

Study of Mechanical Properties of Polypropylene (PP), Sugarcane Bagasse (SCB) and Ground Nut Shell (GNSP) Composites

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ABSTRACT

To determine the possibility of using sugar- cane bagasse (SCB) and ground nut shell particulate (GNSP) waste as reinforcing filler in the thermo plastic polymer matrix, SCB&GNSP-reinforced polypropylene (PP) composites were prepared. The PP and SCB and GNSP composites were prepared by the extrusion of PP and GNSP with 5, 10, 15, and 20 wt % of SCB and GNSP with 3, 6, 9 and 12% filler in a co rotating twin screw extruder. The extruded strands were cut into pellets and injection molded to make test specimens. These specimens were tested for physical and mechanical properties such as tensile, flexural, Izod impact strength shore D hardness and water absorption. It was found that the Tensile strength increased from 28.06 to 30.72 MPa, Flexural strength increased from 27.62 to 42.63 MPa, Izod impact strength decreased from 34.31 to 31.93 J/m, and Shore D Hardness increased from 64.75 to 76.20, with increase in filler loading from 5 to 20% in the PP matrix. The decrease in Izod Impact strength and elongation with addition of SCB & GNSP filler to PP matrix follows the general trend of filler effects on polymer matrix. However, the main purpose of this work was to study the effect of SCB & GNSP waste on the mechanical properties of the PP Composites. The SCB and GNSP waste can be used as filler in the PP composites, which will reduce cost and give environmental benefits.

Keywords : Composite; Polypropylene; Bagasse; Mechanical Properties; Thermal Properties

I. INTRODUCTION

Thermoplastic composites based on synthetic polymers with various amounts of organic fillers from renewable resources are considered as low environmental impact materials. The need for economically feasible degradable products, which do not adversely affect the environment upon disposal, has intensified the attention as an alternative source of raw materials. In recent years, natural fibers and powders have been widely used as reinforcing fillers in place of inorganic fillers and synthetic fibers in thermoplastic polymer matrix.¹⁻¹¹ Reinforced polymeric composites were made using cellulose and lingo cellulosic materials. These natural fillers have several advantages, such as their low cost, renewability, and biodegradability. The biodegradability allows these composites to play an important role in resolving future environmental problems. Agricultural

residues such as bagasse, rice husks, and wood chips are particularly important natural resources. These natural fillers are lighter, cheaper, and provide much higher strength¹²⁻¹⁴ per unit mass than do most of the inorganic fillers such as calcium carbonate, talc, zinc oxide, and carbon black. There is keen interest in utilizing these natural resources^{13,15-24} in polymeric composites because of their positive environmental attributes.

Further, these natural fillers are less abrasive, and do not cause the wear of barrels and screws during processing. The sugarcane bagasse waste, from sugarcane juice makers and from sugarcane industry, is one of the natural resources not utilized for any useful purpose. As these waste fibers are found in large quantity, there is a great interest in finding new applications. Sugarcane bagasse is mainly composed

of cellulose, which is a polymer of significant importance. Compared with studies on natural fibers such as jute, sisal, coir, pineapple, and bamboo, less effort has been made on bagasse fiber reinforced plastics.

With the ongoing research efforts aimed at the preparation and evaluation of hydrophilic/biodegradable polymers,^{25–29} the present study reports the preparation of polypropylene (PP)/sugarcane bagasse (SCB) composites to examine the possibility of using SCB as a filler in PP matrix. In today’s environmentally focused society, the demand for cost effective, environmental friendly materials continues to increase. The driving force behind the use of the sugarcane waste is its low cost, annually renewable resource utilization, and environmental benefits.

II. EXPERIMENTAL

Materials

The thermoplastic polymer polypropylene (PP) was supplied by Reliance India (H 110MA) in the form of homopolymer pellets with density of 0.90 g/cc and a melt flow index (MFI) of 11 g/10min (2308C/2.16 kg). The sugarcane bagasse (SCB) was waste obtained from local sugar factory.

Filler Preparation

The soft inner pulp of the bagasse was dried in sunlight carefully, then cut into small pieces and ground to fine fiber to pass through a 1.5-mm-size screen. This powder was soaked in 10% aqueous sodium hydroxide solution for 24 h at room temperature to remove impurities and waxy substances. Then it was washed with 1% acetic acid solution and distilled water to neutralize excess sodium hydroxide and the SCB was dried again in an oven with air circulation for 16 h at 508C and utilized in this work. The chemical constituents³⁰ of the SCB are crude fibers 40–43%, cellulose 28–30%, lignin 9–11%, crude protein 8–9%, fat 2–2.5%, and ash 5–6%.

Compounding and specimen preparation

The ground SCB fiber was mixed with PP granules in a high-speed mixer (Model FM 10 LB; Henschel, Germany). The mixed material was extruded in a twin screw extruder (Berstorff, Germany) with an L/D ratio

of 33 with a temperature profile of 190, 190, 180, 180, and 1908C. The extruded strand was palletized and stored in sealed packs containing desiccant. Four levels of filler loading(5, 10, 15, and 20 wt %) were designed in sample preparation. Tensile, flexural, Izod Impact, hardness , and water absorption specimens were prepared using an automatic injection molding machine JSW 180H with 100 ton clamping pressure at 2008C and an injection pressure of 1200 psi. After molding, the test specimens were conditioned at (23 6 2)8C and (50 6 5)% RH for 40 h according to ASTM D 618 before testing.

