Effect of Natural Lignocellulosic Fibers on the Mechanical Properties of the Polypropylene Composites

Sharat Chandra Srivastava[1*], Mohd. Farhan Zafar[2], M. Arif Siddiqui[3]

[1] *M. Tech., Aligarh Muslim University, Aligarh, Uttar Pradesh, India*

[2] *Research Scholar, Aligarh Muslim University, Aligarh, Uttar Pradesh, India*

[3] *Associate Professor, Aligarh Muslim University, Aligarh, Uttar Pradesh, India*

***Abstract*: - In the current study different natural fillers like rice husk, wheat husk and wood flour natural fillers were compounded with polypropylene to form composites. The effects of these natural fibres on various mechanical properties of the composites were investigated. Polypropylene composites at various filler loadings were compounded using a twin screw extruder and the test specimens were molded through injection machines.**

Keywords: **Natural Fillers, Biocomposites, Polypropylene, Melt Compounding**

I. INTRODUCTION

The plastic material with features of small specific gravity, high mechanical strength, sound and heat insulation, optimal chemical and electrical isolation, and easy-processing, has been extensively applied in electronic components, motor vehicle parts, textile fabrics, and transportation vehicles. The properties of all basic plastics can be enhanced by the addition of fibers, whiskers and particulate. Plastics so modified are referred to as organic or plastic matrix composites. Today reinforcements include materials such as graphite fibers, boron, glass, organic polymer fibers, silicon carbide, and a number of new inorganic fibers. Plastics will remain the most likely matrix candidates for composites because of the substantial weight savings they offer and of the wide range of properties and the ability to tailor them [1]. Polymer composites materials have been studied for many years and really constitute a very active area for researches in materials science. Among methods used for processing of plastic moulding, the injection moulding has not only the most popular applications in virtue of its advantageous features of high production rate and good precision, mass production for complex objects with same dimensions, low costs of production, and various appropriate materials, but it's crucial technology includes the control of injection moulding and mold design [2].

Various factors that affect the properties of composites are fiber dispersion, orientation and geometry (aspect ratio) of the fibres within the composites, the fiber volume fraction and the quality of interface between the reinforcing fibers and polymer matrices [3]. A variety of thermoplastic polymers have been investigated as matrices including polystyrene [4-7]. A number of researchers have been reported on natural fibers as fillers or reinforcements in thermoplastic composites, which have successfully proven their applicability to various field. Thermoplastics polystyrene (PS) [8] have been compounded with natural fibers such as wood, kenaf, flax, hemp, cotton, kraft pulp, coir, pineapple leaf, oil palm, sisal, jute, henequen leaf, banana fibers abaca and straw to prepare composites.

The goal of this study is to utilize indigenous raw materials to develop agro based composites as number of agricultural waste are available in our country that can be utilized as reinforcements to composite materials and to study the effect of these reinforcements on the mechanical properties of the derived composites.

II. EXPERIMENTAL PROCEDURE

2.1 Materials:

2.1.1. Matrix Polymer: The thermoplastic polymer Polypropylene was supplied by BASF Styrenics Pvt. Ltd. in the form of granules with a density of 0.868 to 0.925 g/cm^3 and a melt flow index of 0.27 to 49 g/10 min.

2.1.2. Reinforcement: The natural fillers used in this research work is rice husk (RH), wheat straw (WS) and wood flour (WF). These fillers were obtained from the local agricultural farms and then grounded and dried in ovens for preparation of composites.

2.1.3. Sample preparation: The fillers were oven dried at 100^{o}C for 24 hours and then stored in air-tight containers prior to compounding. A pre-blended mixture of each filler and matrix combination was formed by mixing base material and natural filler with

paraffin oil. Paraffin oil was used to activate the surface of polypropylene so granules easily attach with flour of natural fibres. A laboratory scale twin screw extruder (JSW 30 α extruder) was employed to compound the pre-blended mixture. The extruded material was quenched in a water bath and cut into small pieces of 15-25 cm long and dried pieces were pelletized by using grinding machine and stored in air-tight polythene bags to avoid moisture absorption. These composites were prepared with three different loadings of 10, 20, 30% wt. Standard test specimen were prepared for each set of experimentation.

2.2. Experimentation

2.2.1. Tensile Test: The tensile test for composites was conducted according to ASTM D638 with an Autograph machine of maximum load of I KN.

2.2.2. Impact test: Impact Test for composites was conducted according to ASTM D 256 with Ceast 6456 Izod Tester at a speed of 3.46 m/s. A total of 10 specimens were tested for each compound.

2.2.3. Hardness test: Rockwell Hardness Test was carried out on specimen using ASTM D785 standard test procedure. The specimen were conditioned at controlled atmosphere of 23±2 ^{o}C and 50 ±5% RH for specified duration.

III. RESULTS & DISCUSSION

3.1. Tensile Test:

Table 1 Tensile strength of RH, WS & WF filled PP composite

(Wt %)	RH	WS	WF
	Tensile strength (MPa)		
10	23.95	24.65	27.40
20	21.60	21.16	17.61
30	23.76	17.75	23.30

Tensile strength of virgin PP is 29.32 MPa

It can be observed from the results that tensile strength of composite decreased with increase in filler loading. The values of tensile strength of rice husk and wood flour filled composite is almost same at 30% loading. The wheat straw filled composite however shows a considerable decrease in the value of tensile strength.

