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POLYPROPYLENE REINFORCED WITH RECYCLE POLYETHYLENE TEREPHTHALATE AS AN ALTERNATIVE MATERIAL FOR NEW PLASTIC PRODUCT

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Abstract

Polyethylene Terephthalate (PET) is one of the most important fibers for industrial application. High performance, low cost, and recyclables are the most attractive candidates for high strength fibers. This paper presents the best ratio of Polypropylene (PP) reinforced with recycle PET fiber, as an alternative material for new plastic product. It gives the high strength of Polypropylene reinforced with recycle PET fiber. PP was mixed with recycle PP fiber utilising the plastic mixer and injection mold machine. The samples were cut according to ASTM standard and tested by using universal testing equipment. The analyses were carried out by using 0% ~ 10% volume compositions of recycle PP fiber. The acquired results indicate that the composition of PP gives higher ultimate tensile strength. It can be seen that the strength of PP increases in the presence of PET. It reduces the manufacturing cost and uses as an alternative material to PP for industrial application.

KEYWORDS: Genuine polypropylene, polyethylene terephthalate fiber, alternative material, ultimate tensile strength.

Introduction

Plastic is a great development found by the researcher and also the manufacturer, engineer or others in terms of plastic value in the industry because of very high demands in markets. There are many types of plastic. In order to consider the cost to produce one product and the quality of the product by the manufacturer, choosing what type of plastic is very important. Polyethylene terephthalate (PET) is one of the most important fibres for industrial production. Due to its high performance, low cost, and recyclability, it is one of the most attractive candidates for high strength fibres [1]. Recently, the recycling of polymers such as PET after use is attracting the attention of many researches aware of environmental problems and wishing to find ways to save earth resources [2]. However, the largest use of PET today is in containers. In this area, beverage bottles are number one. Thus, PET is the star of plastics recycling. In 1995, 1.2 million tons of container PET was recycled, but market demand was 1.8 million tons. One-half of containers go to landfill and incineration [3]. On the other hand, fibre reinforced polymer composites are very attractive because of their ease of fabrication, economy and superior mechanical properties [4]. The effect of fibre content on the mechanical properties of polymer composites is of particular interest and significance. It is often observed that the increase in fibre content leads to an increase in the strength and modulus [5] and [6].

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In the present work, polypropylene (PP) composites reinforced with recycled-PET fibre were prepared by extrusion compounding and injection moulding techniques. Extrusion compounding and injection moulding processes are frequently employed to make polymer composites [7]. PolyPropylene(PP) was chosen since it is part of the group of commodity thermoplastics produced in large quantities and is frequently used reinforced with glass fibres or talc. The mechanical properties of these composites were investigated by tensile strength.

Materials and methods

Material Preparations

Recycle PET flakes were obtained from Greenland Recycle Centre Sdn. Bhd. It was cleaned with the hot water 100°C to remove dirt, residue and other contaminated material. Then, it was crushed to fibre using crusher machine.

Mixing Process

The composition of recycle PET fiber and PP was mixed by using volume measuring container.Recycle PET fiber were mixed with PP pallet according to its volume composition which is

- 0% recycle PET fiber, 100% PP
- 3% recycle PET fiber, 93% PP
- 5% recycle PET fiber, 95% PP
- 7% recycle PET fiber, 93% PP
- 10% recycle PET fiber, 90% PP

The mixing process was mixed by using XS Series TvMbler Mixer.

Specimens preparation

Specimens were produced by using injection mold machine according to the composition been decided. The specimen is prepared based on ASTM D618, for tensile test. The mixed materials were feed into hopper of injection mould. In order to ensure the mixing material is melt, the machine screw extruder is heated to 195°C. The injection parameters were chosen in basis of the PP supplier recommendations. Then, each specimen is tested using tensile test machine. The specimen geometry is width = 19 mm, overall length = 150 mm and thickness = 3 mm

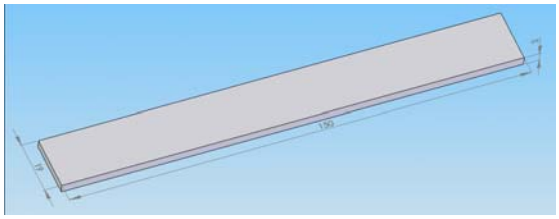

Figure 1: ASTM standard Specimen

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Tensile Test

The specimens tensile strength were analysed by using tensile test instrument (Instron Tensile Test Machine. The tensile properties were determined using three samples for each composition.. The constant cross speed used is 10mm/min. Data obtained as in table 1.

Results and Discussion

Recycle PET fiber was mixed with PP in the volume composition of 0% to 10%. The tensile properties were determined using three samples for each composition to study the effect of recycle PET fiber volume composition to tensile properties. The results of the tensile tests performed with the recycle PET fiber and the pure PP are shown in Table 1. It is observed that the addition of recycle PET in PP does not change significantly the PP tensile strength, increasing that value in 9.8% for the composite with 7% of recycle PET. Figure 2 shows that the presence of recycle PET in PP will increase tensile strength of composite material.

Table 1: Tensile test strength for each of specimen.

