Tensile Properties of Hybrid Sugar Palm/Kenaf Fibre Reinforced Polypropylene Composites

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Abstract. Study on hybridization of two types of natural fibres reinforced thermoplastic composites was an alternative option in research on natural composites. This paper presents the investigation on tensile properties of combining sugar palm and kenaf fibres reinforced polypropylene composites. The hybrid composites were prepared with different amounts of fibres (i.e. 10%, 20% and 30% by weight percent) while the ratios between sugar palm and kenaf fibre are 30:70, 50:50 and 70:30. The composites have been fabricated using melt mixer technique and followed by compression molding process. The specimens were cut according ASTM Standard D638 for conducting the tensile testing. The results shown that tensile strength of composites tend to decreased when the content of loading fibres increased. Among the composites with different ratios, the hybrid composites that contain more kenaf fibres exhibit the higher value in tensile strength than the composites that contain more sugar palm fibres.

Introduction

Natural fibres have been used as reinforcing components in thermoplastic composites due to their advantages such as cheap and environmentally friendly material comparing with glass synthetic fibres. During past decades, many investigations have been conducted by researchers in polymer composites on the reinforcement role of many types of natural fibres like jute, kenaf, flax, hemp, sisal, pineapple leaf, banana, coir, wood, and so on [1-3]. The use applications of natural fibre composites are very wide such as automotive parts, aerospace components, sporting goods and building industry. This is due to the excellence performances of these materials such as light-weight, good strength, free formability and resistance to corrosion [4].

However, these materials have a lot of drawbacks in several aspects therefore they are not able to fulfill the need of demand in its applications. Caused by hydrophilic behavior, natural fibres show lack of compatibility with the hydrophobic polymers. Then, the loads are not full enough transferred between fibre and matrix when the composites used as structural materials. Usually, this weakness is handled by conducting chemically treatment on fibres to improve the compatibility [5-7].

Hybrid composites refer to the combining two or more reinforcing and filling component materials in one matrix with objective to get the better properties than the single one [8]. Common hybrid composites reinforced with natural fibres are combining with synthetic fibres such as glass because they can demonstrate good mechanical performance [9, 10]. However, hybrid composites that prepared by two types of natural fibres as reinforcing agents still face many challenges. The researchers target is to achieve the best utilization of the positive attributes of one fibre and to have been get full attention due to reduce its negative attributes as far as practicable. Some other reasons are to impart fancy effect, reduce cost of the end product, and find out suitable admixture of natural origin to mitigate the gap between demand and supply [11]. Combining sisal and oil palm fibres [12], hemp and kenaf fibre [13], and kenaf and pineapple leaf fibre [14] are some examples of studies of hybrid composites reinforced by two types of natural fibres. This paper reports the investigation on the tensile properties of hybrid sugar palm fibre with kenaf fibre reinforced polypropylene composites.

Materials and Methods

Materials. The materials that used in this study were kenaf fibres, sugar palm fibres and polypropylene (PP). Kenaf fibres were obtained from KEFI Kelantan while sugar palm fibres were obtained from Pahang, Malaysia. Polypropylene pellet was supplied by Petrochemical (M) Sdn Bhd, Pasir Gudang, Johor, Malaysia.

Preparation of Hybrid Composites. Kenaf and sugar palm fibres were crushed using pulverissette machine until final form as short fibre with 0.1-0.5 mm size. Compounding of short sugar palm fibres, kenaf fibres and PP matrix was carried out using a melt mixer (Brabender Plasticorder intensive mixer model PL2000-6) according compositions as shown in Table 1. The mixing temperature and screw speed were set at 170 C and 50 rpm respectively. PP was charged into the chamber and melted (3 min) before dried short mixture fibres were added. The mixing process of short mix fibres and PP took place for about 15 min.

Table 1 Composition of hybrid composites

Hybrid composites	*PP (%wt.)*	*Kenaf (%wt.)*	*Sugar Palm (%wt.)*	*Total (%wt.)*
P100K0S0	100	0	0	100
P90K3S7	90	3	7	100
P90K5S5	90	5	5	100
P90K7S3	90	7	3	100
P80K5S15	80	5	15	100
P80K10S10	80	10	10	100
P80K15S5	80	15	5	100
P70K10S20	70	10	20	100
P70K15S15	70	15	15	100
P70K20S10	70	20	10	100

Compression moulding. The melt-compounded mixture obtained from the previous process was placed in the compression mould (Carver hot press) heated at a temperature of 170 °C and endured the process of preheating for 5 min. Heating was carried out for 5 min followed by cooling for further 5 min. The specimens for the mechanical tests were obtained from these sheets of composites.

