ULTRASONIC STUDIES ON TOLUENE AND ETHYL ACETATE IN POLYSTYRENE

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ABSTRACT

Detailed Ultrasonic velocity (U), Density (ρ) of binary mixtures of toluene and ethyl acetate mixed solution in Polystyrene solution were determined at 303k, 308k, 313k. The experimental data have been used to calculate acoustic parameters such as adiabatic compressibility (β), Intermolecular free length (Lf), density (ρ) have been calculated. The density of a solution is found to increase with increase in concentration of toluene and ethyl acetate in polystyrene. The plots ultrasonic velocity vs composition deviates from linearity according to the degree of compatibility of polymer blends, at all concentrations and temperatures. The curves for compatible systems are linear.

Keyword: *Polystyrene, Ultrasonic velocity, density, adiabatic compressibility, free length.*

1. INTRODUCTION

Ultrasound is the most popular method of non-destructive testing and diagnostics in various fields [1,2]. Ultrasonic technique has been widely used to study the molecular interaction in polymer solutions. This technique is promising and may offer an alternative technique compared to traditional methods for polymer blending. This blending technique is considered one of the fastest method. Acoustic impedance, Molecular free length and Adiabatic compressibility, computed from ultrasonic velocity and density of the solution gives direct information about different interactions involved among the various polymer-solvents. Ultrasonic method is a process that uses high-frequency sound waves in order to create a bond. Ultrasonic study of velocity, density along with acoustic parameters of polymer are essential to understand the molecular interactions between the unlike molecules to develop theoretical models and applications in industrial and some biological processes. The advantage of using ultrasonic velocity measurements for investigating polymer-polymer interactions has been shown by many workers [3, 4]. In the present investigation, the dilute solution density and ultrasonic techniques are employed to investigate and establish the molecular interactions of solute-solvent in the blends of poly styrene toluene and ehtylacetate at ambient temperature 303 k, 308k and 313k. Molecular interactions and structural behavior of molecules and their mixtures can be identified using ultrasonic studies.

2. EXPERIMENTAL

In the present study the solutions of various concentrations were prepared by dissolving a known quantity of polymer in 100 ml of solvent mixture. The organic solvents used were toluene and ethyl acetate. The organic solvents were freshly distilled twice before dissolving the weighed quantities of polystyrene sample. Precautions were undertaken to avoid the various types of degradation of the polymer in the solutions[5].

The temperature of the samples for the measurement of the ultrasonic velocity was maintained constant to an accuracy of ± 0.1 °C by circulating water from a thermostatically controlled water bath, through the double walled chamber of the sample cell. Measurements were carried out at 303k ,308k and 313k temperatures.

The density of the solution were measured by specific gravity bottle. A clean and dry (10 ml) specific gravity bottle is weighed (W_1) on a SHIMADZU Digital balance with (± 0.0001gm) accuracy. The specific gravity bottle is fully filled with distilled water and its weight found out (W_2). Then the specific gravity bottle is filled with the experimental liquid and its weight (W_3) is found. The relative density (R.D) of the liquid system is calculated with the help of the relation

$$\text{Relative density} = \frac{W_3 - W_1}{W_2 - W_1}$$

The velocity of the solution is measured by single frequency ultrasonic interferometer supplied by Mittal enterprises at 2 MHz. The wavelength of the ultrasonic waves in the mixture can be calculated as follows

$$\lambda = 2d/n$$

The velocity of ultrasonic waves in the mixture is given by

$$v = \lambda f$$

3. RESULT AND DISCUSSION

The ultrasonic density, velocity, adiabatic compressibility and intermolecular free length of toluene and ethyl acetate in Polystyrene solution were measured for varying concentrations at 303k, 308k and 313k, it is given in Table 1.The variation of ultrasonic velocity in a solution depends on the intermolecular free length. The increase in ultrasonic velocity decreases the free length as vice-versa

At all compositions, the interaction parameter gives a positive value and indicates the domination of polymer interactions. The measured parameter of ultrasonic velocity u and the derived adiabatic compressibility β and the free length Lf were discussed.