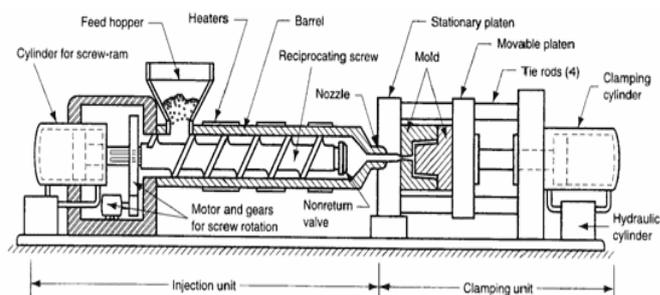


Figure.1 Injection Moulding Machine



Figure 2. Injection Moulding Machine: JSW 180H

Testing methods

Tensile and flexural strength tests were carried as per ASTM D 638 and ASTM D 790 respectively, on Universal Testing machine (Lloyds, LR 100 K). Izod impact strength tests were carried out as per ASTM D 256 Water absorption measurements were made in 50-mm-diameter disc specimens

Tensile test

Batch.no	Modulus(MPa)	Elongation(%)	Ultimate tensile strength (MPa)	Max load(N)
1	323.2	23.67	28.14	1143.7
2	552.0	12.67	32.68	1336.9
3	663.2	9.00	31.05	1262.0
4	643.9	7.33	29.43	1190.0
5	648.9	10.00	31.21	1268.3

Table 1 Tensile strength of PP composites at different filler loadings.

Flexural test

Batch.no.	Modulus(MPa)	Elongation(%)	Ultimate Flexural strength (MPa)	Max load(N)
1	862.1	5.24	29.20	49.79
2	1385.6	5.19	40.74	69.46
3	1676.2	5.25	44.49	75.85
4	1817.8	4.89	41.60	70.93
5	1984.5	5.15	41.46	70.70

Table 2. flexural strength of PP composites at different filler loadings.

Impact test

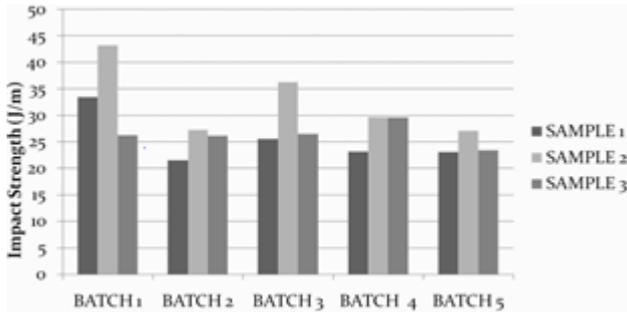


Table 3. impact strength of PP composites at different filler loadings.

Hardness test

S.NO	WITHOUT FILLER	5% SCB & 3% GNSP	10% SCB & 6% GNSP	15% SCB & 9% GNSP	20% SCB & 12% GNSP
1	67	67	71	70	68
2	65	73	65	60	80
3	63	65	70	69	78
4	64	75	67	75	80
5	65	72	68	73	79
AVG	64.8	70.4	68.2	69.4	77

Table 4. hardness of PP composites at different filler loadings.

Water absorption test

Time interval (Hours)	Weight of fibres at different time interval (gm)	*Water soaked weight of fibers (gm)	**Change in weight of the fibers at different time interval (% wt. gain)
0	22.00	0	0
6	22.02	0.02	0.090
12	22.04	0.04	0.181
18	22.056	0.056	0.254
24	22.06	0.06	0.272
30	22.06	0.06	0.272
36	22.06	0.06	0.272

III. RESULTS AND DISCUSSION

S.NO	MECHANICAL PROPERTIES	STANDAR D AND UNITS	pp without fibers	PP WITH 5% BAG&3% GNSP	PP WITH 10% BAG&6% GNSP	PP WITH 15% BAG&9% GNSP	PP WITH 20% BAG&12 %GNSP
1	Tensile Strength	ASTM D638 Mpa	28.06	32.79	30.68	29.04	30.38
2	Flexural Strength	D 790 Mpa	27.62	39.63	42.63	40.94	41.07
3	Impact Strength	D 256 J/m ²	34.31	24.98	31.93	27.50	24.53
4	Hardness	D 2240	64.75	70.00	68.25	69.25	76.20

IV. CONCLUSION

Following conclusions are drawn

1. Polypropylene composites were prepared with SCB and GNSP fillers at different compositions.
2. These specimens were tested for mechanical properties.
3. It was found that the Tensile strength increased from 28.06 to 30.72MPa, Flexural strength increased from 27.62 to 42.63 MPa, Izod impact strength decreased from 34.31 to 31.93 J/m, and Shore D Hardness increased from 64.75 to 76.20, with increase in filler loading from 5 to 20% in the PP matrix.
4. The decrease in Izod Impact strength and elongation with addition of SCB & GNSP filler to PP matrix follows the general trend of filler effects on polymer matrix.
5. However, the main purpose of this work was to study the effect of SCB & GNSP waste on the mechanical properties of the PP Composites.
6. The SCB and GNSP waste can be used as filler in the PP composites, which will reduce cost and give environmental benefits.

V. REFERENCES

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