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A STUDY ON NYLON-66/ABS BLENDS PREPARED BY PHYSICAL BLENDING

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ABSTRACT

Engineering plastics are expanding their applications in the immerging world replacing metal components and reducing weight and amongst most two of them are selected to study their blending behavior. Nylon-66(N-66) and Acrylonitrile butadiene styrene (ABS) co- polymer were blended in basic conventional manner i.e. simple physical melt blending in various proportions. The reason for blending both the polymers is to study their morphology, miscibility and compatibility of blends at various ratios. Blends were studied for mechanical properties i.e. tensile strength, flexural strength, izod impact strength, etc. Blend with optimized level of mechanical property was studied for thermal properties by differential scanning calorimeter (DSC) and thermo gravimetric analysis (TGA). The morphology was studied by scanning electron microscopy (SEM).

Key words: *Polymer blends, physical blending, Nylon-66, ABS.*

INTRODUCTION

The polymer blends which is completely miscible to give a homogeneous single phase exhibit excellent properties and proportional to the ratio of two polymeric components [1-2]. For immiscible and incompatible blends, since their interfacial tension is higher and the interface between them is very sharp, the thickness of their interfacial layer is very small [3]. Quality of a polymer blend depend upon the type of disperses phases, adhesion and cohesion between the phases and the morphology of the system [4-7]. Molecular miscibility and compatibility are two important properties of polymeric components [8-11]. However simple blends of immiscible polymers generally exhibit poor mechanical properties that stem from the unfavourable interactions between their molecular segments. This is manifested as a coarse, unstable phase morphology that develops during melt processing and weak interfaces between the phases in the solid states.

Interest in blends of Nylon-66 with ABS stems from the possibility of combining the desirable characteristics of both of these materials. Blends of N-66 with ABS materials are of significant commercial interest. Nylon-66 provide good strength, stiffness and resistance to non-polar Nylon-66olvents, whereas ABS materials provide toughness and low cost. Although simple blends of Nylon-66 and ABS exhibit poor mechanical properties, their properties can be greatly improved, often with synergistic effects, through appropriate compatibilization. [12]

Nylon-66 (N-66) being a versatile engineering plastic lacks some properties like difficulty in processing, moisture absorption, dimensional instability, sharp melting, lower impact which decreases its area of applications. But it gives superior tensile strength, self lubrication, wear resistance. At this juncture blending with ABS can lead to overcome the limitation and widening the application of Nylon-66. As the chemical resistance of both the polymers is appreciably good they can also be used in biomedical implants, e.g. knee caps; limbs [13-14].

As Nylon-66 and ABS both are leading engineering material used in various applications and up to a certain extent have replaced metals too. Although they have good structural, chemical and mechanical properties, they both tend to have few disadvantages individually.

Most of the work performed was focused on Nylon-6 and its blend with other polymeric materials. The basic reason for the same is the ease of processing Nylon-6 with other polymers as compared to Nylon-66. Nylon-6 having lower processing temperature compared to Nylon-66 allows better control over processing of the material.

Our work deals with the blending of Nylon-66 and ABS in various proportions to study the miscibility between the two polymers and the properties. The blends of Nylon-66and ABS are then studied for various mechanical properties, thermal properties, and chemical properties [15-16].

MATERIALS AND METHODS

Materials Used:

Nylon-66(N-66) – Dupont, Grade – Zytel – EPL-02-2E-30
ABS – Bayer ABS Ltd., Grade – Absolac – 300

Blending Process

As known both Nylon-66 and ABS are hydrophilic in nature and tend to absorb atmospheric moisture. Thus to remove the humidity both the polymers were preheated up to 90ºC for 6 hrs. The preheated material was then weighed in various blend ratios from 5 parts of ABS to 60 parts of ABS in Nylon-66. The blending was done using pelletizer at the processing temperature of material having higher processing temperature. The blends are extruded as strands in cut to form granules. The granules are dried off as were passed through water for cooling. The formed granules are preheated before they can be moulded in the Injection Moulding Machine to form test specimens for tensile, flexural and impact strength.

The blends were tested for mechanical properties as tensile strength, tensile modulus, % elongation [ASTM D 638]; flexural strength, flexural modulus [ASTM D 790]; izod impact strength [ASTM D 265]; Rockwell hardness [ASTM D 758]; water absorption [ASTM D 570]; Flame resistance [ASTM D 635] and electrical properties [ASTM D 6257], [17-19]. From all the above properties, the optimized blend ratio was obtained

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and its thermal properties were studied using differential scanning calorimeter (DSC), make – Perkin Elmer; model – Pyris 1 and thermo gravimetric analysis (TGA), make – Perkin Elmer; model – Pyris 1. The phase morphology of the optimized blend ratio of was studied using the scanning electron microscopy (SEM) make – Philips, Netherlands; model – ESEM EDAX XL 30.

