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Ultrasonic Velocity Studies of Dioxane Solutions of 1,1′-Bis (4-Hydroxyphenyl) Cyclohexane and 4,4′-Dihydroxy Diphenyl Sulfone at 30°C

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The densities and ultrasonic velocities of 1,1′-bis(4-hydroxyphenyl) cyclohexane and 4,4′-dihydroxy diphenyl sulfone in dioxane solutions (0.04–0.25 M) are studied at 30°C at a frequency of 3 MHz. Various acoustical parameters such as isentropic compressibility (Ks), Rao's sound function (R), Van der Waals constant (b) are evaluated and correlated with concentration. The results are interpreted in terms of solute-solvent interaction.

INTRODUCTION

Bisphenols are useful for the preparation of thermally stable polymers, epoxy resins, paints and varnishes[1–3]. The physical and chemical properties are strongly dependent on the structure of bisphenols. Knowledge of ultrasonic sound velocity, isentropic compressibility, Rao's molar sound function[4] and solvation number[5] are powerful means of characterizing the various aspects of physico-chemical behaviour of liquid mixtures and furnish information about interactions occurring in the solution[6–9]. To understand the structure of bisphenols and solute-solvent interactions, acoustical parameters are of great importance. With a view to understand such behaviour, present piece of work describes the ultrasonic velocity studies of 1,4-dioxane solutions of two bisphenols at 30°C.

EXPERIMENTAL

The solvent 1,4-dioxane, 1,1′-bis(4-hydroxyphenyl)cyclohexane (BC)[10] and 4,4′-dihydroxy diphenyl sulfone (BS) (Kochlight) were purified prior to use by appropriate method[10, 11]. A series of bisphenol solutions ranging from 0.04–0.25 M were prepared in 1,4-dioxane. The densities and sound velocity (Single crystal Multifrequency Interferometer Mittal Enterprise operating at a frequency of 3 MHz) measurements were made at 30 ± 0.1°C and were accurate to ± 0.001 g/cm^3 and $\pm 0.2\%$ cm/sec, respectively.

RESULTS AND DISCUSSION

Acoustical parameters

The density (ρ) and ultrasonic sound velocity (U) of dioxane solutions of 1,1′-bis(4-hydroxy phenyl)cyclohexane (BC) and 4,4′-dihydroxy diphenyl

sulfone (BS) at 30°C are reported in Table-1. Using these data, the isentropic compressibility (Ks), Rao's molar sound function[4] (R), the specific acoustic impedance (Z) and van der Waals constant (b) were calculated according to standard equations reported elsewhere[12]. The correlation coefficients and correlation equations are as under:

BC:

$$Ks + (1.0624 \times 10^{-11})\, C = 5.6458 \times 10^{-11}; \quad \gamma = -0.9866$$

$$R - (2232.0358)\, C = 4379.7089; \quad \gamma = 0.9973$$

$$b - (40.8668)\, C = 80.9058; \quad \gamma = 0.9999$$

BS:

$$Ks + (6.4338 \times 10^{-12})\, C = 5.5979 \times 10^{-11}; \quad \gamma = -0.9997$$

$$R - (3944.5980)\, C = 4372.4791; \quad \gamma = 0.9993$$

$$b - (29.0090)\, C = 81.0090; \quad \gamma = 0.9981$$

From above equations, it is clear that excellent linear correlations between parameter and concentration (C) are observed.

It is clear from Table-1 that U increases with concentration and also is observed graphically that the variation of U and C is non-linear which might be due to association between solvent-solute molecules. There is no much change in U with C in case of BS. Nambinarayanan *et al.*[13] have also reported such behaviour in oxalic acid in tetrahydrofuran. It is likely that the solvent dioxane forms H-bonding between the oxygen atoms of dioxane molecules and the phenolic molecules. This hydrogen bond formation strengthens the intermolecular forces (solute-solvent interaction) resulting in a decrease of compressibility and increase of ultrasonic velocity and acoustical impedance. The decrease of Ks and increase of U, Z, R and b imply the solute-solvent interaction. Such results are also observed in a variety of liquid mixtures.[14–17]

TABLE-1
DENSITY (ρ) AND ULTRASONIC VELOCITY (U) OF BC AND BS IN DIOXANE SOLUTIONS AT 30°C

BC			BS		
Concentration (M)	Density (ρ) g/cm^3	Velocity U × 10^5 cm^2/sec	Concentration (M)	Density (ρ) g/cm^3	Velocity U × 10^5 cm^2/sec
0.255	1.0346	1.342	0.250	1.0436	1.325
0.213	1.0318	1.336	0.200	1.0372	1.328
0.148	1.0297	1.331	0.150	1.0335	1.332
0.103	1.0282	1.326	0.100	1.0305	1.326
0.068	1.0274	1.320	0.080	1.0280	1.325
0.034	1.0263	1.311	0.040	1.0265	1.321

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