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Acoustic and Molecular Interaction Studies of PEG 200 in Benzene

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Abstract

In the present study, an attempt has been made to study the nature of Polypropylene Glycol (PEG 200) in Benzene at 303K. Ultrasonic velocity, density, refractive index and viscosity studies are done for different molar concentrations (0, 0.0245, 0.0627, 0.0912, 0.1308, 0.2863 and 1) of the binary liquid mixture of PEG 200 with benzene. The deviation of viscosity, density, ultrasonic velocity and refractive index are calculated for the binary mixture of PEG 200 + benzene. Also, various molecular interaction parameters like Rao's constant, Wada's constant, Bulk modulus, etc are calculated and discussed in terms of polymer-solvent interaction.

Key words : Molecular interaction, Polyethylene glycol, Refractive Index, Ultrasonic velocity,

INTRODUCTION

Ultrasonic studies are widely used to estimate the acoustical properties and predict the intermolecular interactions of binary mixtures [1]. The ultrasonic velocity is one of those physical properties that help in understanding the nature of liquid state [2]. The measurement of ultrasonic velocity have been employed extensively to detect and assess weak and strong molecular interactions in ternary [3-4] and binary [5-6] mixtures, because mixed solvents find practical applications in many industrial and chemical processes. In the present investigation, ultrasonic velocity, density, refractive index and viscosity studies are done for different molar concentrations of the binary liquid mixture of PEG 200 with benzene. Using these measured values, acoustical and thermodynamic parameters such as Rao's constant, Wada's constant, Bulk modulus and surface tension, etc are calculated and discussed in terms of polymer-solvent interaction. Also the deviation of viscosity, density, ultrasonic velocity and refractive index are calculated for the binary mixture of PEG 200 + benzene.

EXPERIMENTAL DETAILS

The chemicals used for this study (SPECTRA grade) are obtained from Southern India Scientific Company, Trichy, India, and they are used without any further purification. The polymer solutions are prepared by dissolving the polymer in benzene to give different molar concentrations of 0, 0.0245, 0.0627, 0.0912, 0.1308, 0.2863 and 1. The ultrasonic velocity, density and viscosity studies are measured at 303 K by standard procedure as reported by few researchers [6-8]. The refractive index measurements are performed using Abbe refractometer with an accuracy of ±0.001. The temperature of refractometer is maintained by an electronically controlled thermostat. The accuracy in the temperature measurement is ± 0.1 K.

RESULTS AND DISCUSSION

It is observed that viscosity, density and ultrasonic velocity increases with increase in concentration of PEG 200 in benzene [Fig. 1-3]. Molecular association is thus responsible for the observed increase of density, viscosity and ultrasonic velocity in this mixture [7]. Fig. 4 shows the variation of refractive index against concentration for PEG 200 in benzene at 303K. A non-linear variation is observed. The disassociation of molecules is responsible for the observed non linear variation of refractive index in this mixture.