RESULTS AND DISCUSSION

The mechanical properties of Nylon-66/ABS blends from 5 parts to 60 parts of ABS measured are tensile strength, % elongation, tensile modulus, flexural strength, flexural modulus, izod impact strength and rockwell hardness as shown in fig. 1-7. In all the graphs we can see a similar sort of trend. The Tensile strength, flexural strength, izod impact strength and Rockwell hardness increase up to 30 parts of ABS and then tends to decrease (Fig.1,.4, 6,.7). A constant increase was observed in tensile modulus and flexural modulus (Fig. 3, 5), whereas there is a constant decrease in % elongation (Fig. 2).

Fig. 8(a-c) shows water absorption of various blend ratios under different conditions. Off all the three graphs it can be clearly interoperated that as the proportion of ABS increases in the blend the amount of water absorption tends to decrease. As the properties of blends were best observed at 30 parts of ABS in Nylon-66 it is further tested for electrical properties i.e. volume and surface resistivity (Table - 1).

Table - 1 values of volume resistivity and surface resistivity 30 parts of ABS in N-66/ABS blends.

Sample	Volume Resistance Ohm/mm	Surface Resistance Ohm
30 parts of ABS in N-66/ABS blend	34×10^{13}	54×10^{11}

The thermal behaviour was studied for the blend composition which has showed most enhanced performance of all the blend compositions. The best enhancement was obtained in 30 parts of ABS in Nylon 66 blend. The DSC and TGA of blend are shown in Figs. 9 and 11 respectively. Both thermal studies show the behaviour of blend without using any aid for the enhancement of the blend compatibility. DSC and TGA are used as references when studying the effect of different aid for improving the blend compatibility.

Scanning electron micrograph (Fig. 11) reveals the morphological characteristics of the blends. The N-66 forms the continuous phase in which the ABS spheres are well dispersed. The dispersed ABS phase has least compatibility when there is less interphase miscibility.

CONCLUSION

The main purpose is to study behaviour of Nylon 66 when ABS is incorporated by blending in various ratios from 5 parts to 60 parts by just physical blending without any sort of aid for enhancing blend compatibility. The behaviour of the blend was studied using Tensile Strength, % Elongation, Tensile Modulus, Flexural Strength, Flexural Modulus, Izod Impact Strength, Rockwell Hardness, Water Absorption and Flame Resistance. The major properties like Tensile Strength, Flexural Strength Izod Impact Strength and Rockwell Hardness were maximum in 30 parts of ABS in Nylon 66 blend. An increasing trend was observed in all the above three properties measured up to 30 parts of ABS in Nylon 66 then the properties starts to decrease. In other properties which were measured the overall enhancement was observed in 30 parts of ABS in Nylon 66.

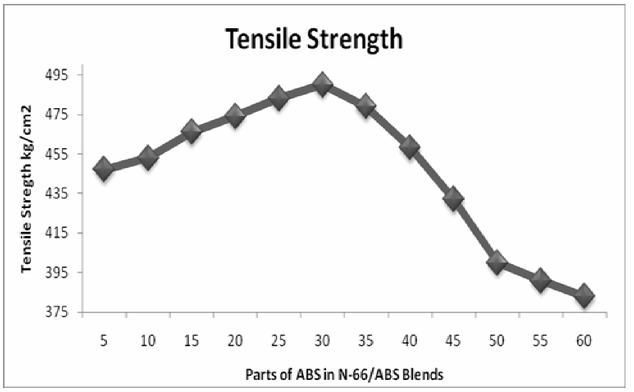

Fig. 1: Tensile Strength of N-66/ABS blends.

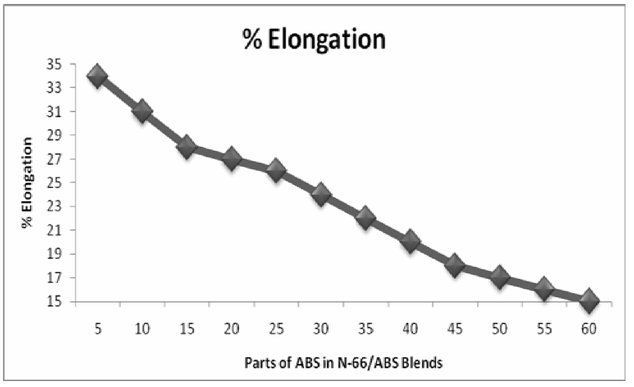

Fig. 2: % Elongation of N-66/ABS blends.

