

Fabrication and Study of Mechanical and Thermal Properties of Natural Fibre Composites Material Based on SCB and GNSP

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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 29.06 to 31.38 MPa, Flexural strength increased from 28.62 to 43.56 MPa, Izod impact strength decreased from 35.11 to 30.93 J/m, and Shore D Hardness increased from 64.88 to 77.89, 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

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 (230⁰ C/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 50⁰ C and utilized in this work. The chemical constituents 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 190⁰C. 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 200⁰ C and an injection pressure of 1200 psi. After molding, the test specimens were conditioned at 23⁰ C according to ASTM D 618 before testing.

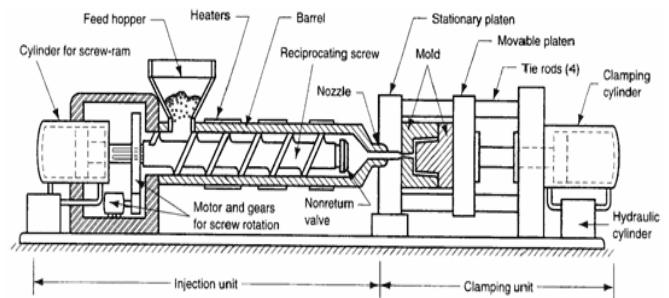


Fig.1 Injection Moulding Machine



Fig.2 Injection Moulding Machine: JSW 180H

Testing method

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	623.2	10.50	31.05	1262.0
4	643.9	9.33	30.43	1240.0
5	648.9	8.85	29.21	1210.3

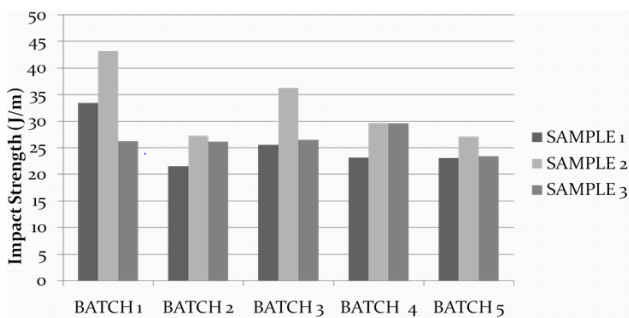
Table 1. Tensile strength of PP composites at different filler loadings.

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	5.20	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



Graph 1. 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 3. Hardness of PP composites at different filler loadings.

TGA Test

Thermo gravimetric analysis or thermal gravimetric analysis (TGA) is a method of thermal analysis in which changes in physical and chemical properties of materials are measured as a function of increasing temperature (with constant heating rate), or as a function of time (with constant temperature and/or constant mass loss)

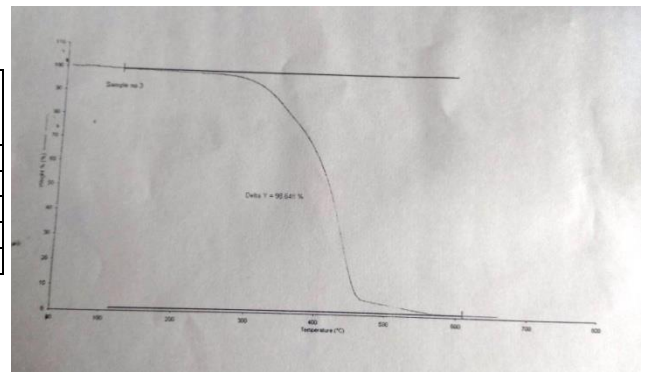


Fig. 3 :- TGA for hybrid composite

Conclusion from TGA test-Curve of hybrid composite as shown in Figure 3. Thermal treatment covered of bagasse fiber & hybrid composite gave an initial weight loss below 150°C due to loss of moisture. The weight loss observed with composite at this reason might be due to the molecular weight of the compounds. The initial weight loss is due to complex secondary reaction and formation of volatile product. Complex secondary reaction and formation of volatile product.

From above Figure shows, it is obvious that no degradation occurred until 100°C for the sample the onset being above 150°C. The maximum rate of weight

loss was observed in the range of 150°C.– 600°C. The amount of residue left is 0.33%.

From the thermograms it is apparent that sample undergoes a two-step degradation process .The first stage, thermal degradation process occurred in the temperature range of 150°C.-350°C. .The second stage degradation in the temperature range of 400°C.-600°C. And may be due to the compound decomposition of fibre and matrix.

The significant thermal behaviour of the compound was determined from the initial degradation temperature which is taken as the temperature at which degradations started and the residue weight percentage denoted as char.

Initial degradation temperature was 150°C and final degradation temperature was 600°C.

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.

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.

V. REFERENCES

- [1]. Syed Mazher Abbas Rizvi, Abhishek Dwivedi, Syed Shane Raza, Anshika Awasthi, Himanshu Gupta, " An Investigation of Thermal Properties of Reinforced Coconut Coir-Bagasse Fibres Polymer Hybrid Composites", International Journal of Scientific Research in Science, Engineering and Technology(IJSRSET), Print ISSN : 2395-1990, Online ISSN : 2394-4099, Volume 3 Issue 1, pp.427-432, January-February 2017URL: <http://ijsrset.com/IJSRSET1731113.php>
- [2]. Syed Shane Raza, S. Mazhar Abbas Rizvi, Abhishek Dwivedi, " Study of Mechanical Properties of Composite Material Based on Polypropylene and Rice Husk Filler : A Review", International Journal of Scientific Research in Science, Engineering and Technology(IJSRSET), Print ISSN : 2395-1990, Online ISSN : 2394-4099, Volume 3 Issue 1, pp.453-457, January-February 2017. URL :