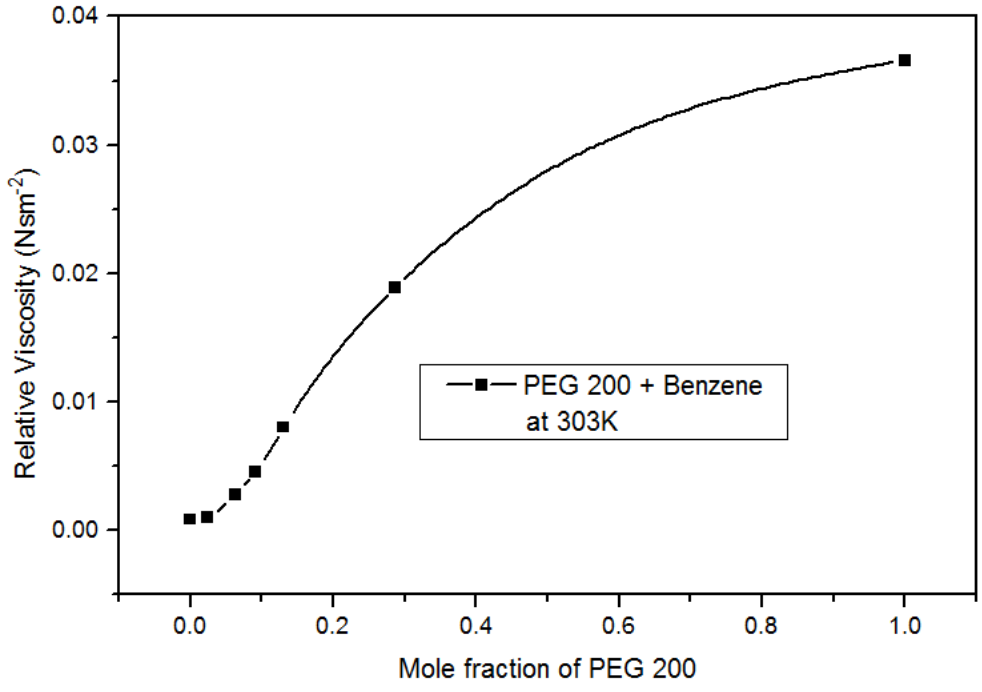

Fig. 1 Variation of relative viscosity against molar concentration

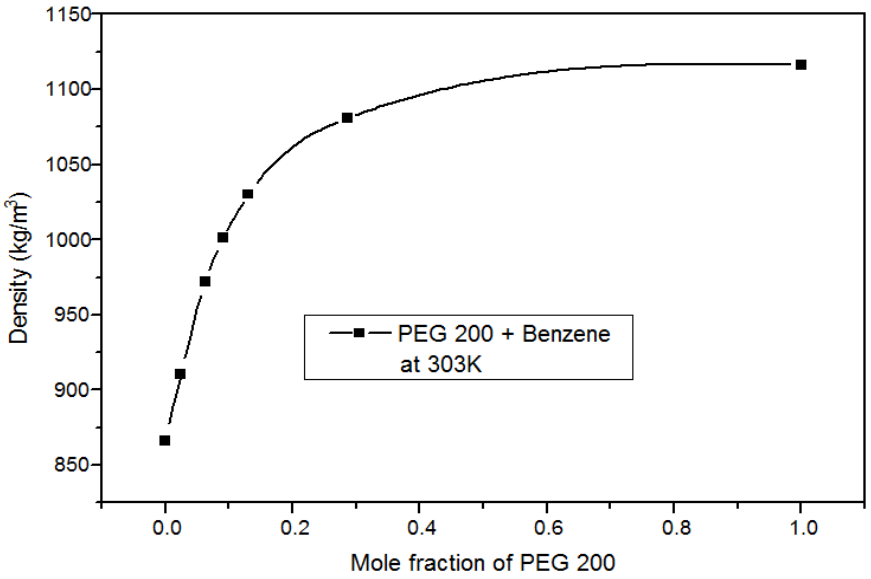

Fig. 2 Variation of density against molar concentration

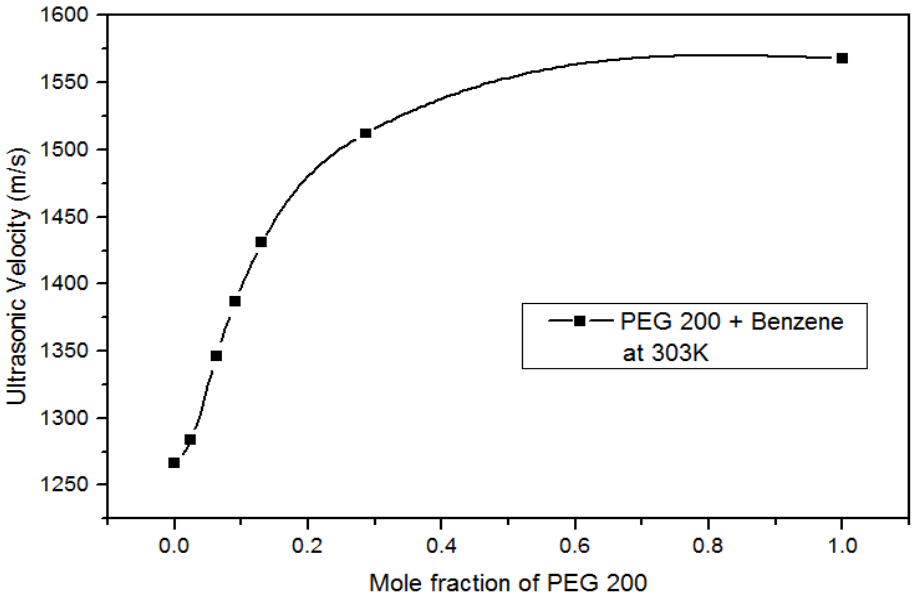

Fig. 3 Variation of ultrasonic velocity against molar concentration

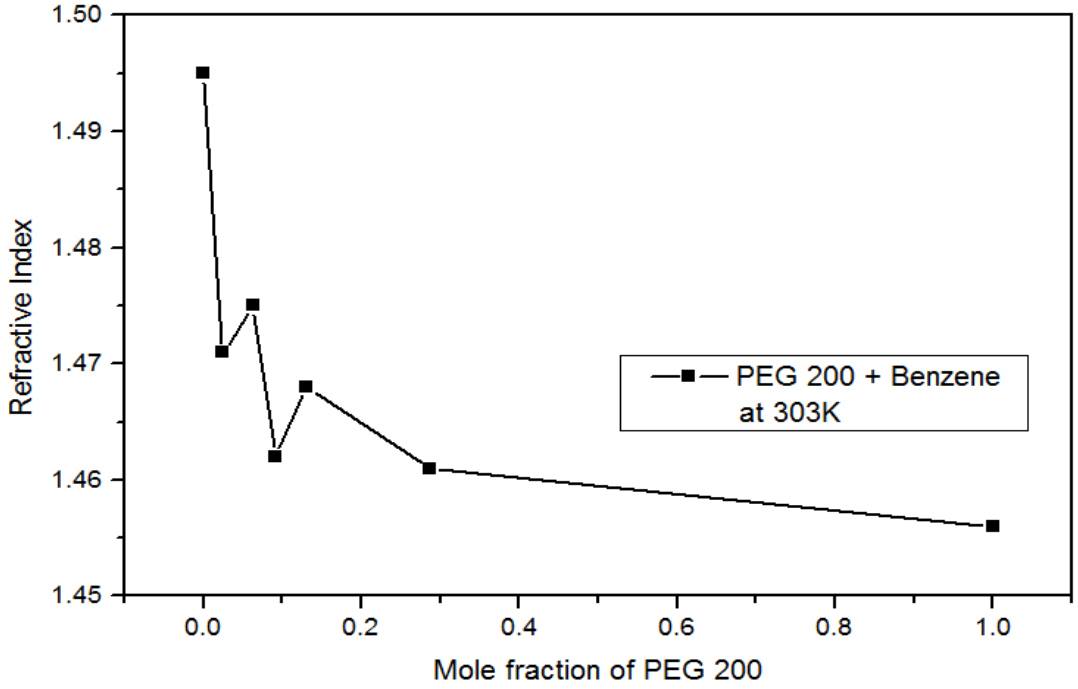

Fig. 4 Variation of refractive index against molar concentration

The deviation of viscosity, density, ultrasonic velocity and refractive index are calculated for the above system. The deviation of viscosity, density and ultrasonic velocity are found to be positive [Fig. 5-7] in the system PEG 200 + benzene. The positive values of deviations indicate that the interactions between binary mixtures are not strong [9].