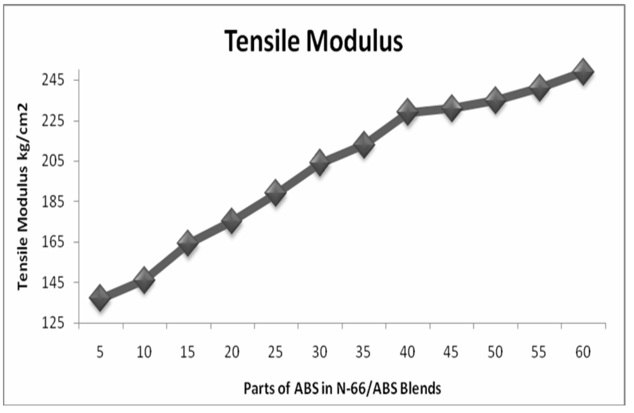

Fig. 3: Tensile Modulus of N-66/ABS blends.

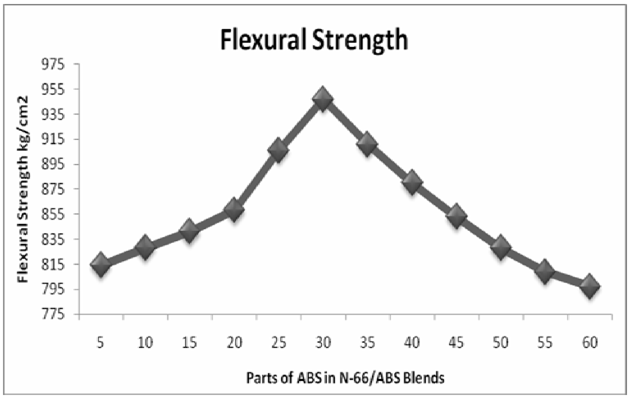

Fig. 4: Flexural strength of N-66/ABS blends.

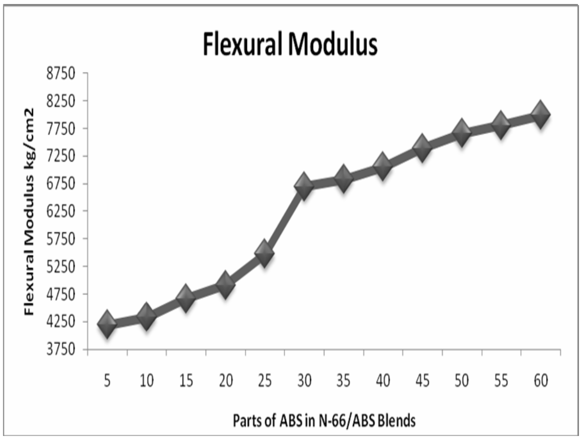

Fig. 5: Flexural modulus of N-66/ABS blends.

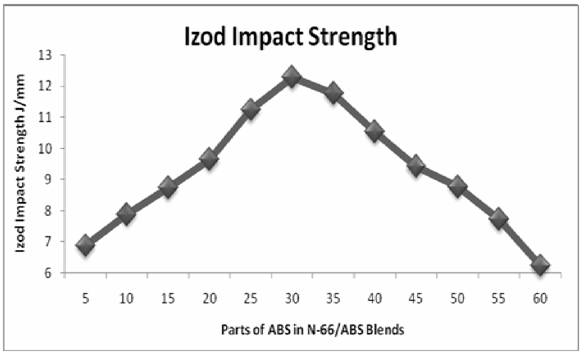

Fig. 6: Izod impact strength of N-66/ABS blends.

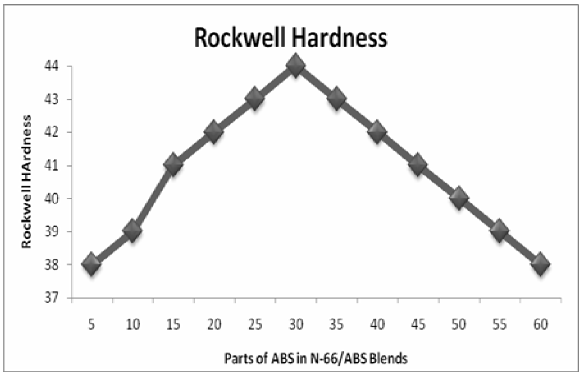

Fig. 7: Rockwell hardness of N-66/ABS blends.

