International Journal of Materials Science ISSN 0973-4589 Volume 12, Number 2 (2017)

A Study on the Compatibility Nature of Polyblend [PEG/HEC] using Physical Methods

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Abstract

Blending of polymers is one of the simplest methods to obtain a variety of chemical and physical properties from the constituent polymers at a molecular level. During the past few years, researchers have paid considerable attention to the study of polymer blending. A combination of synthetic and natural polymers results in new materials, which have specific properties of synthetic components (good mechanical properties, easy possibilities, low production, and transformation costs) and biocompatibility nature of biopolymers. These blends have already been utilized as biodegradable biomaterials drug delivery systems, membranes, materials for agricultural applications, and so forth. In the present attempt, Polyethylene Glycol (PEG 3350) is blended with Hydroxyethyl cellulose (HEC) in water. The miscibility nature of the poly blend is analyzed by density, viscosity, refractive index and ultrasonic velocity techniques at 303K. Furthermore the compatibility nature of the blend is confirmed by Alfa studies.

Key words : Compatibility, Hydroxyethyl cellulose, Polymer blend, Polyethylene glycol

INTRODUCTION

Usage of blended polymers is the most valuable way to produce new multipurpose materials [1]. During the recent years, researchers have paid extensive attention to the study of blending of polymer [2-4]. A combination of natural and synthetic polymers results in new materials, which have specific properties of synthetic components (easy possibilities, low production and good mechanical properties) and biocompatibility nature of biopolymers [5, 6]. For Polymer-Polymer compatibility investigation, the most useful techniques are thermal analysis [3], electronic microscopy [5] and spectroscopy [6]. HEC is high-molecular-weight polymer D-glucose, produced by different bacterial strains. HEC and its derivatives are used as plasma expanders, bone healing promoters and also for dermal and subcutaneous augmentation and for drug delivery [5]. In the present work, the compatibility nature of PEG / Hydroxyethyl

cellulose blends using additive rule [4], density, Ultrasonic velocity, refractometry and α-studies techniques are studied. These polymers are selected because of their industrial and pharmaceutical applications.

MATERIALS AND EXPERIMENTAL METHODS

Polyethylene Glycol and Hydroxyethyl cellulose are purchased from Sri Ganapathy Scienctific Company, Kanchipuram (India) and both were used without further purification. Double distilled water was used as a solvent. PEG and HEC were separately dissolved in double distilled water to form 1% (w/v) solution. The blends of stock solutions (0/100, 20/80, 40/60, 50/50, 60/40, 80/20 and 100/0) of PEG / HEC are prepared by stirring the mixtures at 303 K for about 30 minutes. Viscosity and density measurements are made at 303 K using Digital Viscometer (BROOKFIELD make) and specific gravity bottle, respectively. The required temperature (303 K) was maintained within ±0.1 K by an electronically controlled thermostat. The ultrasonic velocity measurements are performed using Mittal make single frequency Ultrasonic interferometer at 2 MHz (F-81 model) (uncertainty ± 0.01m/s). Refractive index studies are performed at 303K using Mittal make Abbe Refractometer (uncertainty ± 0.5%).

RESULTS AND DISCUSSIONS

Viscosity studies are done for various blend compositions [0/100, 20/80, 40/60, 50/50, 60/40, 80/20, 100/0] of PEG 3350 / HEC for 1% concentration at 303 K with water as solvent. In the present case, it is observed that the change in the relative viscosity [Fig. 1] is linear and this linear variation shows that the blend is compatible or miscible. For further confirmation additive rule is applied.

