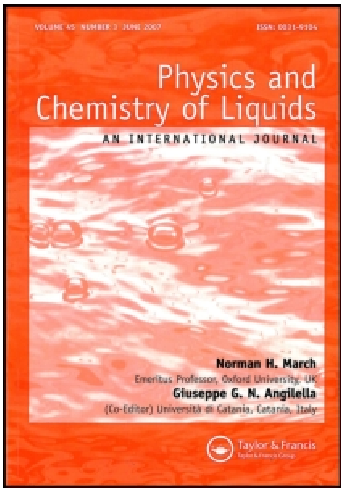

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# ULTRASONIC STUDIES IN BINARY MIXTURES OF 1-2-DIBROMOETHANE WITH ALCOHOLS AT 303.15 K

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Isentropic compressibility data, $K_S$ of 1,2-Dibromoethane + Propan-1-ol, + butan-1-ol, + pentan-1-ol, hexan-1-ol, heptan-1-ol and octan-1-ol at 303.15 K are reported. Deviations in isentropic compressibility, $K_S$ values are found to be negative for mixtures of 1,2-dibromoethane with propan-1-ol over the entire range of composition and while in butan-1-ol the $\Delta K_S$ values are negative at lower molefractions and positive at higher molefractions. Therefore as the chain length increases it is showing the positive deviations. The data are interpreted in terms of specific interactions between the components.

KEY WORDS: Excess volume, isentropic compressibility.

## INTRODUCTION

Though many binary liquid mixtures have been studied ultrasonically, it appears that very few binary mixtures of associated liquids have been studied. It has been shown that mixtures of associated liquids generally show non-ideal behaviour in respect of properties like excess volume and isentropic compressibility. Raman *et al.*[1–3] have studied excess volume extensively the binary mixtures containing 1,2-Dibromoethane as common component. Like excess volume, isentropic compressibility also throws a light on the nature and degree of molecular interactions present in the binary mixture. Hence our work is extended to ultrasonic studies of the binary mixtures. Recently we have published the ultrasonic behaviour of binary mixtures of 1,2-Dibromoethane with ketones[4]. The present paper reports Sound velocities, densities and isentropic compressibilities for the binary mixtures of 1,2-Dibromoethane with alcohols. Alcohols include propan-1-ol, butan-1-ol, pentan-1-ol, hexan-1-ol, heptan-1-ol and octan-1-ol.

## EXPERIMENTAL

The liquids were purified as described in our earlier work[1]. The purity of the final samples were checked by density measurements. Ultrasonic sound velocities were measured with a single crystal interferometer working at a fixed frequency of $2MH_2$. The temperature of the experimental liquid in the cell was maintained by circulating water from a thermostatic bath through the double walled liquid container. Densities were measured using a bi-capillary type pycnometer of Naidu *et al.*[5] The densities and sound velocities were accurate to $\pm 0.00005$ gcm$^{-3}$ and $\pm 0.15\%$ respectively. All the measurements were made at $303.15 \pm 0.01$ K.

## RESULTS AND DISCUSSION

Isentropic compressibilities $K_S$ were derived from the expression

$$K_S = U^{-2}\rho^{-1} \tag{1}$$

where $U$ and $\rho$ denotes sound velocity and density respectively. The deviation in isentropic compressibility $\Delta K_S$ has been calculated from the equation

$$\Delta K_S = K_S - \phi_1 K_{S_1} - \phi_2 K_{S_2} \tag{2}$$

where $K_S$, $K_{S_1}$ and $K_{S_2}$ are the isentropic compressibilities of the mixture and pure components and $\phi_1$ and $\phi_2$ are volume fractions. Densities, Sound velocities were accurate to $\pm 0.00005$ gcm$^{-3}$ and $\pm 0.15\%$ are given in Table 1.

The experimental $\Delta K_S$ values against volume fraction $\phi_1$ may be represented by

$$\Delta K_S = \phi_1\phi_2[b_0 + b_1(\phi_1 - \phi_2) + b_2(\phi_1 - \phi_2)^2] \tag{3}$$

The values of $b_0$, $b_1$ and $b_2$ obtained by least squares are included in Table 2 along with standard deviation $\sigma(\Delta K_S)$.

