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Ultrasonic Investigation of Molecular Interaction in Binary Mixture of Salicylaldehyde and Ethanol

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Abstract

The ultrasonic velocity was measured in binary mixture of salicylaldehyde with ethanol at 303.15k. The relative merits of Nomotos theory, Van Deal Vangeel ideal mixing relation in the binary liquids mixture are compared. The values of molecular interaction term á for the liquid mixture are used to explain the molecular interactions.

Key words : Ultrasonic velocity, Salicylaldehyde + Ethanol, Binary mixture, molecular interaction.

Introduction

Ultrasonic velocity has been subject of active interest in understanding the nature of molecular systems and physio-chemical behavior in liquid mixtures during the recent years. Ultrasonic propagation parameters yield valuable information regarding the behavior of [1-4] liquid binary systems because intramolecular and intermolecular association, dipolar interactions, complex formation and related structural changes affect the compressibility of the system which in turn produces corresponding variations in the ultrasonic velocity. Nomoto[5] and coworkers made successful attempts to evaluate sound velocity in binary liquid mixtures. Ramaswamy and Ambanathan[6] and Kannappan *et al.*[7] carried out ultrasonic investigation on some liquid mixtures and correlated the experimental results of ultrasonic velocity with the theoretical relation suggested by Nomoto and Van Deal Vangeel[8] and interpreted the results in terms of molecular interaction. In the present paper an attempt has been made to evaluate the ultrasonic velocities in salicylaldehyde + ethanol mixture using Nomoto and ideal mixing relation.

Experimental

Ultrasonic velocities was measured (with an accuracy of ± 0.5 ms^{-1}) by a single crystal variable path ultrasonic interferometer (Mittal Enterprise Model f – 81) operating at a frequency of 5 MHz. Water from a thermostatically regulated bath (Toshniwal, India) equipped with Jumo – D.B.P. temperature sensor was

circulated around the sample holder (with double wall) to maintain the temperature of liquid constant at 303.15 k with a precision of ± 0.01 k. The chemicals used were of extra pure A.R. Grade (SRL). All the chemicals were purified by standard procedure discussed by Perrin and Armarego [9].

Theory :

Nomoto developed the following relation for theoretical values of ultrasonic velocities in binary liquid mixture.

$$U = \left[\frac{X_1R_1 + X_2R_2}{X_1V_1 + X_2V_2} \right]^3$$

Where X_1 and X_2 represent mole fractions of first and second components of mixtures respectively. R_1 and R_2 the molar sound velocity, V_1 and V_2 molar volumes of the components of the mixture. Van Deal and Vangeel suggested the ideal mixing relation for the ultrasonic velocity Uim.

$$\left[\frac{1}{X_1M_1 + X_2M_2} \right] \frac{1}{Uim^2} = (X_1/M_1U_1^2) + (X_2/M_2U_2^2)$$

The degree of molecular interaction α is calculated from Uim and Uexp using the relation.

$\alpha = U^2exp / U^2im$

Where, Uexp is the experimental Ultrasonic velocity and Uim is the theoretical Ultrasonic velocity by Van Deal and Vangeel ideal mixing relation.

Table – I. Experimental and theoretical ultrasonic sound velocities and degree of molecular interaction in salicylaldehyde + ethanol mixture at 303.15K.

Concentration	Uexp m/s	Nomoto	Van Deal Uim	Molecular Interaction (α)
0.0016	1140	1153.7	2545.4	-0.799
0.0033	1141	1155.5	2533.6	-0.797
0.005	1142	1157.3	2519.0	-0.794
0.0066	1146	1158.9	2507.2	-0.791
0.0083	1147	1160.7	2492.5	-0.788
0.01	1148	1162.4	2480.5	-0.786
0.0116	1150	1164.06	2468.6	-0.783
0.0132	1150	1165.6	2456.6	-0.781
0.015	1156	1167.4	2444.4	-0.776
0.0165	1152	1168.8	2432.4	-0.775
0.0182	1158	1170.5	2420.2	-0.771
0.02	1157	1172.2	2408.0	-0.769