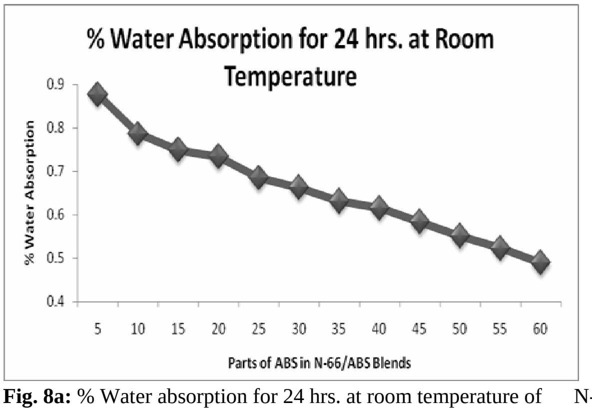

Fig. 8a: % Water absorption for 24 hrs. at room temperature of N-66/ABS blends.

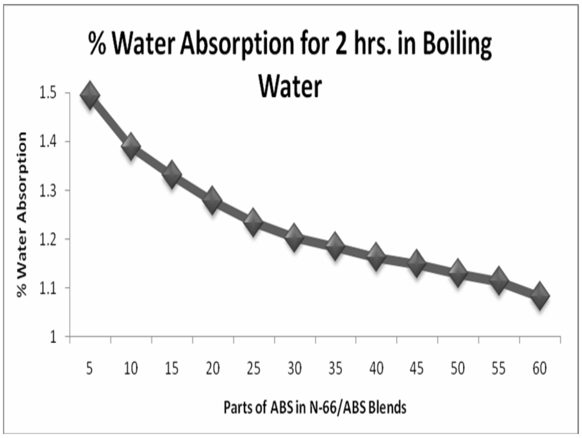

Fig. 8b: % Water absorption for 2 hrs. in boiling water of N-66/ ABS blends.

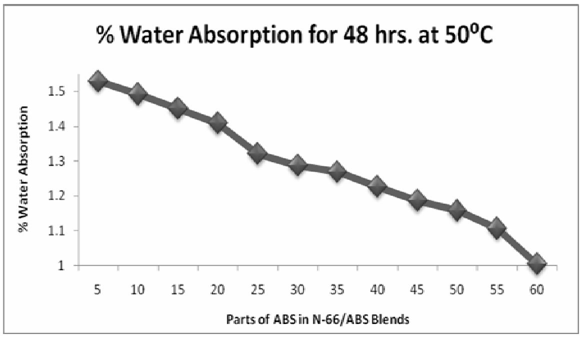

Fig. 8c: % Water absorption for 48 hrs. at 50 C of N-66/ABS blends.

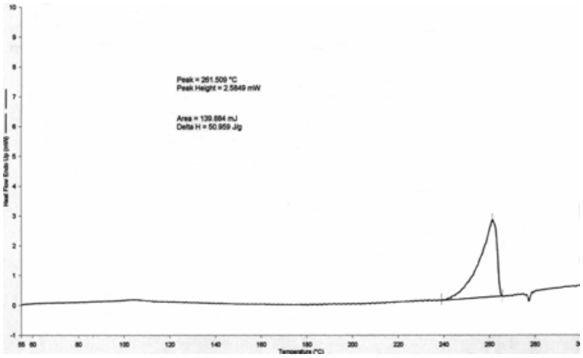

Fig. 9 DSC of 30 parts of ABS in N-66/ABS blend.

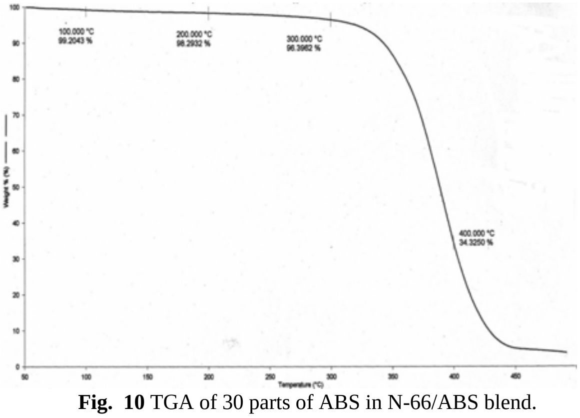

Fig. 10 TGA of 30 parts of ABS in N-66/ABS blend.

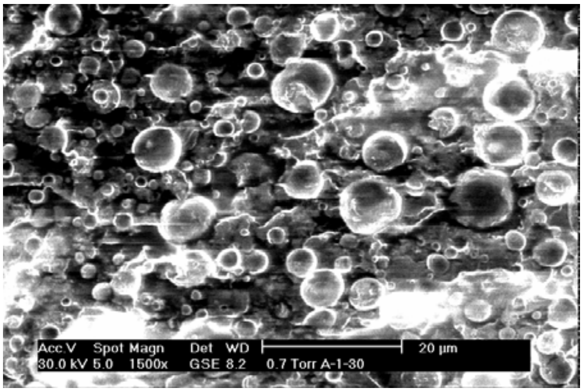

Fig. 11 SEM of 30 parts of ABS in N-66/ABS blend.

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