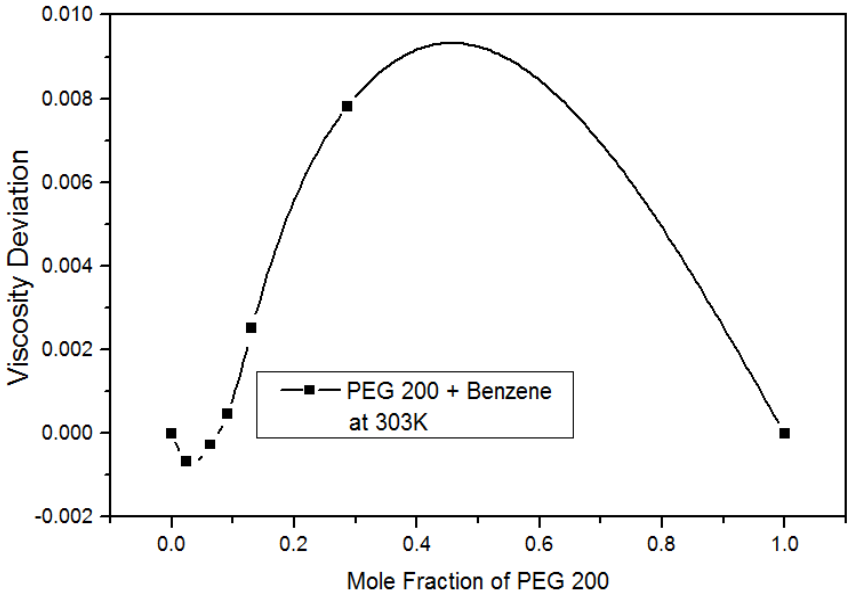

Fig. 5 Variation of viscosity deviation against molar concentration

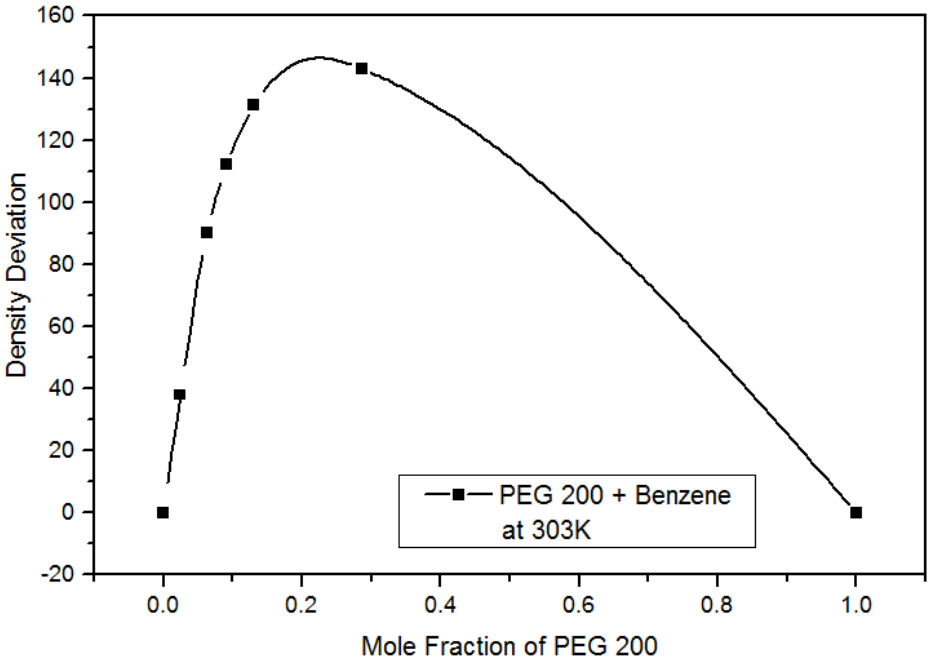

Fig. 6 Variation of Density Deviation against Molar Concentration

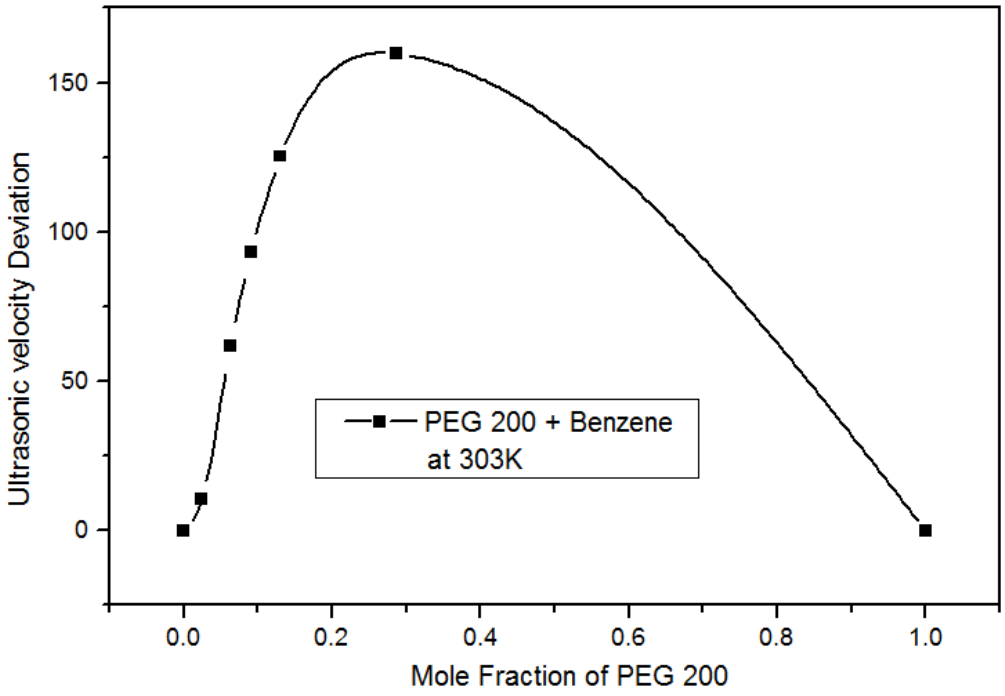

Fig. 7 Variation of ultrasonic velocity deviation against molar concentration

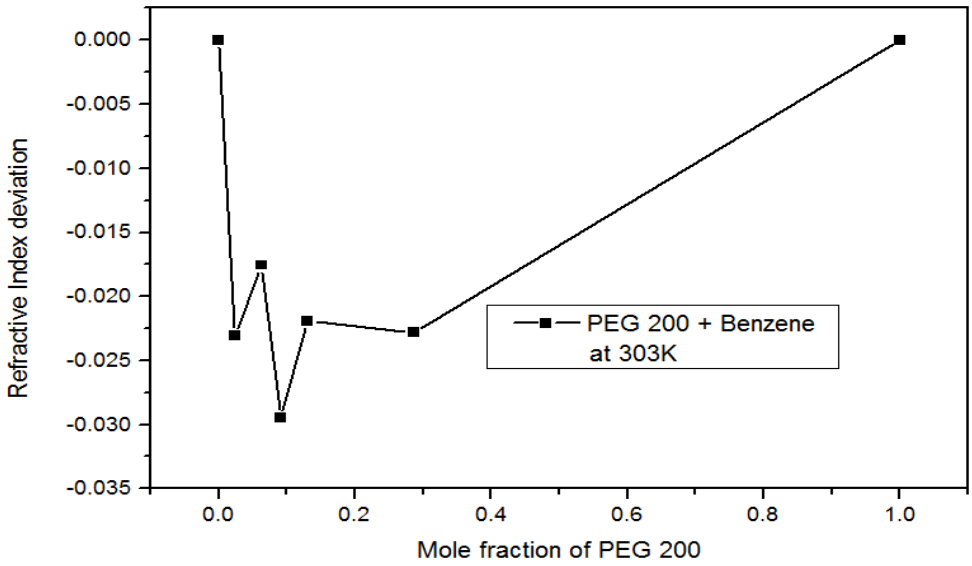

Fig. 8 Variation of refractive index deviation against molar concentration

The variation of refractive index deviation, with the mole fraction of binary system is shown in Fig. 8. A negative peak value refractive index deviation (-0.0294) is observed at 0.0912 mole fraction which indicates that the presence of a strong interaction between binary mixtures.

