Jute Fiber-PP Bio-Composite: State Of Art, Low Investment, In-House and Manual Preparation of Injection Moldable Bio-Composite Granules

***M A Gulbarga, ** Prof S B Burli**

*Correspondence Author, **Professor, Dept. of IPE, BVBCET, Hubli

Abstract:- This paper briefs on manual fabrication process, to prepare injection moldable granules of jute-pp (NF-PP) bio composite, with different loading of jute reinforcement up to 30 % by weight(Jute or NF ratio 10, 20, 30, by wt%), without using parallel twin screw extruder. Low investment process for jute/NF composition up to 30% by wt of jute/NF in bio composite. External hot mixing of jute/NF and PP is accomplished in a pan, with incremental heat and control. Modified manual injection molding machine is used as extruder for in-house granule preparation. Even flax, hemp, sisal and any NF with PP can be prepared for test and development locally.

Index Terms: Jute, PP, Injection Moldable, Low Investment, Manual Preparation.

I. Introduction

Materials from renewable resources – are called biomaterials or 'green' materials – are currently gaining in importance worldwide. The natural fiber reinforced plastics are the bio-composites in demand for replacement in aero and auto industries. Injection mold ability is significant due to Low cost and high production, Interchangeability, Weight reduction, Metal part replacement & compatibility, abundant availability, easy to transport, and PP composition possibility. The bio composites are biodegradable and non-toxic. Jute products merge with the soil, provides nourishment to the soil. Being made of cellulose, on combustion, jute does not generate toxic gases. Molded bio composites provide good dimensional stability and harmlessness. And technically jute has high specific properties, low density. Jute is less abrasive to the processing equipment.

II. Experimental set up

The experimental set up is aimed to produce moldable bio composite granules manually to help produce in house which is an alternate to huge investment setups. This state of art experimental continuous and fragmented processes set up that will help researchers to carry out their work with least investment, and also flexibility in preparation of required bio composite compositions. The entire process is sub divided into smaller processes, suitable to use available equipment with technical modifications as needed.

The experimental procedure involves Hot mixing of fiber and pp, flake formation, flake cutting, converting flakes into jute-pp composite bar, cutting of bar into granules. The granules can now be sent to injection molding machine for molding. Some photographs of molded parts are shown.

2.1 Materials

2.1.1. PP Matrix

Polypropylene is commonly made from the monomer propylene by polymerization; the result is an iso-tactic polymer, in which all the methyl groups are on the same side of the chain. Isotactic polypropylene has good mechanical properties as well as low density. It is a non-polar material. The crystalline iso-tactic polypropylene is insoluble in all common solvents at room temperature, it starts swelling and is finally dissolved by specific

solvents only at temperatures generally higher than 100°C. Its tensile strength, surface hardness and stiffness are higher than that of polyethylene.

CH2—CH—CH2—CH--CH2—CH--CH2-- CH
CH3 CH3 CH3 CH3

Figure: 1 Chemical structure of iso-tactic polypropylene

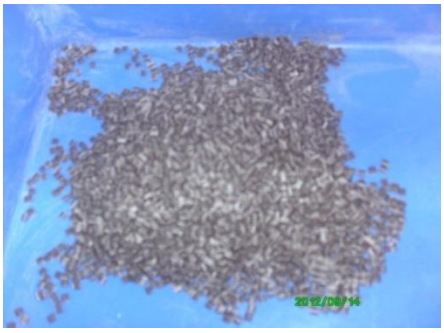

Figure: 1 Polypropylene Granule

2.1.2 Jute fiber

The biodegradable and low priced jute products merge with the soil after using and provide nourishment to the soil. Being made of cellulose, jute does not generate toxic gases on combustion. Due to jute's low density combined with relatively stiff and strong behavior, the specific properties of jute fiber can compare to those of glass and some other fibers. Recent reports indicate that plant based natural fibers can very well be used as reinforcement in polymer composites, replacing to some extent more expensive and non renewable synthetic fibers such as Glass. The maximum tensile, impact and flexural strengths for natural fiber reinforced plastic (NFRP) composites reported so far are 104.0 MN/m2 (Jute - Epoxy), 22.0 kJ/m2 (Jute - Polyester) and 64.0 MN/m2 (Banana - Polyester) respectively.

2.1.3 Jute fiber length

The fiber length plays an important role in the mechanical performance of fiber reinforced composites. The Table:1 as shown below summarizes the average fiber lengths and diameters derived from compound granules and plates.

TABLE: 1

Samples	Fiber Length (µm)	Diameter (µm)	Ratio of F.L/D
Granules	243 – 162	23 - 15	10.6
Plates	244 – 154	22 - 12	11.1

Table 1: shows Average fiber length, diameter, and length/diameter ratio.

2.2 State of art manual moldable granule preparation

In the manual process of bio-composite granule preparation Jute fiber reinforced polypropylene composites were prepared under various processing parameters using hot mixing by manual and modified injection molding technique for extruding long bar of composites to make granules. The goal of this work is to

design a manual process to ease and accelerate the in house development and research of bio composite and at very low investment. This process is sub divided into six steps.

2.2.1 Step-I: Treatment of jute fiber and dehumidification

The focus of the paper is to design a process to prepare moldable quality jute-PP bio composite granules for low quantity productions. The fibers are treated for chemical effects. 3% NAOH treated jute is directly used. The treated jute is now de-Humidified. The fibers are treated in hot air oven, at 70°C, for 24 Hrs, to remove water contents.

