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Fabrication of Human hair and Polypropylene and Evaluation of Tensile Strength

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ABSTRACT: *Due to increase in population, natural wealth is being exploited to a large extent as an alternative to synthetic materials. Due to this, the use of natural fibres for the reinforcement of the composites has received growing attention. Over the years, composite materials, plastics and ceramics have been the dominant emerging materials due to their low cost, fairly good mechanical properties and high aspect strength. Contemporary composite materials constitute a considerable proportion of the engineered materials market ranging from everyday products to sophisticated niche applications. Present effort has been undertaken to study the effect of human hair fibre mixed with polypropylene. Experiments were conducted with various percentages of human hair fibre such as 3%, 5%, 8% in polypropylene using Injection moulding process. Each amalgamation of proportions is tested for their mechanical properties. I t was found that Polypropylene and hair fibre polymer reinforced composite have superior flexural and impact strength than Polypropylene alone and has inferior tensile strength than simple polypropylene.*

I. Introduction

The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper. (10). Now-a-days, natural fibres reinforced composites perform superior mechanical properties such as tensile strength, compressive strength, hardness etc. Polymer may be classified as Thermoplastic and Thermoset which provides reinforcement to the natural fibre. Polypropylene (PP), also known as polypropene, is a thermoplastic polymer, made by the chemical industry and used in a wide variety of applications, including packaging, textiles (e.g. ropes, thermal underwear and carpets), stationary, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components, and polymer banknotes. An addition polymer made from the monomer propylene, it is rugged and unusually resistant to many chemical solvents, bases and acids.

In recent years, polypropylene composites have been proposed as an alternative to traditional polypropylene matrix composites for a wide range of applications. In our daily life, we find its uses in the form of various house wares. Food containers made of polypropylene are of superior quality and can be safely washed in a dishwasher. It is also used for making cans and syrup bottles that are required for food packaging [1-2].

The hair fibre is composed of keratin and having alpha helix structure. The actual composites of hair are carbon, oxygen, hydrogen, nitrogen and sulphur with their percentages of 45.68%, 27.9%, 15.72%, 5.03% respectively. Natural fibre provides many advantages such as high toughness, biodegradability, good strength properties, low cost. Now mentioning disadvantages in case of cellulose fibre provide poor resistance to moisture, large diameter with finite length introduces a challenge to use of it with advanced composites. The main physical proprieties of the hair depend mostly on its geometry; the physical and mechanical properties of hair involve characteristics to improve: elasticity, smoothness, volume, shine, and softness. Human hair is strong in tension; hence it can be used as a fibre reinforcement material. Hair Fibre (HF) an alternate non-degradable matter is available in abundance and at a very cheap cost. Hair is used as a fibre reinforcing material in concrete for the various reasons such as it has a high tensile strength which is equal to that of a copper wire with similar diameter. Hair, a non-degradable matter is creating an environmental problem so its use as a fibre reinforcing material can minimize the problem [3-5].

The main objective of the present work is based on the fabrication of composite of human hair with 3%, 5% and 8% in polypropylene. Thereafter, the evaluation of mechanical property as tensile strength of fabricated specimen is also the part of this study.

II. Fabrication and Experimentation

To fabricate the composites of human hair and polypropylene according to the weight fraction of reinforcements, we used Injection moulding machine. The descriptions of machine are given in Fig 1. The composites of different weight fraction are as follows:

1. 15gm human hair and 485gm polypropylene (that is 3% human hair and 97% polypropylene composite).
2. 25gm human hair and 475gm polypropylene (that is 5% human hair and 95% polypropylene composite).
3. 40gm human hair and 460gm polypropylene (that is 8% human hair and 92% polypropylene composite).

