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ER AND PS DIFFERENT COEFFICIENT TO USE PHYSICAL PROPERTIES

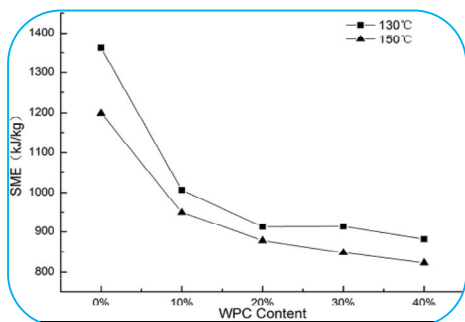
Jayashri B. Mutagar¹ and Dr. J. Sannappa²

¹Asst.Prof Dept.of Physics Hulkoti.

² Professor Kuvempu University, Janasahyadri, Shankarghatta, Karnataka.

ABSTRACT:

Blending of polymers provides an efficient way of developing new materials with tailored properties. and thus has received much attraction from academic and industry. By blending different polymers, several properties can be improved, while retaining some of the original properties. However, the desire of polymer scientists and engineers to produce improved products by blending a particular pair of polymers is often frustrated by their low compatibility. The incompatibility between polymer pairs and their consequently poor phase morphology are responsible for the poor mechanical properties of most polymers blends. As a result, there is a strong need to enhance compatibility, and the compatibilization of polymer blends by the addition of polymer blends by the addition of block or graft copolymer has become an important feature of polymer science and technology.



KEYWORDS: original properties, polymer pairs, academic and industry.

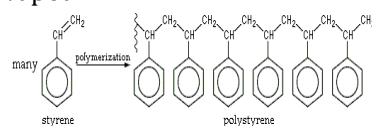
INTRODUCTION

Polystyrene(PS) is a thermoplastic substance, which is in solid (glassy) state at room temperature, but flows if heated above its glass transition temperature (for molding or extrusion), and becomes solid again when it cools off, Pure solid polystyrene is a colourless, hard plastic with limited flexibility. it can be cast into molds with fine detail. Polystyrene can be transparent or can be made to take on various colors. Solid polystyrene is used, for example, In disposable cutlery, plastic models, CD and DVD cases, and

smoke detector housings, Products made from foamed polystyrene are nearly ubiquitous, for example packing materials, insulation and foam drink cups. Polystyrene can be recycled and has the number "6" as its recycling symbol. Polystyrene does not biodegrade, and is often abundant as a form of pollution in the outdoor environment particularly along shores and waterways.

The chemical makeup of polystyrene is a long chain hydrocarbon with every other carbon connected to a phenyl group (the name given to the aromatic ring benzene, when bonded to complex carbon substituent). Polystyrene's chemical formula is $(C_8H_8)_n$; it contains the chemical elements

carbon and hydrogen. because it is an aromatic hydrocarbon, it burns with an orange-yellow flame, giving off soot, as opposed to non-aromatic hydrocarbon polymers such as polyethylene, which burn with a light yellow flame (often with a blue tinge) and no soot. Complete oxidation of polystyrene produces only carbon dioxide and water vapour.



Polystyrene is generally flexible and can come in the form moldable solids or viscous liquids. The force of attraction in polystyrene is mainly due to short range van

der Waals attractions between chains. Since the molecules and long hydrocarbon chains that of thousand of atoms, the total attractive force between the molecules is large. However, when the polymer is heated (or equivalently deformed at a rapid rate, due to a combination of viscoelastic and thermal insulation properties), the chains are able to take on a higher degree of conformation and slide past each other. This intermolecular weakness (versus the high intermolecular strength due to the hydrocarbon backbone) allows the polystyrene chains to slide along each other, rendering the bulk system flexible and stretchable. The ability of the system to be readily deformed above its glass transition temperature allows polystyrene (and thermoplastic polymers in general) to be readily softened and molded with the addition of heat. Polystyrene has been blended with many polymers like natural rubber, polyacrylamide nylon etc.

Resin(RN) exudated from the *Alianthus Malabaricum* is an amorphous aromatic polymer and it is bulkily available in south India. To the best of our knowledge, no attempt has been made to study Polystyrene /Resin (exudation of *Alianthus malabaricum* tree) system so far and is a new system for investigation. It is proposed to carry out an extensive study on this system such as processing characteristics, miscibility and polymer-polymer interaction, stability and mechanical properties.

The sorption and diffusion of benzene through blends of Polystyrene (PS) and Exudated Resin (ER) of varying compositions were studied at 35, 55 and 65 °C by conventional weight – gain experiments. The effects of blend ratio on the diffusion. Sorption and permeation coefficients were determined. The sorption data were used to estimate the activation energies of diffusion and permeation parameters, which were found to show a decrease when the amount of ER of PS was increased. The transport of benzene through most of the blends was anomalous, although at 35 °C the transport of toluene through the 60/40 blend was Fickian and at 35 °C pseudo – Fickian. The enthalpy of sorption of benzene obtained is positive and suggests a Henry's type sorption.