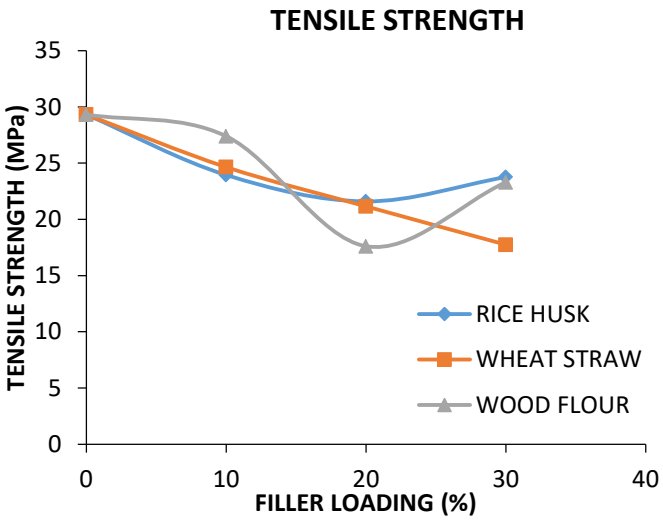

Figure 1: Effect of natural fillers (e.g. RH, WS & WF) on tensile strength of PP composites.

3.2. Impact Test:

Table 2: Impact strength of RH, WS and WF filled PP composite.

(wt %)	RH	WS	WF
	Izod Impact strength (J/mm)		
10	29.60	24.19	29.62
20	32.01	20.89	25.92
30	31.57	18.79	22.64

Izod impact strength of virgin PP is 33.07 J/mm

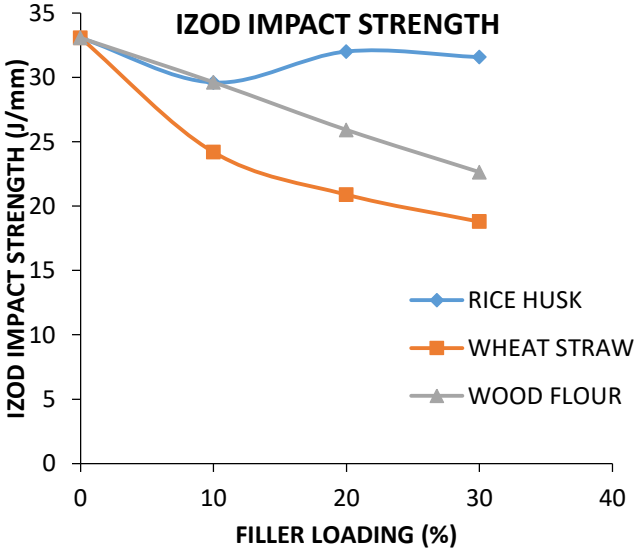

Figure 2: Effect of natural fillers on impact strength of PP composites.

As the results clearly depicts the decrease in the impact strength as we increase in the filler loading of the composite in case of wheat straw and wood flour filled composites. In this case also the maximum decrease is shown by the wheat straw filled composite. However in case of rice husk filled composite, there is an increase in impact strength as we increase the filler loading.

3.3. Hardness Test:

Table 3: Rock –well hardness of RH, WS and WF filled PP composite.

(Wt %)	RH	WS	WF
	Rockwell hardness "R scale"		
10	53	77	74
20	41	83	60
30	79	74	68

Rockwell hardness of virgin PP is 45 "R scale"

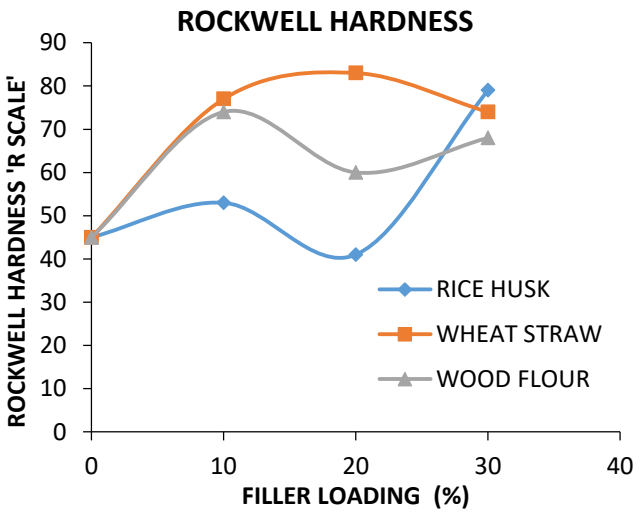

Figure 3: Effect of natural fillers (e.g. RH, WS & WF) on hardness of PP composites.

As we increase the filler loading into the PP, an increase is observed in Rockwell hardness. WS-PP composite showed better result than the other two fillers containing composites.

IV. CONCLUSIONS

In general tensile strength of PP composite decreases with increase in filler concentration. Impact strength was decreased with the addition of fillers used at all level loading.

The addition of fillers used, in general, modifies the mechanical properties of the composite. Due to fair strength and good toughness it can be used in automobile industry as similar to other thermoplastic polymer. Due to good stiffness property of PP composite it can be used in the furniture industry as well as automobile industry and household equipment manufacturing industry.

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