



The Study of Excess Molar Volume and Deviation in Viscosity of Binary Mixture of Propyl Amine in Benzene and Toluene at 306K Ultrasonically

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Abstract: Densities, ultrasonic velocities and viscosities of propyl amine with benzene and toluene have been measured over entire range of composition at 306 K and atmospheric pressure. The computed acoustic and thermodynamic properties of propyl amine in benzene and toluene will give excess values of isentropic compressibility, molar volume and viscosity. The excess values will decide the nature and extent of molecular interaction of propyl amine with benzene and toluene at 306K.

Keywords: molar volume, viscosity, propyl amine, benzene, toluene

I. 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 behavior is due to deviation from ideality cause the solvent interaction¹⁻³. Subbarangaiah et al⁴ and Eyring & Hirschfelder et al⁵ investigated ultrasonic behavior of aqueous solution and discuss the results by hydrogen bonded complex formation. Verma et al⁶⁻⁷ 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 and viscosity for binary mixtures of propyl amine in benzene and toluene.

II. EXPERIMENTAL

Propyl amine, benzene and toluene 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 $\pm 0.057\%$.

Density of pure liquid and binary mixtures was 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 viscosity measurement was ± 0.0002 c.p.

Molar volume (V_m) were calculated by following relation

$$V_m = M/\rho \quad (1)$$

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

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

$$V_m^E = V_{m_{exp}} - (X_1 V_{m1} + X_2 V_{m2}) \quad (2)$$

Where $V_{m_{exp}}$, V_{m1} and V_{m2} are molar volumes of mixture and pure component 1 and 2 respectively and X_1 and X_2 are mole fraction of component 1 and 2.

Excess Viscosity has been calculated by using the relation

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

III. RESULTS AND DISCUSSION

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

Table-1 indicated ultrasonic velocity decreases with increasing mole fraction of the propyl amine. It is obvious that the moles of propyl amine are less dense that their density is less in comparable to benzene. The V_m^E values are positive for propyl amine with benzene.

As can be seen from Table-2 that ultrasonic velocity decreases with increasing mole fraction of propyl amine. It is obvious that the moles of thiophene are less dense that their density is less in comparable to toluene. The V_m^E values are positive for propyl amine with toluene¹.

The η^E values are positive for propyl amine with benzene as well as positive for toluene.

Treszezanowics and Benson⁸ suggested that V_m^E is 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 nonspecific interaction between the real species present in the mixture, contributes positive term to V_m^E . The chemical or specific interaction result in a volume decreases and these include charge transfer type forces and other complex forming interactions. This effect contributes negative value to V_m^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 V_m^E . The negative deviations in viscosity -ve η^E . It expect non-specific molecular interactions between the unlike molecules. The tabulated experimental and computed data throw light on molecular interaction. The nature and extent of interaction define molecular interaction between the binary mixtures. The hexanol-1 having more carbon atom in alkyl group has least repelling power to other molecules and toluene.

Table-1: Mole fraction (X₁) of propyl amine, ultrasonic velocity, density, excess molar volume and excess viscosity for propyl amine with benzene at 306 K

Mole Fraction of propyl amine X ₁	Ultrasonic velocity v m/s	Density ρ (gm/l)	Excess Molar Volume (V_m^E) ml/mole	Excess Viscosity η^E
0.0000	1260	0.8550	0.00	0.0000
0.1316	1244	0.8299	0.40	0.0010
0.2613	1227	0.8068	0.60	0.0017
0.3890	1210	0.7842	1.11	0.0024
0.5148	1194	0.7621	0.85	0.0027
0.6388	1178	0.7411	0.83	0.0027
0.7610	1163	0.7210	0.69	0.0021
0.8813	1147	0.7022	0.34	0.0011
1.0000	1130	0.6840	0.00	0.0000

Table-2: Mole fraction (X₁) of Propyl amine, ultrasonic velocity, density, excess molar volume and excess viscosity for propyl amine with toluene at 306K

Mole Fraction of propyl amine (X ₁)	Ultrasonic velocity v m/s	Density ρ gm/l	Excess Molar Volume V_m^E ml/mole	Excess Viscosity η^E c.p.
0.0000	1250	0.8430	0.00	0.0000
0.1535	1234	0.8192	0.49	0.0013
0.2973	1218	0.7970	0.79	0.0028
0.4323	1202	0.7759	0.94	0.0041
0.5593	1188	0.7557	0.98	0.0047
0.6790	1174	0.7363	0.91	0.0039
0.7920	1160	0.7180	0.72	0.0025
0.8988	1146	0.7001	0.47	0.0012
1.0000	1130	0.6840	0.00	0.0000

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