The past decades have witnessed increasing importance of polymer blending since it is possible to obtain desirable properties by simple blending of polymers. Generally, the blending of two or more polymers makes it possible to obtain a material with properties superior to those of individual constituents and thus, be used in application areas that are not possible with either of the constituent polymer blending include impact strength, heat distortion temperature, flame retardancy permeability characteristics, and processability, in addition to cost reduction [1]. The physical properties of polymer blends are controlled generally by many factors such as the nature of polymer [2] blend composition [3-5] and interfacial adhesion [6-12]. The blending of natural rubber not only leads to a reduction in the cost of the compound. It also makes it easier to fabricate complex shapes during production [13, 14]. The presence of solvents in polymers or blends assumes significance since most polymers after swelling in the solvent show a reduction in its properties. Therefore polymers for commercial applications should be chemically resistant and retain their mechanical strength and dimensional stability on contact with solvents. Thus the basic transport phenomenon plays a prominent role in many industrial and engineering applications of polymers [15-20] It has been pointed out the study of diffusion, sorption, and permeation in blend structure provides valuable means for additional characterization of polymer blends [21] Natural rubber, an elastomer has been extensively studied because of its wide usage in tyre production. Since no elastomer has all the characteristics required in many application areas. Elastomers are commonly blended to be improve their performance. Blends of natural rubber have been reported to be compatible with desirable mechanical properties [22-26] Excellent reports exist in the literature on the diffusion and sorption processes in elastomer and their various blends. Thus transport studies have been conducted on natural rubber/epoxidized natural rubber [27] natural rubber/polystyrene [28] nitrile rubber/polypropylene [29] and ethylene – propylene rubber/nylon blends [30] In the presents paper, blends of Polystyrene (PS) and Exudated Resin (ER) of *Ailanthus Malabaricum* have been prepared. The diffusion of benzene, an aromatic solvent, through the blends has been investigated and the mechanism of sorption through the blends was determined. The diffusion, sorption, and permeation coefficients were calculated. Also the effects of blend composition and temperature were studied. The analysis of diffusion of benzene through Polystyrene (PS) and

Exudated Resin blends has not been reported in the scientific literature to pur knowledge. Benzerne, an aromatic solvent generally used in the rubber industry was chosen as the solvent for this investigation.

RESULTS AND DISCUSSION

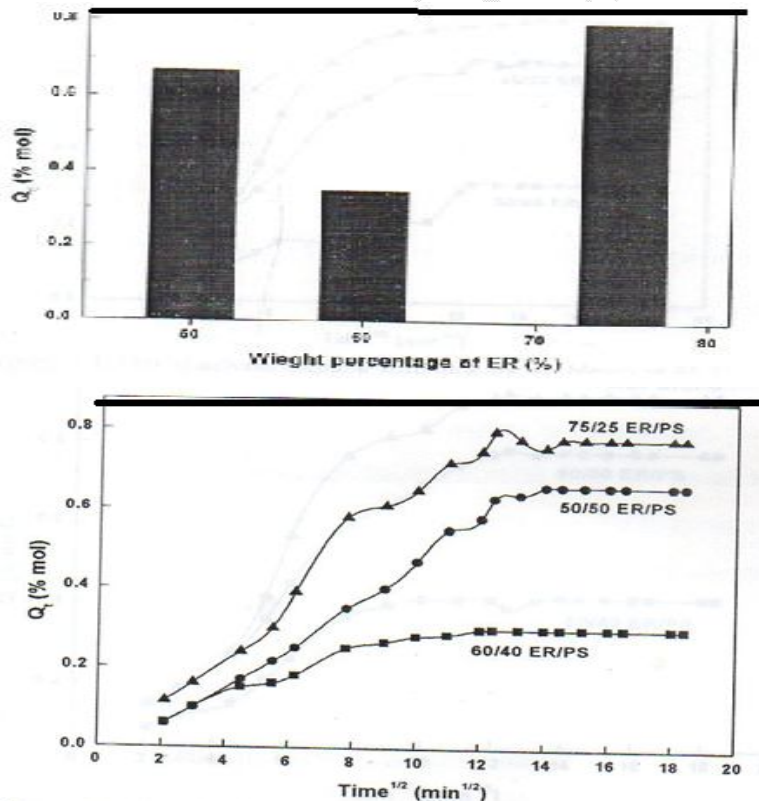
Solvent uptake

The sorption data of toluene into ER/PS blends at different temperatures (35.55, and 65 °C) were determined and expressed as the molar percentage uptake (Q_t) of benzene per gram of ER/PS blends. Q_t was calculated using Equation (1) [34].

$$Q_t = \frac{M_2}{(MW/M_1)} \times 100 \quad (1)$$

where M_2 is the mass of solvent absorbed. MW is the molecular weight of benzene and M is the initial mass of the blend sample.