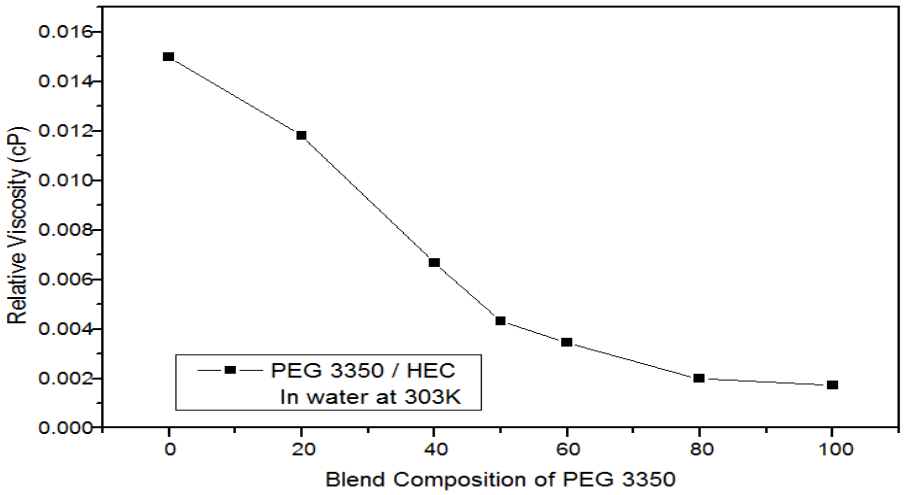

Fig. 1 Variation of Relative viscosity against Blend composition of PEG 3350

Padmanaban et al [7] have recommended viscometric method to study polymer-polymer miscibility. The basic idea of using viscosity as a parameter for compatibility

determination of polymer blends lies in the fact that in solution the repulsive interaction may cause shrinkage of polymer coils resulting in the viscosity of the polymer mixture that is lower than the value calculated from viscosities of the pure components on the assumption of additive law. Researchers [3-4] have used a empirical and semi empirical equations for predicting the miscibility of polymer blends based on viscosity viz., the additive rule, log additive rule, and free volume additive rule. In the case of completely miscible blends, that is 100% miscible blends, the experimental values will be the same as the values calculated from the additive rule of the mixture. When the blend is less than 100% miscible or partially miscible the values predicted from log additive rule of the mixture will be close to the experimental value.

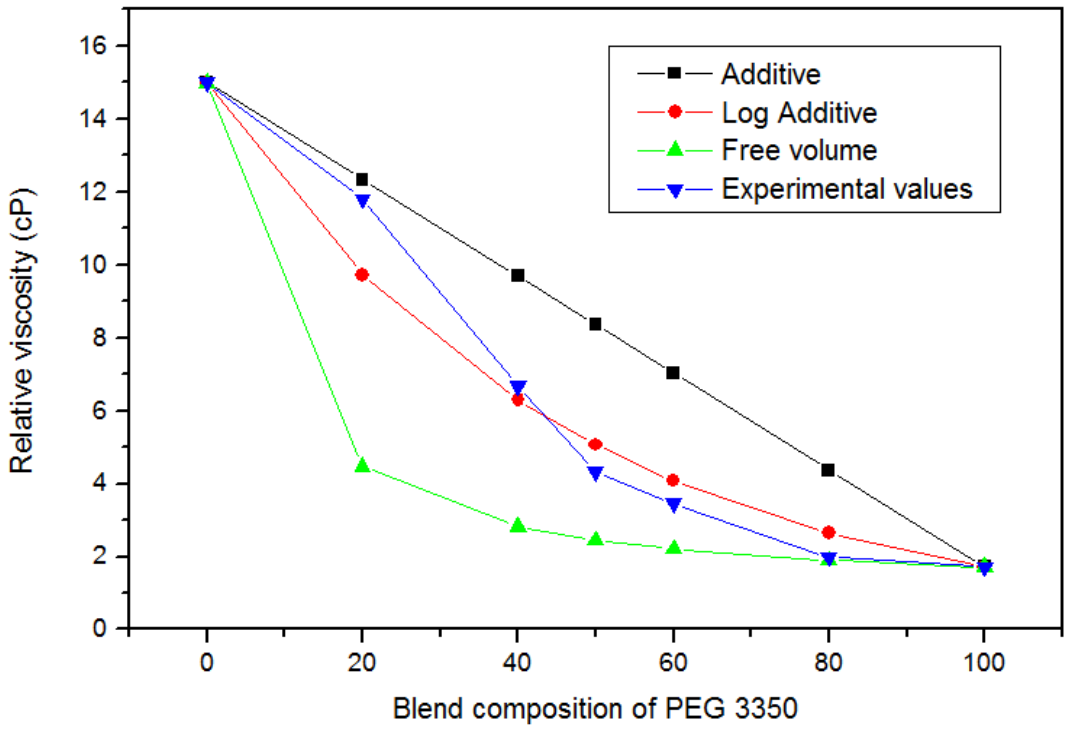

Fig. 2 Variation of Relative viscosity against Blend composition of PEG 3350

From Fig. 2, it is observed that the experimental values are negatively deviated. This may be due to force of attraction between polymers, which in turn causes the macromolecules to expand. This shows that the blend is immiscible for these composition ranges. Hence, it can be understood that the entire region the blend is incompatible. For further confirmation density studies are performed.