Results and Discussion

It is observed from Fig. 1 that the ultrasonic velocity (U) increases initially as a function of increasing concentration of the solution. Theoretical ultrasonic velocities calculated using Nomoto and ideal mixing relation for salicylaldehyde + ethanol system show near agreement between experimental and theoretical values (Table – 1). It is found that Nomoto's relation is marginally better than ideal mixing relation for the evaluation of ultrasonic velocity. Negative values of intermolecular attraction (α) suggest lesser interaction in salicylaldehyde + ethanol mixture. There may be intermolecular hydrogen bond in salicylaldehyde as suggested by negative values. The present study shows that both the theoretical models yield qualitative results. It may be concluded that ultrasonic studies provide for a comprehensive investigations of complex formation of binary mixtures.

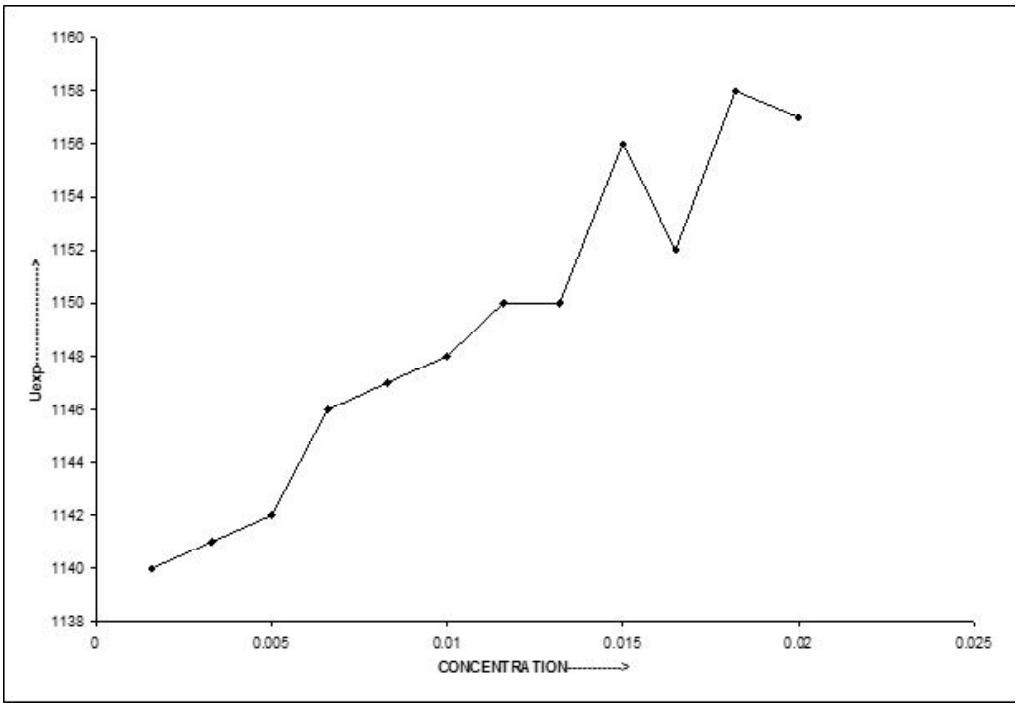

Fig.1: Variation of Uexp with concentration for salicylaldehyde + ethanol binary mixture at 303.15 K

