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THE STUDY OF EXCESS MOLAR VOLUME AND DEVIATION IN VISCOSITY OF BINARY MIXTURE OF THIOPHENE IN PENTANOL-1 AND HEXANOL-1 AT 303 K

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ABSTRACT

Densities, ultrasonic velocity and viscosities of thiophene with pentanol-1 and hexanol-1 have been measured over entire range of composition at 303 K and atmospheric pressure. The computed acoustic and thermodynamic properties of thiophene in alcohol will give the excess values of isentropic compressibility, molar volume and viscosity. The excess values will decide the nature and extent of molecular interaction of thiophene in pentanol-1 and hexanol-1 at 303 K.

Key words: Molar volume, Viscosity, Thiophene, Pentanol-1, Hexanol-1.

INTRODUCTION

Ultrasonic velocity, density and viscosity related parameters such as isentropic compressibility, intermolecular free length, molar and available volume, yield valuable information about intermolecular interaction between the non-polar and polar molecules. The interaction behaviour is due to deviation from ideality cause the solvent interaction[1-3]. Subbarangaiah et al.[4] and; Erying and Hirschfelder et al.[5] investigated ultrasonic behaviour of aqueous solution and discuss the results by hydrogen bonded complex formation. Verma et al.[6] reported various thermodynamic parameters in binary mixtures of higher alcohols with benzene, toluene and carbon tetrachloride. The present investigation deals with the study of excess isentropic compressibility, molar volume, available volume, intermolecular free length and viscosity for binary mixtures of thiophene in alcohols.

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EXPERIMENTAL

Thiophene, pentanol-1 and hexanol-1 were used after single distillation. Binary mixtures were prepared by mixing known volume of each liquid in air tight stoppard glass bottle. Care was taken to avoid contamination during mixing.

Ultrasonic velocity was measured by ultrasonic interferometer M-80 manufactured by M/s Mittal Enterprises, New Delhi having accuracy of about ± 0.057.

Density of pure liquid and binary mixtures were measured by using double walled Picknometer. The Picknometer was calibrated with distilled water. The value obtained were tally with the literature values. The viscosities have been determined by using Ostwald viscometer. The accuracy in density measurements was ± 0.0002 c.p.

Molar volume (Vm) were calculated using following relation

$$Vm = \frac{M}{\rho} \qquad \ldots(1)$$

Where M is effective molecular weight and ρ is the density.

Excess value of molar volume (Vm^E) have been calculated by following formula.

$$Vm^E = Vm_{exp} - (X_1 Vm_1 + X_2 Vm_2) \qquad \ldots(2)$$

Where Vm_{exp}, Vm_1 and Vm_2 are molar volumes of mixture and pure component 1 and 2, respectively and X_1 and X_2 are molar fraction of component 1 and 2.

Excess viscosity has been calculated by using the relation.

$$\eta^E = \eta_{exp} - (X_1\eta_1 + X_2\eta_2) \qquad \ldots(3)$$

RESULTS AND DISCUSSION

The values of ultrasonic velocity, density, viscosity, isentropic compressibility and their excess parameters are represented in Table 1 and 2.

As it can be seen from the Table 1 that ultrasonic velocity increases with increasing mole fraction of the thiophene. It is obvious that the moles of thiophene are so dense that their density is more in comparable to pentanol-1.

Table 1: Mole fraction (X_1) of thiophene, ultrasonic velocity, density, excess isentropic compressibility (βs^E), excess molar volume (Vm^E) and viscosity for thiophene with pentanol at 303 K

Mole fraction (X_1)	Ultrasonic velocity V(m/s)	Density r (g/mL)	Isentropic compressibility (bs^E)	Excess molar volume (Vm^E) Ml/mole	Excess viscosity η^E (c.p.)
0.0000	1260	8248.0000	0.00	0.00	0.0000
0.1429	1273	0.8455	-0.02	-0.72	0.0102
0.2728	1287	0.8649	-0.04	-1.17	0.0205
0.3914	1301	0.8828	-0.07	-1.36	0.0244
0.5001	1315	0.8990	-0.10	-1.33	0.0263
0.6001	1329	0.9138	-0.12	-1.15	0.0302
0.6924	1342	0.9293	-0.09	-1.06	0.0260
0.7778	1354	0.9437	-0.05	-0.87	0.0222
0.8572	1367	0.9571	-0.04	-0.60	0.0179
0.9311	1380	0.9698	-0.02	-0.29	0.0088
1.0000	1392	0.9824	0.00	0.00	0.0000

Table 2: Mole fraction (X_1) of thiophene, ultrasonic velocity, density, excess isentropic compressibility (βs^E), excess molar volume (Vm^E) and viscosity for thiophene with hexanol at 303 K

Mole fraction (X_1)	Ultrasonic velocity V(m/s)	Density r (gm/mL)	Isentropic compressibility (bs^E)	Excess molar volume (Vm^E) Ml/Mole	Excess viscosity η^E(c.p.)
0.0000	1305	0.8356	0.00	0.00	0.0000
0.1572	1335	0.8572	-2.00	-1.08	0.1080
0.2956	1367	0.8764	-4.00	-1.65	0.0217
0.4184	1416	0.8932	-7.01	-1.81	0.0249
0.5281	1454	0.9082	-8.80	-1.73	0.0286

Cont…

Mole fraction (X_1)	Ultrasonic velocity V(m/s)	Density r (gm/mL)	Isentropic compressibility (bs^E)	Excess molar volume (Vm^E) Ml/Mole	Excess viscosity η^E(c.p.)
0.6267	1486	0.9219	-10.00	-1.50	0.0311
0.7157	1461	0.9358	-7.52	-1.32	0.0274
0.7966	1438	0.9487	-5.20	-1.07	0.0228
0.8704	1428	0.9607	-3.80	-0.74	0.0179
0.9379	1411	0.9718	-1.92	-0.38	0.0102
1.0000	1392	0.9824	0.00	0.00	0.0000

The Vm^E values are negative for thiophene with pentanol-1 as well as negative for thiophene with hexanol-1.

The η^E values are positive for thiophene with pentanol-1 as well as positive for thiophene with hexanol-1.

Treszezanowics and Benson[7] suggested that Vm^E is the resultant contribution from several opposing effects. These may be divided arbitrarily in to the three types, namely chemical, physical and structural. Physical contribution that is non-specific interaction between the real species present in the mixture, contributes positive term to Vm^E. The chemical or specific interaction result in a volume decreases and these include change transfer type forces and other complex forming interactions. This effect contributes negative value of Vm^E. The structural contributions arising from geometrical fitting (interstitial accommodation) of one component into another due to the differences in the free volume and molar volume between components lead to a negative contribution to Vm^E.

The negative deviations in viscosity –ve n^E. It expect non-specific molecular interactions between the unlike molecules. The tabulate experimental and computed data throw light on molecular interaction. The nature and extent of interaction define molecular interaction between the binary mixtures. The haxonal-1 having more carbon atom in alkyl group has least repelling power to other molecules and toluene.

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