Molecular Interaction Studies

From Fig. 9 & 10, it is observed that, Rao's constant and Wada's constant increases with increase in concentration of PEG 200 in benzene. This indicates that there is a significant interaction between solute and solvent molecules. It can be taken as an indication for formation of complexes [7].

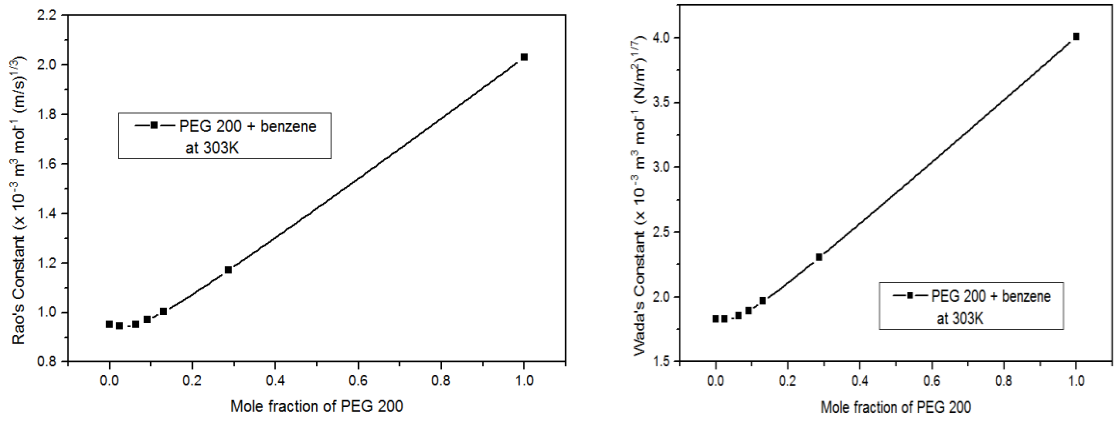

Fig. 9 & 10 Variation of Rao's constant and Wada's constant against Molar concentration