Tensile testing. All tensile test specimens were cut into dogbone shape. The tests were conducted following the ASTM D638 type IV using Instron universal testing machine (model 5569). A load cell of 10 kN and a crosshead speed of 5 mm/min were used in these tests. For each type of composites, six specimens were tested to failure and were used in calculating the average tensile value.

Results and Discussion

Figure 1 shows the average values of tensile strengths of various hybrid composites. It can be seen that all the hybrid composites show the lower value than the pure PP one. While the percentages of fibres in composites increase, it makes the tensile strength decrease. This result indicates that the decrease of tensile strength values resulted from the weak fibre-matrix interface as a result of differing polarities of the hydrophilic natural fibres and hydrophobic PP polymer matrix. The same behavior also shown by some researchers' work result [15,16], especially for untreated composites. The interesting finding was appearing for the value of tensile strength of the different ratio between kenaf and sugar palm fibre. For every group of percentage fibre, the composites that contain more kenaf fibre show the highest value of tensile strength. It was logic; caused by the individual tensile strength of kenaf fibre was higher than the sugar palm fibre [17].

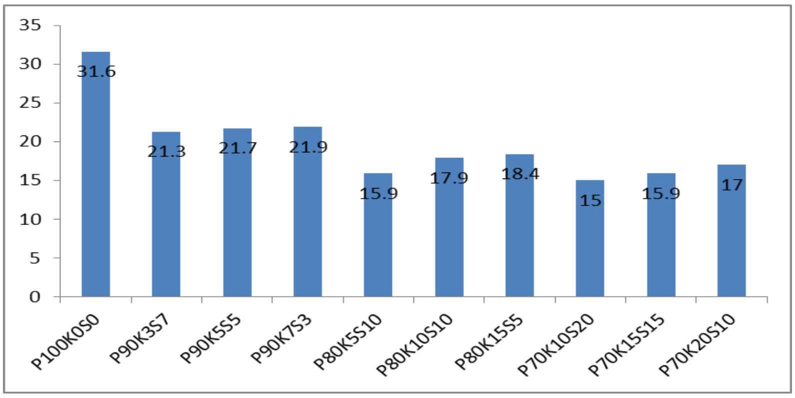

Fig. 1: Tensile strength of hybrid composites (in MPa)

Figure 2 and Figure 3 show the values of tensile modulus and elongation at break for hybrid composites. Tensile modulus indicates the stiffness of materials. The result also shows the higher value for all type of hybrid composites compare to pure PP one, except for P80K5S10 specimen. While the elongation at break indicates the capability of hybrid composites to resist change of shape without crack formation.

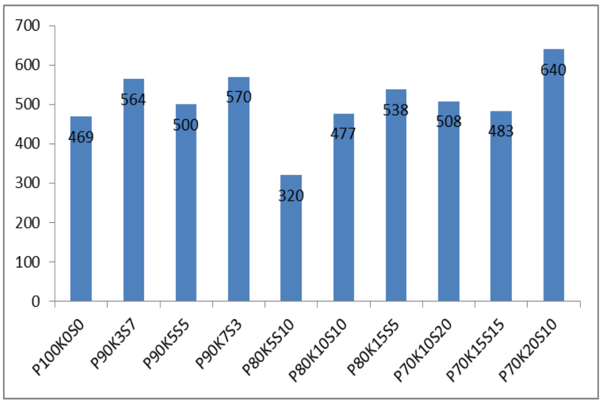

Fig. 2: Tensile modulus of hybrid composites (in MPa)

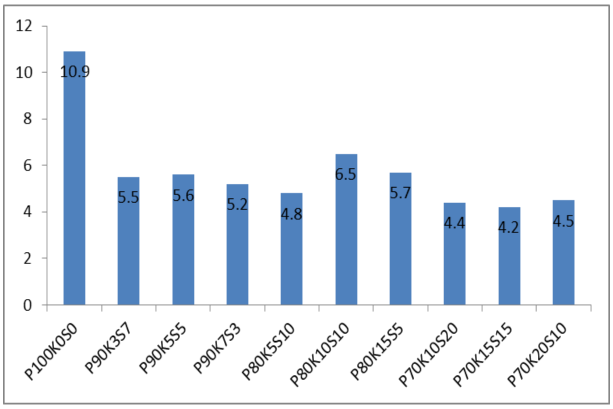

Fig. 3: Elongation at Break of hybrid composites (in %)

Conclusion

The objectives of this study were to determine tensile properties of hybrid sugar palm/kenaf fibre reinforced polypropylene composites. It was concluded that tensile strength of composites tend to decreased when the content of loading fibres increased. Among the composites with different ratios, the hybrid composites that contain more kenaf fibres exhibit the higher value in tensile strength than the composites that contain more sugar palm fibres. Generally, the stiffness of hybrid composites were higher than the pure PP and the capability of hybrid composites to withstand the shape before break were less than pure PP.

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