The molar percentage uptake (Q_t) at any particular temperature was plotted against the square root of time (\sqrt{t}) as shown in figures show initial increases in the mass of benzene absorbed until the maximum absorption was reached at which time, the mass of the absorbed benzene remained constant that is equilibrium absorption was attained. These figures show that at any particular temperature, the 75/25 blend sorbed more benzene than the 50/50 or 60/40 ER/PS blend. The order in the amount of benzene absorbed (Q_t) by the blends at the three temperatures studied is 75/25.50/50.60/40 ER/PS blend.



Diffusion Coefficient (D)

The diffusion coefficient of a solvent molecule through a polymer membrane can be obtained using Fickian's second law of diffusion [35]

$$D = \frac{h^2}{4Q_{\infty}} \left(\frac{dQ}{dt} \right)^2 \quad (2)$$

where h is the blend thickness o is the slope of the initial linear of the plot Q_t against $2\sqrt{t}$ and Q_{∞} is the equilibrium absorption. The D values are given in Table 1 along with other sorption parameters. From Table I and for the ER/PS blends 50/50 and 60/40 the diffusion coefficient (D) was observed to increase with increase in the sorption temperature. However, for the 75/25 ER/PS blend. The diffusion coefficient was observed to decrease at 55 °C but increased again at 65 °C. At the sorption temperatures of 35 °C and 65 °C investigated the order of the diffusion coefficient of the blends (ER/PS) is 75/25.50/50.60/40 However. At 55 °C the order in the values of diffusion coefficient (D) is 50/50.75/25.60/40 ER/PS. From this study no dependence of diffusion coefficient (D) on the amount of ER and PS in the blends was observed.

Sorption Coefficient (S)

The sorption coefficient (S) was calculated using.

$$S = \frac{M_{\infty}}{M_0} \quad (3)$$

where M_{∞} the mass of toluene absorbed at equilibrium and M_0 is the initial mass of the blend. M_{∞} is given as

$$M_{\infty} = Z \times \text{molecular weight of toluene} \quad (4)$$

Where A denotes moles of solvent sorbed at equilibrium swelling. The values of the sorption coefficient (S) are also shown in table 2. Table1 it is evident that the 75/25 ER/PS blend has the highest value of S at all the temperatures investigated while the 60/40 blend has the least value. The order in the variation of S with temperature of investigations for the blends is 75/25 > 50/50 > 60/40 ER/PS. From Table. I also it is clear that as the sorption temperature increased, the values of S also increased for the blends 50/50 and 75/25 (ER/PS) the 60/40 blend (ER/PS) did not show any definite order of S with the sorption temperature. This behaviour was also noted for the diffusion coefficient of the blend.

Permeability Coefficient (P)

The permeability coefficient (P) of toluene in the rubber blends was obtained as follows [35]

$$P = D.S \quad (5)$$

Where D is the diffusion coefficient and S is the sorption coefficient. The values of P are given in Table. 1 the permeability coefficients of the blends 50/50 and 60/40 ER/PS were observed to increase with increases in the sorption temperature. And followed the same trend same trend as the diffusion coefficient (D) It may be inferred that the diffusion process controls the permeability. At the temperatures of 35 and 65 °C studied the observed order in the values of P is 75/25 > 50/50 > 60/40 while at 55 °C the observed order is 50/50 > 75/25 > 60/40. The 75/25 ER/PS Blend showed a decrease in permeability at 55 °C and which later increased at 65 °C This behaviour was also noted for the diffusion coefficient (D) of this blend that is 75/25 ER/PS blend.

Table Sorption properties of the blends with different temperatures.

Temp (°C)	Blend Composition ER/PS	Diffusion Coefficient D (cm ² /min)	Sorption S(%)	Permeation P (cm ² /min)
35	50/50	9.52 x 10 ⁺⁵	15.00x10 ⁺²	14.30x10 ⁺⁶
	60/40	3.86x 10 ⁺⁵	10.30x10 ⁺²	3.98x10 ⁺⁶
	75/25	24.50 x 10 ⁺⁵	17.90x10 ⁺²	43.90x10 ⁺⁶
55	50/50	17.90 x 10 ⁺⁵	16.90x10 ⁺²	30.30x10 ⁺⁶
	60/40	4.20x 10 ⁺⁵	10.00x10 ⁺²	4.20x10 ⁺⁶
	75/25	12.40 x 10 ⁺⁵	18.40x10 ⁺²	22.80x10 ⁺⁶
65	50/50	23.00 x 10 ⁺⁵	20.20x10 ⁺²	46.50x10 ⁺⁶
	60/40	7.78 x 10 ⁺⁵	14.10x10 ⁺²	11.00x10 ⁺⁶
	75/25	45.5 x 10 ⁺⁵	22.90x10 ⁺²	105.60x10 ⁺⁶

