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Ultrasonic Sound Velocity Studies of Dioxane-Water Solutions of 3-α-Furyl Acrylic Acid at 30°C

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Ultrasonic sound velocity studies of 3-α-furyl acrylic acid (FAA) in varying proportions of aqueous dioxane mixtures (90, 70, 50 and 30 weight %) were investigated at 30°C using interferometer operating at a frequency of 1 MHz. The decrease of β_{ad} and increase of U and Z with concentration indicated the presence of strong interaction through H-bonding between acid and dioxane molecules. This is further supported by non-linear increase of η with concentration. The positive values of S_n implied the structure-making tendency while that the negative values implied the structure-breaking tendency of FAA in a given solvent mixture at 30°C.

INTRODUCTION

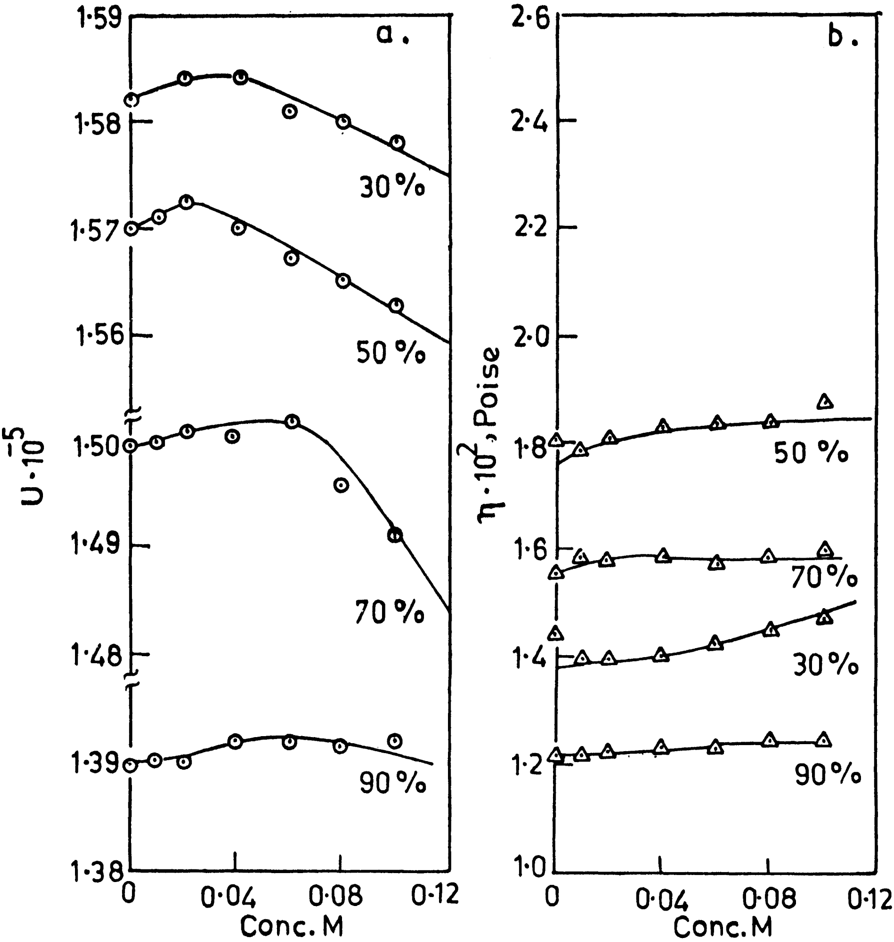
Knowledge of acoustical properties of any solution provides information about the interaction occurring in the solutions[1–4]. In continuation with our earlier work[5], the present paper describes the ultrasonic velocity studies of 3-α-furyl acrylic acid (FAA) in varying proportions (90, 70, 50 and 30 weight %) of dioxane at 30°C.

