Mechanical and Thermal Properties of Nylon 66/Flyash Composites: Effect of Flyash

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Abstract - In the current study, the effect of flyash (FA) on the physic-mechanical, electrical, thermal and morphological behavior of nylon-66 (PA) was investigated. PA/FA composites were prepared by melt mixing via twin screw ex- truder, with varying weight percent (5 wt %, 10 wt %, 15 wt % and 20 wt %) of flyash. The results of composites were optimized and compared with vir- gin nylon-66. Mechanical and electrical properties of composites improved up to 10 wt% of FA loading without compromising the properties. The fly- ash filled nylon-66 composites showed a low abrasive wear rate. Increase the heat distortion temperature of composites with an increase in weight percent of flyash while opposing the melt flow rate. Flyash filler enhances the stiffness of plastics but significantly reduces the impact properties. Dis- persion of flyash was examined by impact fracture surface of composites using a scanning electron microscope.

KeyWords:Nylon66,Flyash,Composites,Voids,Morphology

1.INTRODUCTION

Presently around the world huge amount of industrial 'coal ash' waste is entity discharged from the thermal pow- er plant. Many problems such as dumping sites and rising costs of its disposal have made it difficult to manage. For this motive, a range of methods to supportively use coal ash has been upward [1]. This a promising way to reuse flyash in the plastic industry, as plastic products are fre- quently compounded with flyash as an inorganic filler [2,3]

2. Body of Paper

The materials were prepared in a hot air oven at 80 °C for 8 hours. Using the manual-based injection molding machine (M/s R. H. Windsor India Ltd.) fitted with mould containing cavity. After molding, ejections from the mould samples were packed in a dedicator. Moulding parameters were same for the all the formulations and temperatures set in zone 1 (260 °C), zone 2 (275 °C), and zone 1 (280 °C). Schematic presentations for mixing and sample preparation are shown in Figure 1.

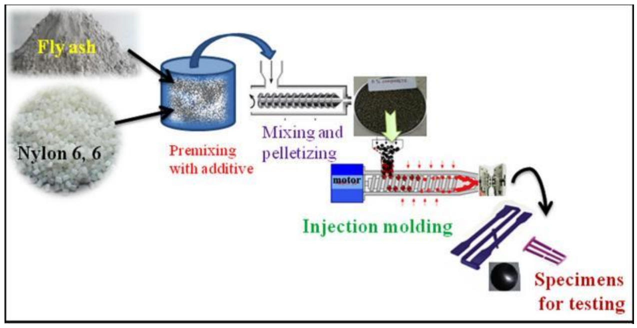

Figure 1. A schematic presentation of the procedure for mixing and specimen preparation

2.3.1 Mechanical Properties

The tensile strength of nylon-66 and its composite were calculated as per the ASTM D 638 test method using a Universal Testing Machine (Instron-3382 UK) with a crosshead scan speed of 10 mm/min. Dumbbell-shaped specimens with a dimension of (165 × 12.7 × 3) mm3 were subjected to the tensile strength measurement. An average of five samples were taken for each analysis and reported. The flexural strength and modulus of compos- ites were analyzed as per the ASTM D790 method, using UTM (Instron-3382 UK). The specimens of the dimension(172 × 12.7 × 3) mm3 with the three-point bending mode at 100 mm span length and crosshead speed 2.0 mm/min.

The impact strength of the composite was determined according to ASTM D256 using an impact strength tester (Tinius Olsean, USA) and notch cutter. The specimen of di- mension (65 × 12.7 × 3) mm3 and 2.54 deep standard V-notch was impressed on each sample. The unit of impact strength is J/m. The shore D hardness was determined as per ASTM D 2240 on the specimen with a thickness of 3 mm.

2.3.2 Abrasive Wear Rate

Abrasive wear analysis of nylon-66 and its composites were studied using an abrasion wear (M/s Taber Model 530 Abrader) testing machine. The test was conducted using the disc shape specimen of 100 mm diameter and 3 mm thickness. The sample was held against the rotating platform and gripped at a constant load of 4.9 N for 15 minutes and the sample weights before and after the tests are noted. Materials of higher wear resistance will have a lower volume loss. The test was conducted using a cal- ibrated CS-10 wheel. The Taber wear index is evaluated using Equation (4) [14]:

$$\text{Wear index} = \frac{(\text{initial weight} - \text{final weight})}{\text{time of test cycle}} \times 1000$$

where, the initial and final weights of samples are in grams, and the time of the test cycle is in minutes.

Sample code	Flyash (< 38 μm) (%)	Theoretical density (Td) (g/cc)	Experimental density (Ed) (g/cc)	Void content (%)	Water absorption (%)
PA	00	...	1.135	...	1.70
PA/FA-1	05	1.164	1.158	0.502	1.40
PA/FA-2	10	1.194	1.187	0.559	1.41
PA/FA-3	15	1.226	1.207	1.561	1.43
PA/FA-4	20	1.259	1.235	1.973	1.48

3. CONCLUSIONS

The different weight percent of nylon-66/flyash composites were prepared by the melt mixing method. The higher loading of flyash notably decreased the tensile strength and flexural strength whereas modulus increased. The incorporation of flyash into nylon-66 shows higher dielectric properties. The impact strength of composites decreased whereas the hardness was increased up to 10 wt% compared to virgin polymer. Abrasive wear analysis shows that flyash reduces the material deletion rate of composites. Owing to the improved polymer filler inter- action established by the water uptake behavior. However, the water tendency was higher at a higher wt% of flyash. This was attributed to the poor physical interface between the filler and the matrix due to clusters formed. Increase heat distortion temperature of composites with an increase in weight percent of flyash whereas opposing the melt flow rate. Fracture surface morphology shows the interac- tion between matrix with the filler at this loading. Overall results found that flyash acts as reinforcement in the poly- mer matrix.

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