The values of $\Delta K_S$ are negative in the mixture 1,2-Dibromoethane–propan-1-ol over the entire range of composition, while in butan-1-ol it is negative at lower mole-fractions and positive at higher molefractions and pentan-1-ol onwards upto octan-1-ol it is showing positive nature. Therefore as the chain length increases the trend is changing from negative towards positive Alcohols[6–8] are self-associated in the pure state. The values of $\Delta K_S$ may be ascribed to the relative strengths of opposing effects which influence the free space defined by Jacobson[9]. Mutual breaking up of hydrogen bonds in the alcohol and in the 1,2-Dibromoethane by each other leads to an increase in free spaces in mixtures contributing to positive deviations in sound velocity and negative deviations in compressibility. However, this effect will be counteracted by the interaction due to the hydrogen bond by Br–H–O, type between dibromoethane and alcohol, which leads to positive deviation in compressibility. The actual values of $K_S$, therefore, would depend upon relative strengths of these two opposing effects. The positive values of $K_S$ in all the mixtures suggest the predominating hydrogen bond interaction between dibromoethane and alcohol and also supports the contention made previously[1] that Br–H–O bonding is relatively stronger. These are attributed to weak dipolar interactions between unlike molecules which leads to decrease in free length, increase in sound speed and negative deviations in isentropic compressibility. These interactions are infected decrease with increase in chain length.

**Table 1** Volume factors ($\phi_1$), densities ($\rho$), sound velocities ($u$) and isentropic compressibilities ($K_S$) and deviation in isentropic compressibilities $\Delta K_S$ of binary liquid mixtures of 1,2-dibromoethane with alcohols at 303.15 K.

| $\phi_1$ | $\frac{\rho}{g\,cm^{-3}}$ | $\frac{U}{mg^{-1}}$ | $\frac{K_S}{TPa^{-1}}$ | $\frac{\Delta K_S}{TPa^{-1}}$ |
|---|---|---|---|---|
| | 1,2-dibromoethane + propan-1-ol | | | |
| 0.0000 | 0.79604 | 984 | 884 | 0 |
| 0.1270 | 0.96856 | 1121 | 822 | − 11 |
| 0.2130 | 1.08564 | 1086 | 781 | − 17 |
| 0.4126 | 1.35606 | 1035 | 688 | − 28 |
| 0.5081 | 1.48564 | 1008 | 663 | − 21 |
| 0.5861 | 1.59177 | 998 | 631 | − 16 |
| 0.6352 | 1.65828 | 992 | 613 | − 14 |
| 0.7726 | 1.84556 | 980 | 564 | − 07 |
| 0.8859 | 1.99972 | 977 | 524 | − 1 |
| 1.0000 | 2.15967 | 984 | 479 | 0 |
| | 1,2-dibromoethane + butan-1-ol | | | |
| 0.0000 | 0.80201 | 1232 | 821 | 0 |
| 0.0960 | 0.93128 | 1168 | 787 | − 1 |
| 0.2026 | 1.07488 | 1113 | 751 | − 1 |
| 0.3373 | 1.25673 | 1063 | 705 | − 2 |
| 0.3594 | 1.28631 | 1057 | 696 | − 2 |
| 0.5207 | 1.50420 | 1017 | 643 | 0 |
| 0.5578 | 1.55430 | 1011 | 630 | 0 |
| 0.7822 | 1.85870 | 985 | 555 | 2 |
| 0.8802 | 1.99304 | 980 | 522 | 2 |
| 1.0000 | 2.15967 | 984 | 479 | 0 |
| | 1,2,dibromoethane + pentan-1-ol | | | |
| 0.0000 | 0.80760 | 1270 | 768 | 0 |
| 0.0998 | 0.94115 | 1185 | 757 | 18 |
| 0.2217 | 1.10442 | 1120 | 722 | 18 |
| 0.2743 | 1.17483 | 1100 | 704 | 17 |
| 0.3777 | 1.28200 | 1062 | 692 | 16 |
| 0.3972 | 1.33960 | 1058 | 667 | 15 |
| 0.5457 | 1.53902 | 1022 | 662 | 12 |
| 0.7732 | 1.84681 | 989 | 554 | 9 |
| 0.8878 | 2.00381 | 982 | 518 | 7 |
| 1.0000 | 2.15967 | 984 | 479 | 0 |
| | 1,2-dibromoethane + hexan-1-ol | | | |
| 0.0000 | 0.81204 | 1288 | 742 | 0 |
| 0.1191 | 0.97071 | 1201 | 714 | 3 |
| 0.2081 | 1.08916 | 1150 | 694 | 7 |
| 0.2613 | 1.16008 | 1126 | 680 | 7 |
| 0.3863 | 1.32672 | 1075 | 652 | 12 |
| 0.5453 | 1.53937 | 1032 | 610 | 11 |
| 0.5910 | 1.60678 | 1025 | 595 | 8 |
| 0.7500 | 1.81550 | 998 | 553 | 7 |
| 0.8881 | 2.02545 | 982 | 512 | 4 |
| 1.0000 | 2.15967 | 984 | 479 | 0 |