Density, ultrasonic velocity and refractive index techniques are play a vital role in determining the compatibility of the polymer blends. Venkatramanan et al [2 & 4] reported that (a) if the variation of density, ultrasonic velocity and refractive index with blend composition is of S -type, the blend is immiscible, (b) if the ultrasound velocity shows a linear relation with blend composition, then the blend is compatible

or miscible and (c) for semi compatible system, the nature of the curve is in between straight line and s-shape. From figures [Fig. 3-5], the variation of density, ultrasonic velocity and refractive index shows the S-type variation and these variations show that the blend is incompatible or immiscible in nature. To confirm further, alpha studies are carried out.

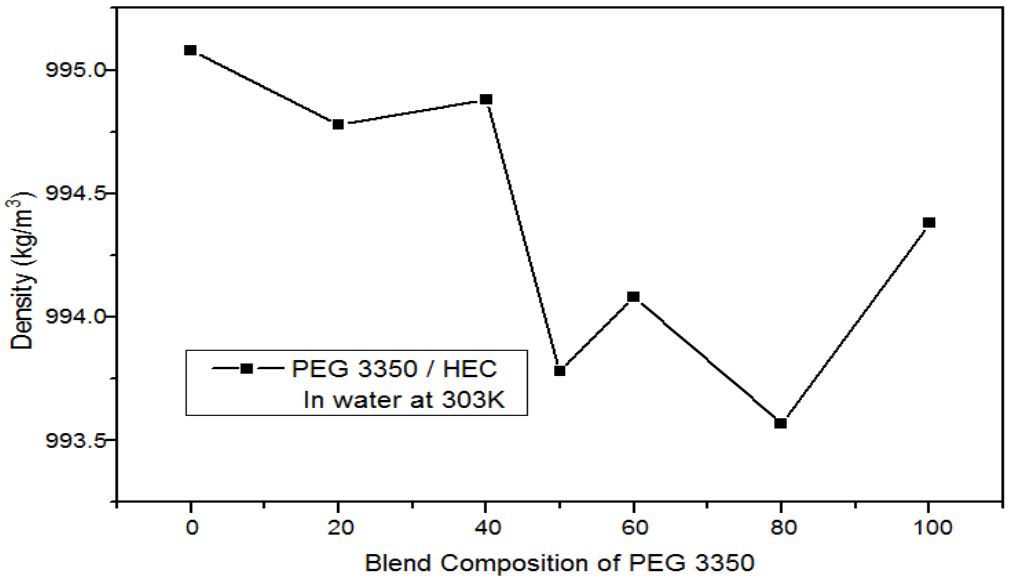

Fig. 3 Variation of Density against Blend composition of PEG 3350

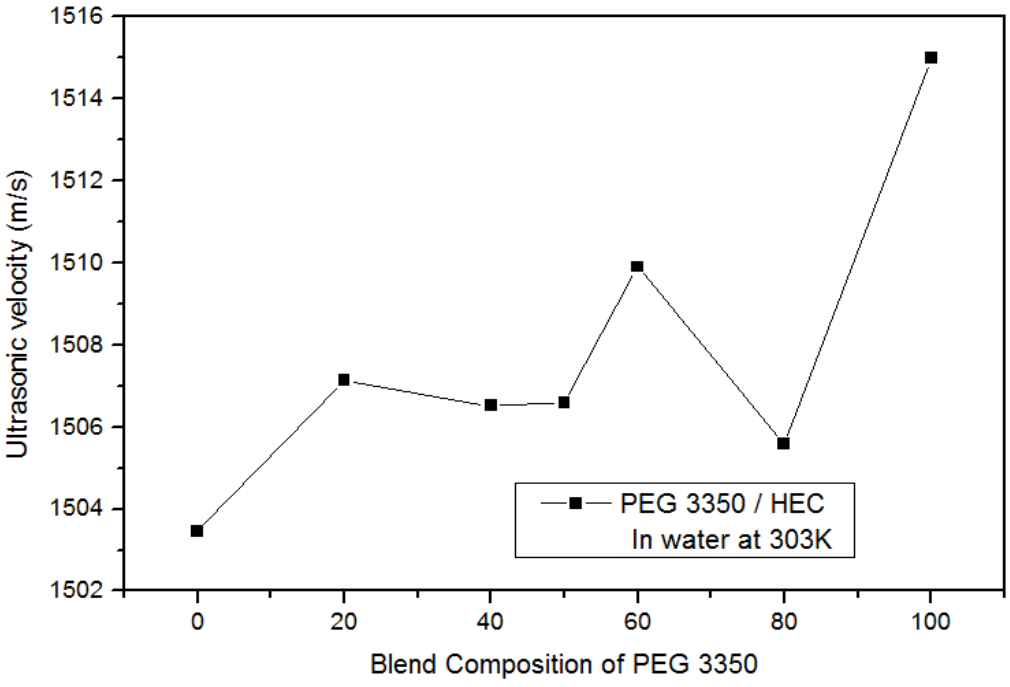

Fig. 4 Variation of Ultrasonic velocity against Blend composition of PEG 3350

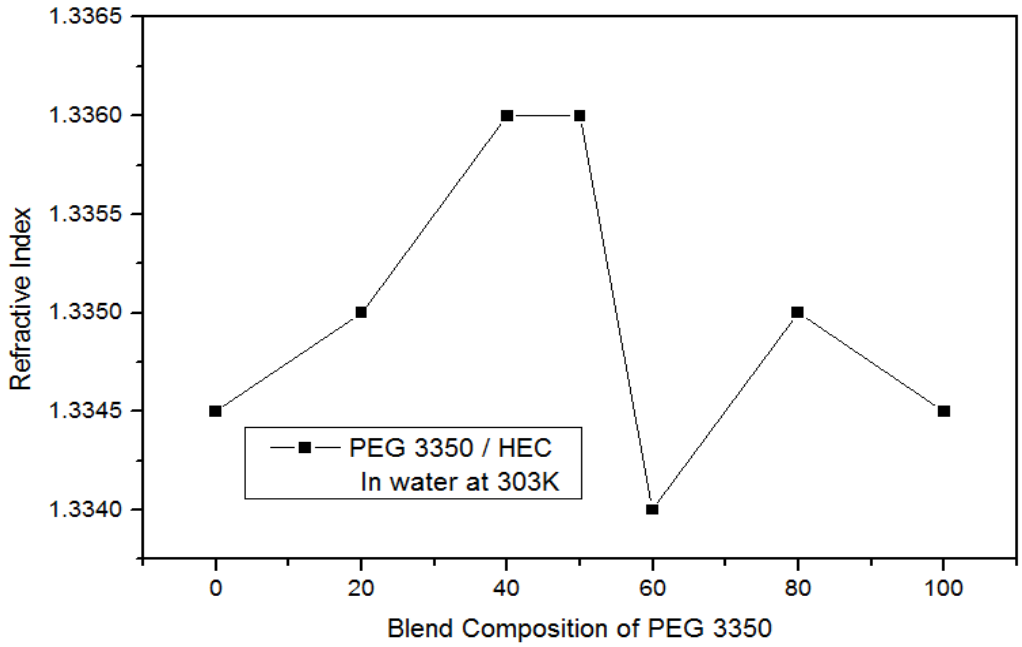

Fig. 5 Variation of Refractive Index against Blend composition of PEG 3350

The interaction parameter α , is based on the long range hydrodynamic interactions for pairs of single molecules, the interaction due to double molecules and their inter molecular attraction, viscosities of double and single molecule species at molecular level, indicating miscibility, depending on attractive or repulsive forces in dilute solution [4]. If $\alpha > 0$ then the system is miscible and immiscible when $\alpha < 0$. In the present case [Table 1], it is observed that $\alpha < 0$ for all the blend compositions. Hence the blend systems are concluded to be immiscible in nature.

Table 1 α- values for PEG 3350 / HEC in water

Blend system	Composition	α -value
PEG 3350 / HEC	0/100	0
	20/80	-2.7233
	40/60	-2.8688
	50/50	-0.2665
	60/40	-0.9716
	80/20	-2.4342
	100/0	0

CONCLUSION

PEG 3350 is blended with HEC in water at 303K and the compatibility nature of the blend has been analysed by various physical methods like viscosity, additive rule, density, ultrasonic velocity, refractive index and α-studies. The blend showed immiscible behavior.

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