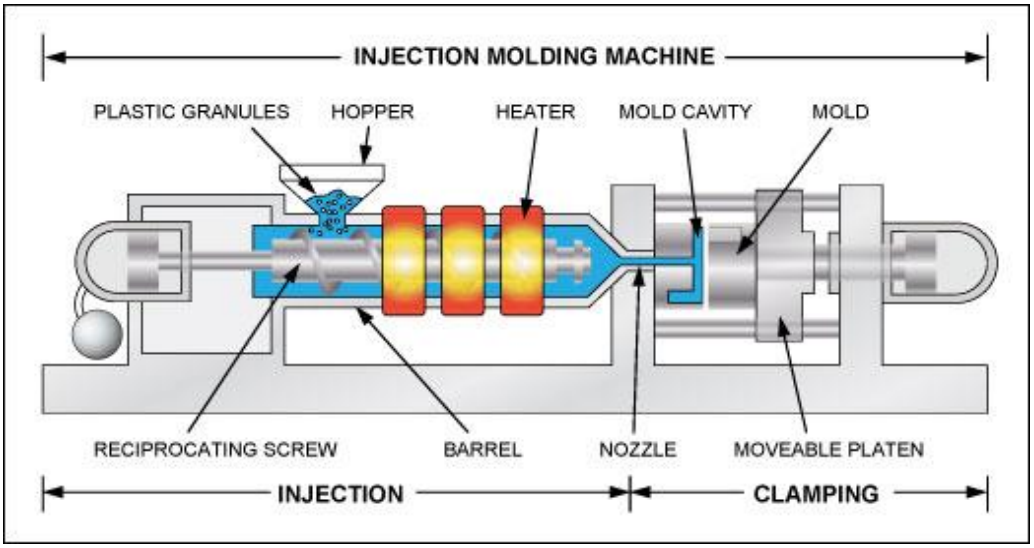

Fig. 1 Injection moulding machine with basic component

This process goes on various steps; in the first step, the polypropylene granules and the human hair of small pieces (3-10 mm) are mixed together. Then the mixture is fed into the hopper in Injection moulding machine. From the hopper, the mixture is dropped into the channel between the barrel and the screw and is conveyed along the direction of the hot runner with the revolving screw. In the course of the conveyance, the mixture is in a molten state due to electrical heating and the shearing heat of itself and gets stored in front of the screw. Then the molten mixture is injected into the mould with high pressure until the entire mould is filled with the mixture and then it is cooled by holding the pressure, then the cooled composite specimen is taken out as shown in Fig. 2

Fig.2 Tensile test specimens produced by injection moulding machine.

Now we get three different specimens with specified proportion in % of human hair and polypropylene according to above are as follows:

1. Specimen I (3 % human hair and 97 % polypropylene).
2. Specimen II (5 % human hair and 95 % polypropylene).
3. Specimen III (8% human hair and 97 % polypropylene).

III. Tensile Tests of Composite Specimens

Tensile tests are performed one by one on Specimen I, Specimen II, and Specimen III respectively, however; due to insufficiency of space in presenting the paper, observation of specimen I only is analysed for properties evaluation through Table 1.

Table 1 Experimental observation for tensile test of Specimen I.

Load P (N)	Elongation δ (mm)	Linear Strain, ε_x (x10^{-6})	Strain at 45° ε_{45} (x10^{-6})	Lateral Strain,ε_y (x10^{-6})	Calculated Stress, σ (MPa)	Calculated Strain
0	0	-	-	-	0	0
100	1.18	-	-	-	2.62	0.024
200	2.88	-	-	-	5.25	0.057
300	4.19	-	-	-	7.87	0.084
400	5.18	-	-	-	10.50	0.104
500	6.22	-	-	-	13.12	0.124
600	7.38	-	-	-	15.74	0.147
700	8.78	-	-	-	18.37	0.175
800	10.22	-	-	-	21	0.204
900	11.86	-	-	-	23.62	0.237
1000	14.76	-	-	-	26.25	0.295
1022.5	Specimen break				26.83	Specimen break

The evaluation is done with the help of following calculations-

$$\text{Stress, } \sigma = \frac{\text{Load (P)}}{\text{Area (A)}}$$

$$\text{Area (A)} = \text{Length} * \text{Thickness}$$

Where, width =12.7mm Thickness = 3 mm

Area (A) = 38.1 mm^2

For example, for serial no. 3 of Table 1,

$$\sigma = \frac{200}{38.1} = 5.25 \text{ MPa}$$

$$\text{Strain } \varepsilon = \frac{\text{Elongation } (\delta)}{\text{Gauge length } (L)}$$

Gauge length =50mm

For example, for serial no. 3 of Table 1,

$$\varepsilon = \frac{2.88}{50} = 0.057$$

Stress at break point in composite for Specimen I = 26.83 MPa.

The pictorial representation of stress-strain for Specimen I is shown in Fig. 3.