(*continued*)

**Table 1** (*continued*)

| $\phi_1$ | $\frac{\rho}{g\,cm^{-3}}$ | $\frac{U}{MG^{-1}}$ | $\frac{K_S}{TPa^{-1}}$ | $\frac{\Delta K_S}{TPa^{-1}}$ |
|---|---|---|---|---|
| | 1,2-diobromoethane + heptan-1-ol | | | |
| 0.0000 | 0.81573 | 1310 | 714 | 0 |
| 0.1226 | 0.97800 | 1220 | 687 | 2 |
| 0.1928 | 1.07112 | 1172 | 680 | 11 |
| 0.2794 | 1.18605 | 1128 | 663 | 15 |
| 0.3252 | 1.24690 | 1108 | 653 | 15 |
| 0.5065 | 1.48855 | 1049 | 611 | 16 |
| 0.5594 | 1.55924 | 1035 | 599 | 16 |
| 0.7949 | 1.87715 | 992 | 541 | 14 |
| 0.8749 | 1.98656 | 989 | 515 | 7 |
| 1.0000 | 2.15967 | 984 | 479 | 0 |
| | 1,2 dibromoethene + octan-1-ol | | | |
| 0.0000 | 0.94160 | 1330 | 688 | 0 |
| 0.0765 | 0.92253 | 1265 | 677 | 5 |
| 0.1638 | 1.03753 | 1204 | 665 | 11 |
| 0.2185 | 1.10960 | 1172 | 656 | 14 |
| 0.3758 | 1.31737 | 1100 | 627 | 18 |
| 0.4765 | 1.45103 | 1064 | 609 | 21 |
| 0.5288 | 1.52055 | 1050 | 597 | 20 |
| 0.6705 | 1.71007 | 1019 | 563 | 15 |
| 0.8922 | 2.01087 | 990 | 507 | 6 |
| 1.0000 | 2.15967 | 984 | 479 | 0 |

**Table 2** Values of parameters in Eq. (3) and the standard deviation $\sigma(\Delta K_S)$ at 303.15 K.

| 1,2-*Dibromoethane* + | $b_0$ | $b_1$ | $b_2$ | $\sigma(\Delta K_S)$ |
|---|---|---|---|---|
| Propan-1-ol | −88.622 | 61.392 | 58.257 | ±3 |
| butan-1-ol | −2.374 | 19.091 | 11.611 | ±1 |
| Pentan-1-ol | 41.074 | −59.594 | 144.049 | ±2 |
| hexan-1-ol | 42.346 | 1.888 | −11.861 | ±1 |
| heptan-1-ol | 75.471 | 16.870 | −37.133 | ±3 |
| octan-1-ol | 79.380 | −9.797 | −18.572 | ±1 |

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