Transport mechanism

In order to study the mechanism of transport phenomenon, the sorption data have been fitted into the relation [36]

$$\log\left(\frac{Q_t}{Q_\infty}\right) = \log k + n \log t \quad (6)$$

where Q_t is the swelling quotient at time t , and Q_∞ , the equilibrium swelling. k is a constant which depends on the polymer morphology and the polymer-solvent interaction. The value of n determines the mode of transport of toluene through the rubber blends. For a Fickian transport, $n = 0.5$, when $n = 1.0$, it indicates Case II (relaxation controlled) transport and when n lies between 0.5 and 1.0, it indicates anomalous transport behaviour. The values of n and k were obtained from the plot of $\log(Q_t/Q_\infty)$ against $\log t$ and are shown in Table 2. shows that with the exception of the 60/40ER/PS blends at 35 and 55 °C, the values of n obtained for the different ER/PS blends at different temperatures are non-Fickian and may be described as anomalous. At 55 °C, the transport of toluene through the 60/40 ER/PS blend is best described as Fickian. The value of n obtained for the 60/40ER/PS blends at 35 °C is 0.4, which indicates that the transport of benzene through the blend at 35 °C is either Fickian nor anomalous, and therefore may be regarded as pseudo-Fickian. The values of k were observed to decrease with increase in sorption temperature for the blends 60/40 and 72/25. For 50/50ER/PS blend, the values of k were found to decrease at 55 °C but increased again at 65 °C. The 60/40 ER/PS blend has the highest values of k at all the temperatures studied. The order observed in the variation of k with blend composition (ER/PS) at 35 and 55 °C is 60/40 > 75/25 > 50/50. However at 65 °C the observed order is 60/40.50/50 > 75/25. The value of the constant k obtained in this study for the elastomer blends is an indication of the degree of ER blend - benzene interaction.

Table 2. Values of Equilibrium Benzene Uptake Q_t (mol%) and k for ER/PS blend at different temperatures

Temp (°C)	Blend Composition ER/PS	Q_t (mol%)	n	k
35	50/50	0.620	0.6	0.0485
	60/40	0.370	0.4	0.0952
	75/25	0.260	0.6	0.0584
55	50/50	0.660	0.9	0.0247
	60/40	0.360	0.5	0.0850
	75/25	0.780	0.7	0.0535
65	50/50	0.790	0.7	0.0433
	60/40	0.490	0.6	0.0610
	75/25	0.920	0.8	0.0289

Activation Parameters

The temperature dependence of transport properties was used to evaluate the activation energy for the diffusion and permeation processes using the Arrhenius relation [37]

$$\log X = \log X_0 - (E_x/2.303RT) \quad \text{_____} \quad (7)$$

Where X represents either D or P, X_0 is a constant representing either D_0 or P_0 , E_x is either E_D or E_p . Plots of X against $1/T$ were used to calculate the activation parameters of diffusion (E_D) and permeation (E_p). Values of E_D and E_p are presented in Table 3. From Table 3 it is seen that as the amount of PS decreased in the blend, the values of E_D and E_p also decreased, and vice-versa. Conversely, as the amount of ER increased in the blend the values of E_D and E_p also decreased and vice-versa. Generally the direction of increase of E_D and E_p value indicates the direction of increasing solvent resistance of the blends. And vice versa. In essence therefore, and in agreement with our earlier observation on the molar percentage uptake (Qt) of benzene by different blend compositions. The 75/25 blend is least resistant to benzene sorption. The heat of sorption, ΔH_s , was calculated using the relation.

$$\Delta H_s = E_p - E_D \quad \text{_____} \quad (8)$$

The values of ΔH_s obtained are included in Table 3. The order in the variation of ΔH_s with blend compositions is 75/25 > 50/50 > 60/40 ER/PS. The variation of ΔH_s with blend compositions was within ± 2.0 . The positive ΔH_s values obtained in the study for the blends suggest that sorption in this study is dominated by Henry's type sorption with an endothermic contribution.

Table 3. Values of activation energies of diffusion (E_D) Permeation (E_p) and heat of solution (H_s) for various ER/PS blends.

Blend compositions ER/PS	E_D (kJ/mol)	E_p (kJ/mol)	ΔH_s (kJ/mol)
50/50	12.45	33.38	7.93
60/40	17.33	24.67	7.34
75/25	10.24	18.82	8.58

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