- <http://ijrsrset.com/IJSRSET1731117.php>Dweiri, R.; Azhari, C. H. J Appl Polym Sci 2004, 92, 3744.
- [3]. Hiristov, V. N.; Krumova, M.; St. Vasileva; Michler, G. H. J Appl Polym Sci 2004, 92, 1286.
- [4]. Pandey, J. H.; Ahmad, A.; Singh, R. P. J Appl Polym Sci 2003,90, 1009.
- [5]. Eboatu, A. N.; Akuaka, M. U.; Ezenweke, L. O.; Afiukwa, J. N. J Appl Polym Sci 2003, 90, 1447.
- [6]. Rodriguez, C. A.; Medina, J. A.; Reinecke, H. J Appl Polym Sci 2003, 90, 3446.
- [7]. Zhang, F.; Endo, T.; Qiu, W.; Yang, L.; Hiriostsu, T. J Appl Polym Sci 2002, 84 1971.
- [8]. Yang, H.-S.; Kim, H.-J.; Son, J.; Park, H.-J., Lee, B.-J.; Hwang, T.-S. Compos Struct 2004, 63, 305.
- [9]. Krishnan, M.; Narayanan, R. Mater Res Soc Sym Proc 1996, 93,266.
- [10]. Narayanan, R. Presented at the AIChE Spring National Meeting, New Orleans, LA, March 29 – April 2, 1992, 25C.
- [11]. Narayanan, R. In Emerging Technologies for Materials and Chemicals from Biomass; Rowell, R. M., Schults, T. P.,
- [12]. Narayanan, R., Eds. American Chemical Society: Washington ,DC, 1992. Am Chem Soc Symp Ser 476, pp 57–75.
- [13]. Mohana Krishnan, C. K.; Narayanan, R.; zio, J. D. W. Presented at the AIChE Annual Meeting, Los Angeles, CA,
- [14]. Jana, S. C.; Prieto, A. J Appl Polym Sci 2002, 86, 2159.
- [15]. Bledzki, A. K.; Gassan, J. Prog Polym Sci 1999, 24, 221.
- [16]. Bledzki, A. K.; Reihmane, S.; Ganesan, J. Polym Plast Technol Eng 1998, 37, 451.
- [17]. Oskman, K.; Skrifauers, M.; Selin, J.-F. Compos Sci Tech 2003,63, 1317.
- [18]. Van der Oever, M. J.; Bos, H. L.; Kemenade, M. V. Appl Compos Mater 2000, 7, 387.
- [19]. Iannace, S.; Nocilla, L.; Nicolais, L. J. J Appl Polym Sci 1999,73, 585.
- [20]. Cyras, V. P.; Iannace, S.; Kenny, J. M.; Va ´zquez, A. Polym Compos 2001, 22, 1.
- [21]. Dufresne, A.; Vignon, M. R. Macromolecules 1998, 31, 2693.
- [22]. Alvarez, V. A.; Kenny, J. M.; Va ´zquez, A. Polym Compos 2004, 25, 280.
- [23]. Alvarez, V. A.; Va ´zquez, A. Polym Degrad Stab 2004, 84, 13.
- [24]. Thwe, M. M.; Liao, K. Comp Sci Tech 2003, 63, 375.
- [25]. Li, T. Q.; NG, C. N.; Li, R. K. Y. J Appl Polym Sci 2001, 81,1420.
- [26]. Van der Velde, K.; Kiekens, P. Polym Test 2001, 20, 885.
- [27]. Ramaraj, B.; Poomalai, P. J Appl Polym Sci 2005, 98, 2339.
- [28]. Ramaraj, B.; Radhakrishnan, G. Polymer 1994, 35, 2167.
- [29]. Ramaraj, B.; Radhakrishnan, G. J Appl Polym Sci 1994, 51, 979.
- [30]. Ramaraj, B.; Radhakrishnan, G. J Appl Polym Sci 1994, 52, 837.
- [31]. Ramaraj, B.; Rajalingam, P.; Radhakrishnan, G. J Appl Polym Sci 1991, 43, 23.
- [32]. Chiellini, E.; Cinelli, P.; Solaro, R.; Laus, M. J Appl Polym Sci 2004, 92, 426.
- [33]. Ismail, H.; Nizam, J. M.; Abdul Khalil, H. P. S. Polym Test 2001, 20, 125.
- [34]. Ismail, H.; Edyham, M. R.; Wirjoosentono, B. Polym Test 2002,21, 139.
- [35]. Ismail, H.; Jaffri, R. M. Polym Test 1999, 18, 381.
- [36]. Premalal, H. G. B.; Ismail, H.; Baharin, A. Polym Test 2002, 21,833.
- [37]. Nicolais, L.; Narkis, M. Polym Eng Sci 1971, 11, 194.
- [38]. Joseph, P. V.; Kuruvilla, J.; Thomas, S. Compos Sci Technol 1999, 59, 1625.
- [39]. Nielsen, L. E. J Appl Polym Sci 1966, 10, 97.
- [40]. Nielsen, L. E. J Compos Mater 1967, 1, 100.
- [41]. Hassan, M. L.; El-Wakil, N. A.; Sefain, M. Z. J Appl Polym Sci 2001, 79, 1965.
- [42]. Pramani, P. K.; Dickson, B. ANTEC, 1997; p 3136.
- [43]. Krautz, F. G. SPE J 1971, 27, 74. McNally, D. Polym Plast Technol Eng 1977, 8, 101.

- [44]. Wollerdorfer, M.; Bader, H. *Ind Crops Prod* 1998, 8, 105.
- [45]. 44. Albano, C.; Gonzalez, J.; Ichazo, M.; Kaiseer, D. *Polym Degrad Stab* 1999, 66, 170.

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