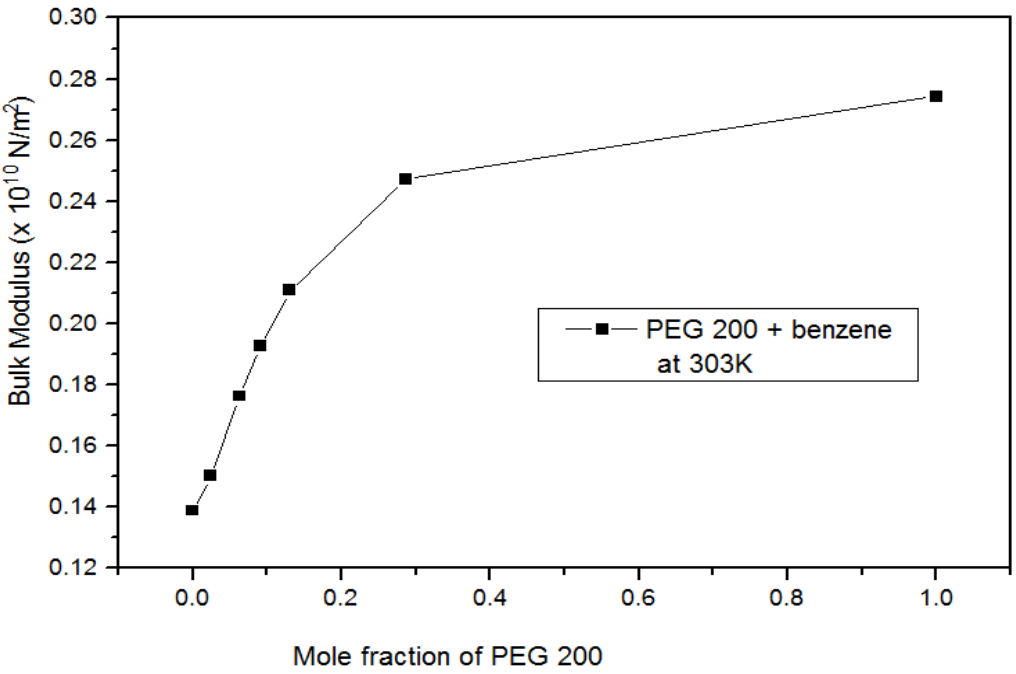

Fig. 11 Variation of Bulk Modulus against Molar Concentration

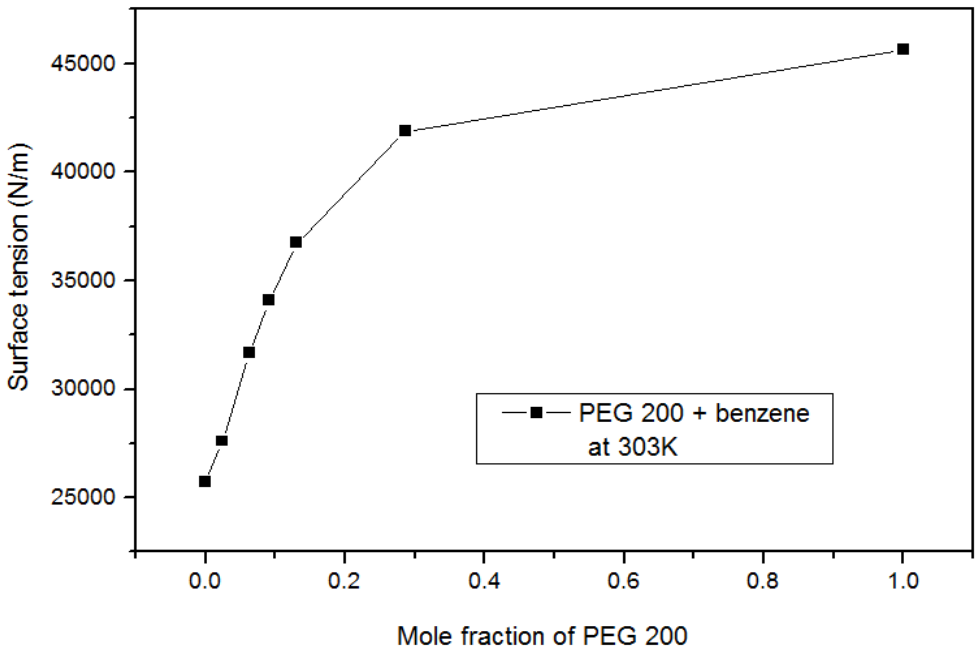

Fig. 12 Variation of Surface tension against Molar Concentration

An increasing trend in the bulk modulus with molar concentration (Fig. 11) is observed in the present study. Bulk modulus determines the compressible nature of a fluid and explains the variation of density when subjected to pressure. Higher values of Bulk modulus indicate that it is difficult to compress the fluid. It is observed that surface tension increases linearly for PEG 200 in benzene at 303K (Fig. 12). Surface tension increases with increase in the concentration for the entire range of system taken for study.

CONCLUSION

In the present investigation, density, viscosity and ultrasonic velocity are studied for the binary liquid mixtures of PEG 200 with benzene of various concentrations at 303K. From these experimental values, the deviation of density, viscosity and velocity and various molecular interaction parameters are determined. Variation of molecular interaction parameters with different concentrations suggested the presence of strong solute-solvent interaction at higher concentration and the effect of concentration is thus analysed.

ACKNOWLEDGMENT

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