EXPERIMENTAL

The measurements of density, viscosity and sound velocity (1 MHz) of FAA in varying proportions (90, 70, 50 and 30 weight %) of dioxane-water system were made at 30°C according to our earlier publication[5].

RESULTS AND DISCUSSION

Figs. 1 (a) and (b) show the experimental density (ρ) and sound velocity (U) plots against concentration of FAA in aqueous dioxane (90, 70, 50 and 30 wt. %) at 30°C. It is found that U increases with increase in FAA concentration, reaches maximum and then decreases. This type of variation of U generally indicates association between molecules. It is likely that the solvent dioxane breaks the acid dimers into monomer form and H-bonds are formed between the oxygen of dioxane molecules and the monomer of acrylic acid. The H-bond formation strengthens the intermolecular forces resulting in a decrease of compressibility and increase of U. This structure-breaking tendency is observed up to a certain



concentration of binary mixtures and again the reverse phenomena takes place with increasing FAA concentration, *i.e.*, dimerization of FAA, and as a result U decreases. This is further supported by non-linear increase of U with concentration (Fig. 1 (b)) indicating structural changes. Thus, the decrease of isentropic compressibility β_{ad} and increase of U and acoustical impedance (Z) with concentration confirms the presence of strong interaction through H-bonding between acid and dioxane molecules. Such results are also observed in variety of liquid mixtures[6–8]. Ultrasonic velocity studies in the solutions of carboxylic acids in dioxane[9] indicate association between the monomers of carboxylic acids and oxygen of dioxane.

The solvation number S_n is useful in understanding the structure-breaking and structure-making tendency of added electrolyte in a particular solvent[10]. The variation of S_n with FAA concentration is presented in Table-1. It is found graphically that S_n decreases exponentially for 70% dioxane, which might be probably due to ion-ion interaction. In case of 30, 50 and 90 wt % dioxane, S_n is found to increase up to about 0.02 M, then decreases with FAA concentration.

The increase in S_n indicates the decrease of ion-ion interaction and hence occurrence of the association with solvent molecules. The positive and negative values of S_n, respectively imply the structure-forming and structure-breaking tendency of FAA in a given solvent composition.

TABLE-1
VARIATION OF S_n WITH FAA CONCENTRATION IN VARIOUS COMPOSITIONS OF DIOXANE AT 30°C

Concentration M	S_n weight %			
	30	50	70	90
0.01	0.1	1.1	22.8	–4.0
0.02	2.4	2.9	12.8	–2.4
0.04	1.4	–0.3	6.1	–0.2
0.06	–0.9	–1.0	4.4	–0.1
0.08	–1.5	–1.6	2.2	0.0
0.10	–1.8	–1.5	0.5	0.1

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REFERENCES

1. R.T. Bayer and S.V. Lecher, Physical Ultrasonics, Academic Press, New York (1969).
2. Ch. J. Burton, *J. Acoust. Soc. Amer.*, **20**, 86 (1948).
3. S. Bagchi, S.K. Neema and R.P. Singh, *Eur. Polym. J.*, **22**, 851 (1968).
4. G.V. Reddy and R.P. Singh, *Acoustica*, **46**, 342 (1980).
5. Shipra Baluja and P.H. Parsania, *Asian J. Chem*, **7**, 417 (1995).
6. J. Nath and Rashmi, *J. Chem. Soc. Faraday Trans.*, **86**, 3399 (1990).
7. T.M. Aminbhavi, M.I. Arrlaguppi, S.S. Joshi, S.B. Khinna, R.S. Var and R.H. Balundgi, *Indian J. Tech.*, **30**, 303 (1992).
8. V. Rajendran, A. Marikani and N. Palanively, *J. Pure Appl. Ultrason.*, **16**, 16 (1994).
9. B. Anbanathan, B. Krishan and S. Rao, *Indian J. Chem.*, **13**, 512 (1975); **14**, 277 (1976).
10. M. Woldan, *Z. Physik. Chemie*, **269**, 628 (1988).

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