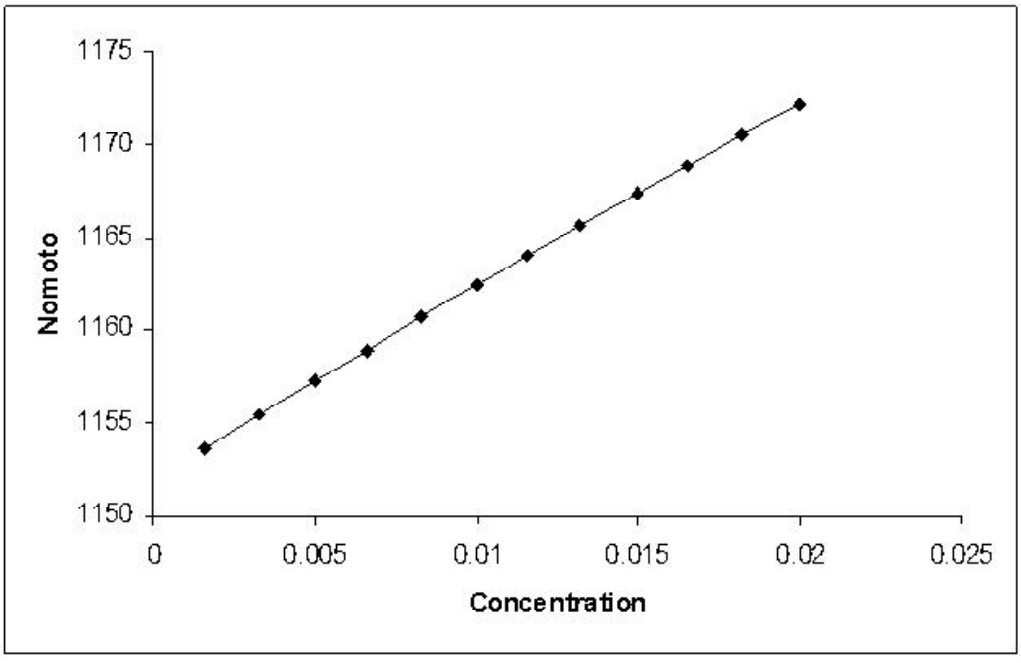

Fig 2: Variation of theoretical Nomoto velocity with concentration for salicylaldehyde + ethanol binary mixture at 303.15K

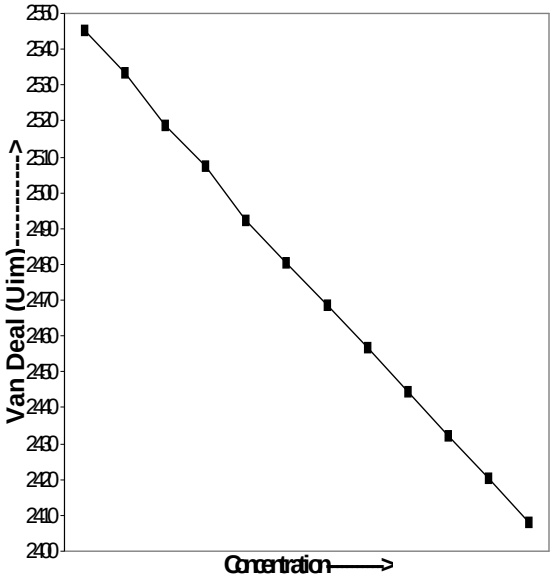

Fig. 3: Variation of Uim with concentration for salicylaldehyde + ethanol binary mixture at 303.15K

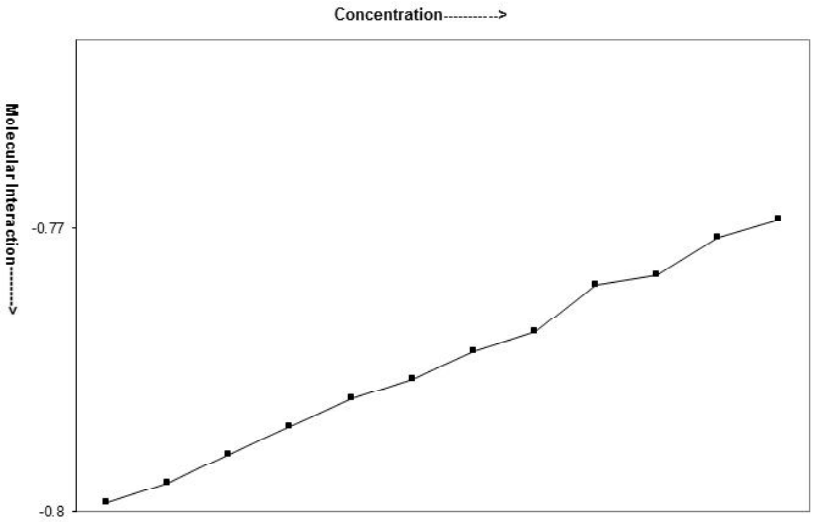

Fig. 4: Variation of molecular interaction (α) with concentration for salicylaldehyde + ethanol binary mixture at 303.15K

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