Specimen	Volume composition		Maximum Stress (MPa)	Maximum Strain (mm/mm)	Maximum Strain %
	Recycle PET (%)	PP (%)			
1	0	100	27.52	0.0937	9.37
2	3	97	27.89	0.1027	10.27
3	5	95	29.91	0.1162	11.62
4	7	93	30.04	0.1217	12.17
5	10	90	28.91	0.1089	10.89

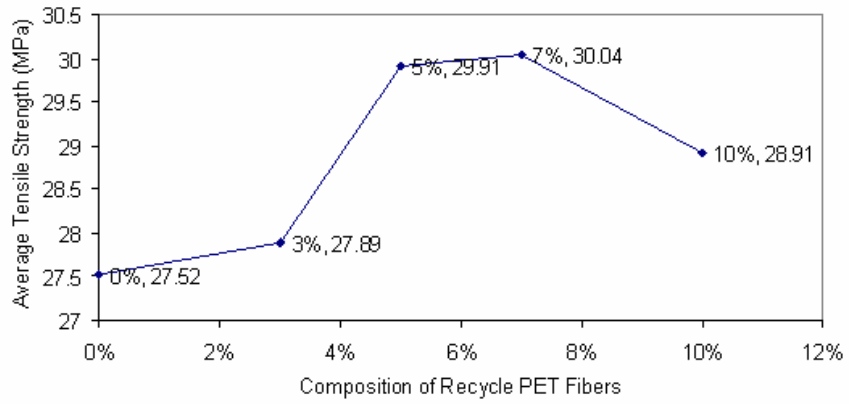

Figure 2: Effects on Tensile Strength in Different Composition of Recycle PET Fibers

Figure 3 shows the presence of recycle PET fibers influence the maximum load. The graph shows the maximum load increases gradually until the composition of 7% recycle PET, with maximum load 1.712 kN. But, at 10 % recycle PET fiber, the maximum load is drop down to

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3.7%. It's happened due to the increases of PET fibre dramatically decreases the strength of material and be more brittle.

Table 3 shows the result of elongation . It shows the elongation has increased gradually from 8% to 12.17%. . Reinforcing PP with recycle PET fiber shows the tendency to increase the ductility of composite material. The higher value of elongation shows that the material is more ductile. This shows that recycle PET fibers has influencing the ductility of composite material but at maximum level of 7% recycle PET. The reason of limited ductility is due to the tendency for the extension of the voids perpendicularly to an axial stress.[1] The presence of recycle PET in a PP matrix can be an efficient way to recycle PET, increasing significantly the mechanical properties of the PP.

Table 2 : Load displacement for each specimen

Specimen	Volume composition		Maximum Load (kN)	Maximum Displacement (mm)
	Recycle PET (%)	PP (%)		
1	0	100	1.568	6.561
2	3	97	1.589	7.189
3	5	95	1.705	8.133
4	7	93	1.712	8.522
5	10	90	1.648	7.622

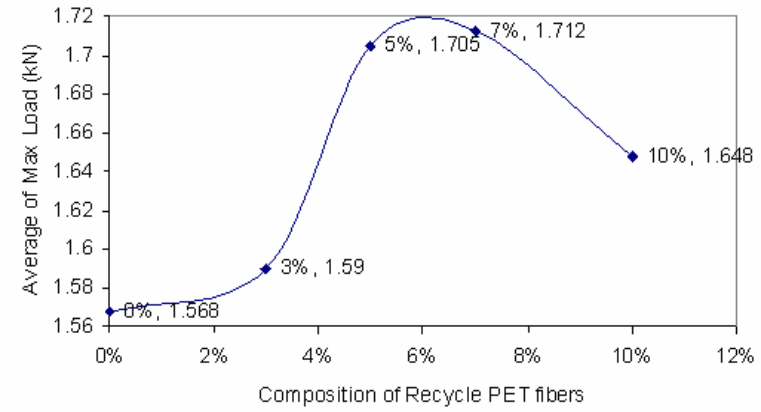

Figure 3: Effects on Maximum Load in Different Composition of Recycle PET Fibers

Table 3: Average data of Elongation Volume / fiber content

Volume fiber content		Average Elongation (%)
Recycle PET (%)	PP(%)	
0	100	9.373
3	97	10.27
5	95	11.62
7	93	12.17
10	90	10.89

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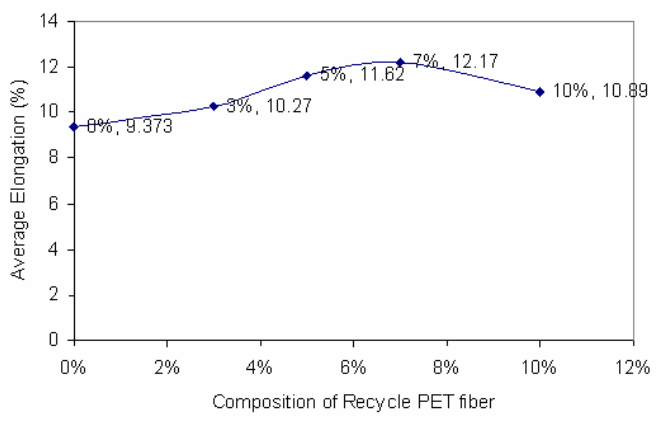

Figure 4: Effects on Elongation in Different Composition of Recycle PET Fibers

Conclusion

The main objective of this study is to find the best ratio of Polypropylene and recycle PET fiber based on the highest tensile strength of the specimen. The specimens were divided into 5 groups of volume compositions. This study shows that recycle PET fiber has plays a role to improve the tensile properties of the mixing product, where from the experiment it was found that specimen has improved in its tensile strength properties at certain composition of recycle PET fiber. The presence of 7% recycle PET fiber has contributed tensile strength increased to 30.04Mpa, with 9.8% compared to the genuine PP. As a conclusion PET can improve the mechanical properties of composites if it is present only in a small amount.

It is suggested future analysis should be improved by adding the experiments such as dynamic mechanical test (charpy test) and failure characterisation by using SEM. Apart of that the researcher should find a method to make the composite better homogenization of the fibre distribution in the matrix.

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