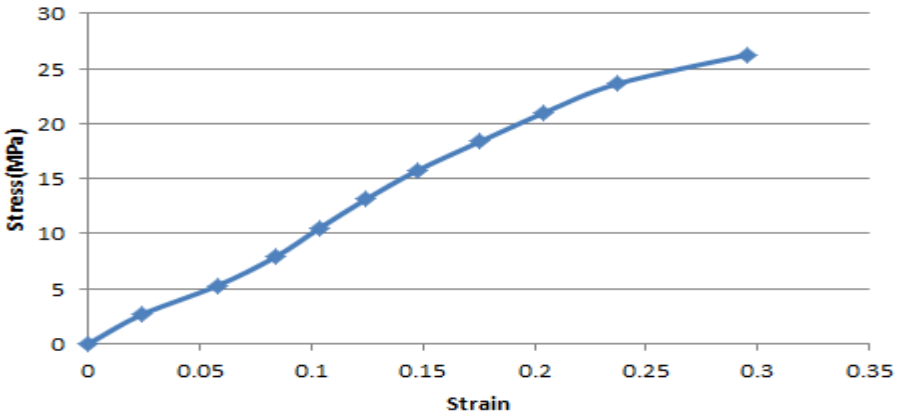

Fig. 3 Stress-strain curve for Specimen I

Further, we have performed same test on Specimens II and III respectively and obtained results as

For Specimen II
Stress at break point = 27.37 MPa

For Specimen III
Stress at break point = 28.82 MPa

The comparison of tensile strength for Specimens I, II and III using stress-strain diagram are presented in Fig. 4.

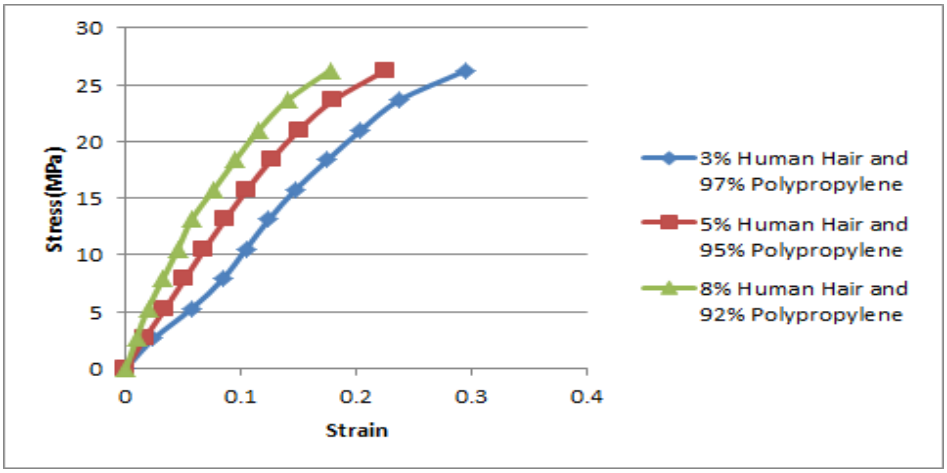

Fig. 4. Comparison of tensile strength using stress-strain diagram.
Colour indications are, as blue for Specimen I, red for Specimen II and green for Specimen III.

IV. Result and Discussion

As we performed Properties evaluation test for Tensile strength on three different specimens prepared by varying % of human hair with add of Polypropylene as 3%, 5% and 8% with 97%, 95% and 92% respectively and observed the favourable results. Tensile strength varies from 26.83 MPa (which is for 3% human hair 97% polypropylene composite) to 28.82 MPa (which is for 8% human hair 92% polypropylene composite) and tensile strength for 5% human hair 95% polypropylene composite is 27.37 MPa. Thus, we see 8% human hair 92% polypropylene composite is the strongest in tension.

V. Conclusion

The materials human hair and polypropylene are fabricated with the help of Injection Moulding process and properties are evaluated and analysed for Tensile strength. The following conclusion are obtained.

i. The tensile strength of the composite fibre is very high and Specimen does not break at a small value of tensile stress.
ii. There is a reasonable increment in the value of Tensile Strength of Specimen with a variation in the % of Human hair.
iii. The best performance of Specimen is observed with 8 % human hair, 92 % Polypropylene and holds the value of tensile stress as 28.82 MPa.
iv. It is suggested that human hair and Polypropylene composite fibre can be used as an alternate of synthetic fiber reinforced composite materials

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