Ultrasonic velocity varies in accordance with molecular interactions in solutions. Fig. 1 & Fig. 2 shows the variation of velocity with concentration of the mixtures.

The increase in ultrasonic velocity and decrease in adiabatic compressibility indicates the hydration behavior of the solute in the solvent. It is reported that the adiabatic compressibility of the solution is found to be less than that of pure solvent due to hydration. The observed values of free length show a decrease with respect to the pure solvent . The decrease of Lf is attributed to the close packing of molecules and that the solute dissolves in the solvent.

Table 1 Values of density, velocity, adiabatic compressability and intermolecular free length

n_3(M)	n_1(M)	Temperature(K)	ρ(kg m^{-3})	C (ms^{-1})	β($N^{-1}M^{-2}$)	L_f x 10^{-9} m
0.096	10.298	303	1.003	1199	6.935	1.6656
	10.320	308	1.005	1196	6.956	1.6681
	10.342	313	1.007	1193	6.977	1.6710
0.194	10.239	303	1.008	1204	6.844	1.6545
	10.250	308	1.009	1202	6.859	1.6565
	10.272	313	1.011	1197	6.903	1.6617
0.243	10.205	303	1.010	1211	6.751	1.6433
	10.227	308	1.012	1205	6.805	1.6499
	10.248	313	1.014	1200	6.849	1.6551
0.292	10.181	303	1.013	1223	6.599	1.6248
	10.203	308	1.015	1209	6.740	1.6419
	10.236	313	1.018	1206	6.754	1.6436
0.341	10.157	303	1.016	1248	6.319	1.5899
	10.168	308	1.017	1237	6.425	1.6032
	10.189	313	1.019	1221	6.582	1.6227
0.393	10.141	303	1.020	1253	6.245	1.5804
	10.173	308	1.023	1249	6.266	1.5832
	10.184	313	1.024	1239	6.355	1.5952

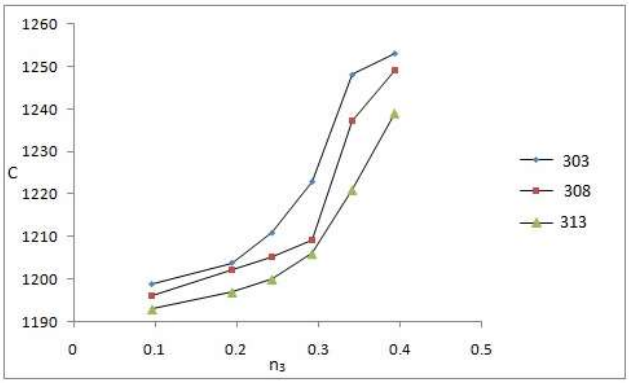

Fig 1 C Vs n_3

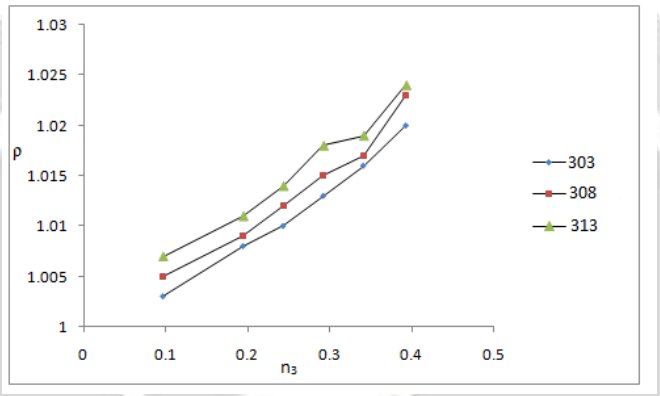

Fig 2 ρ Vs n_3

4. CONCLUSION

In this study, the measurement of ultrasonic velocity and other acoustical parameters of toluene and ethyl acetate in polystyrene solution were studied in different concentrations at 303k, 308k and 313k. The experimental ultrasonic velocity data and other acoustical parameters contain valuable information regarding the solute-solvent interactions in the aqueous solution.

5. REFERENCES

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