4-dimethylbenzene		
1.0000	4.7503	48.15
0.9215	4.4000	47.20
0.8548	4.0802	46.72
0.6801	3.5022	44.81
0.5889	3.3016	44.23
0.4919	3.0812	43.36
0.4044	2.8810	42.15
0.2622	2.6633	40.76
0.1362	2.4006	37.04
0.0000	2.2502	36.57

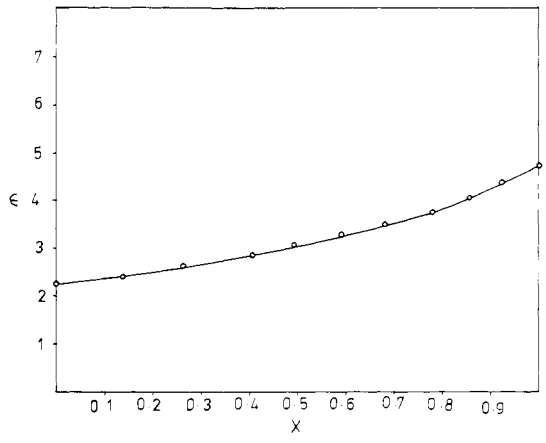

Figure 6. Plot of dielectric constant ϵ against mole fraction x of (x)1,2-dibromoethane + (1 - x)1,4-dimethylbenzene.

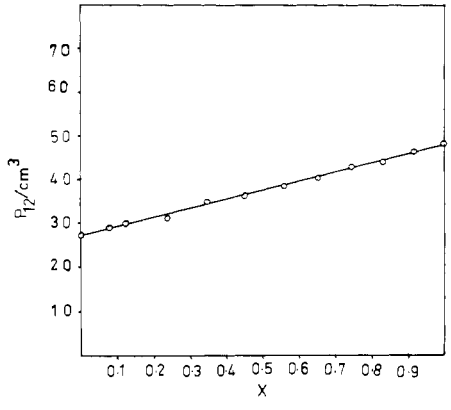

Figure 7. Plot of molar polarization P_{12} against mole fraction x of (x)1,2-dibromoethane + (1 - x)cyclohexane.

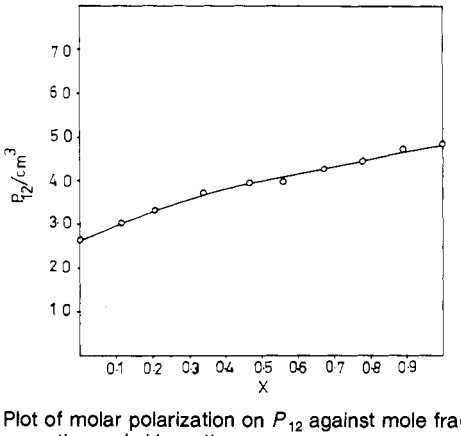

Figure 8. Plot of molar polarization on P_{12} against mole fraction x of (x)1,2-dibromoethane + (1 - x)benzene.

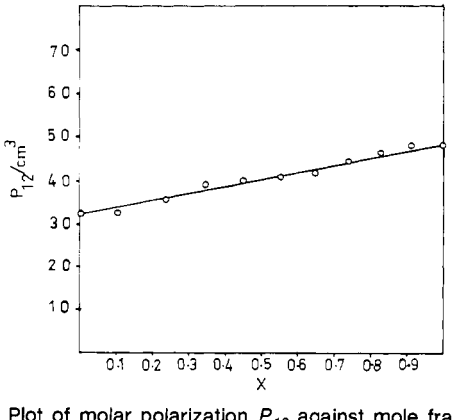

Figure 9. Plot of molar polarization P_{12} against mole fraction x of (x)1,2-dibromoethane + (1 - x)methylbenzene.

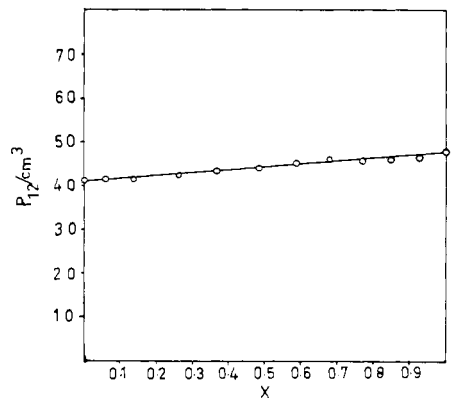

Figure 10. Plot of molar polarization P_{12} against mole fraction x of (x)1,2-dibromoethane + (1 - x)1,2-dimethylbenzene.

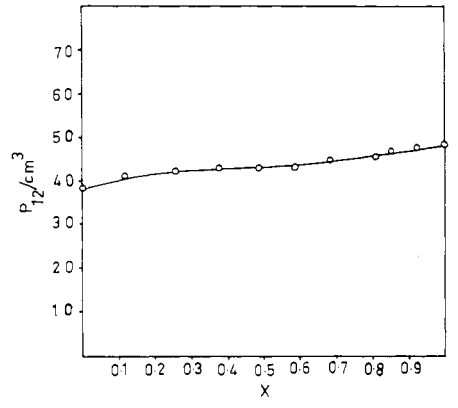

Figure 11. Plot of molar polarization P_{12} against mole fraction x of (x)1,2-dibromoethane + (1 - x)1,2-dimethylbenzene.

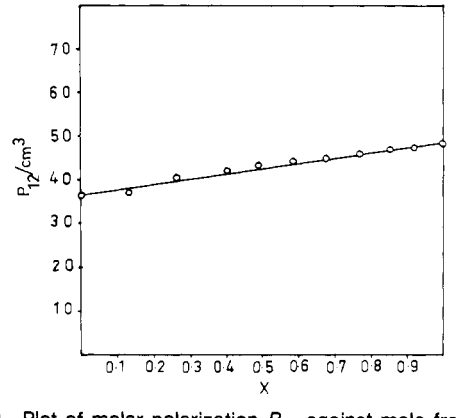

Figure 12. Plot of molar polarization P_{12} against mole fraction x of (x)1,2-dibromoethane + (1 - x)1,4-dimethylbenzene.

systems are due to dipole–dipole interactions.

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