2.2.2 Step-II: Sizing of jute fibers

The fibers are cut to required size, and separated to individual fibers. Hammer milling is used to separate individual fibers and to achieve size and are shown in the following Figure: 2

Figure: 2 Jute fibers cut to size.

2.2.3 Step-III: Hot mixing method

In this step, the treated and dehumidified and sized jute fibers are mixed with hot PP. This process is shown pictorially in figure: 3 below. All the required quantities and planned mix ratios, and in batches, are kept ready in separate trays. Take complete batch quantity PP in the vessel, (the quantity may depends on vessel quantity). As the material starts melting start adding Jute pp and keep stirring and blending, the jute shall be added according to the requirement in small quantities and blended properly.

This step requires skill, technique and understanding of material behavior. Mixing of hot pp, burn control of jute, and complete pp-film wrap around jute fiber are obtained in one go, but it attracts simultaneous action. Temperature control and blending action go hand in hand so that no pp vapors are produced and blending is not stopped till the composite solidifies. PP must melt, jute fibers should not burn and complete wrap of pp, are the conditions to be monitored, this can be achieved by constant observation, blending and temperature control simultaneously.

Figure: 3 manual hot mixing of jute with pp

2.2.4 Step-IV: cutting to flakes

After complete blending, the mixed compound is allowed to cool and cut manually by scissor. The bio-composite flakes are ready and are shown in the Figure: 4 below, the bio-composite flakes can also be used directly for injection molding.

Figure: 4 Jute-PP Bio composite flakes

2.2.5 Step-V: Extrusion of the jute-PP mix

The bio-composite flakes produced by hot mixing method are extruded in the modified manual and hand injection molding machine.

The modifications done on the manual injection molding machine are - the pressure push flow control wedge, filter mesh of the manual injection machine are removed. The nozzle is redesigned to have single aperture of 5mm diameter to extrude one long bar of 5mm diameter. One long bar can be drawn in one shot, and it is of 50 grams of composite material. Thus the manual extruder works to produce long bars of composite.

Figure: 5 Modified manual injection molding m/c

Figure: 6 Extruded bar before cutting to pellet size

2.2.6 Step-VI: cutting to Pellet size granules

The long bars of 5mm obtained from the modified manual extruder are now manually cut to the size 5mm or 6 mm and these are called pellets of jute-pp. These pellets can now be molded in the injection molding machine of any type manual, hydraulic or automatic. The bio composite material needs more area of cross section in gates of the moulds to facilitate the flow of molten material into the mould. Metal flow behavior of the bio composite varies with percentage mix of bio material.

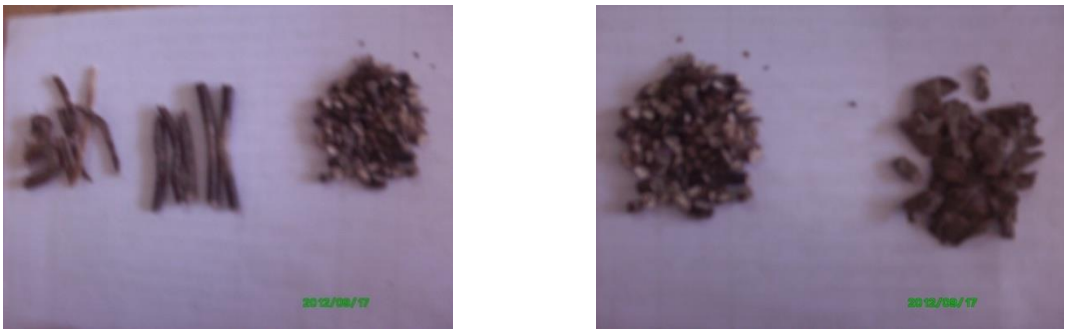

Figure: 7 Extruded bars and bio composite granules

III. MOULDABILITY OF GRANULES

Granules, as well as bio composite flakes also can be used in the injection molding machine. Following are the photographs of the injection mould prepared by different compositions of bio composites prepared by this state of art manual method as shown in Figure: 8.

Figure: 8 Bio composite molded Auto wind shield part .

IV. CONCLUSIONS

- Uniform mix of fiber is possible.
- Fiber bunches can be avoided.
- Burning of fibers can be controlled.
- Higher ratio mixing is difficult.
- Attracts moderate risk, skill and energy.
- Most suitable for R&D and study projects.

REFERENCES

1. Injection Molding of Polypropylene Reinforced with Short Jute Fibers. A. C. KARMAKER and J. A. YOUNGQUIST USDA Forest Service, Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53705.

2. Abaca fibre reinforced PP composites and comparison with jute and flax fibre PP composites, A. K. Bledzki A. A. MamunO. FarukInstitut für Werkstofftechnik, Kunststoff- und Recyclingtechnik, University of Kassel, Mönchebergstrasse 3,34109 Kassel, Germany.

3. Short Jute Fiber-Reinforced Polypropylene Composites: Effect of Compatibilizer A. K. Rana,A. Mandal,B.C. Mitra,R. Jacobson,R. Rowell, A. N. Banerjee. Indian Jute Industries' Research Association, 17 Taratola Road, Calcutta-700 088.

4.Extrusion compounding Technology to produce low cost, high performance natural fiber re-inforced plastic granules,PP-NF Technology, Agro Technology & Food innovation.

5. Investigation on jute fibres and their composites based on polypropylene and epoxy matrices.

6. Facts and Myths on agro fiber composite- A techno-economic outlook on the granule production.5th Global composite symposium Kassel Germany.

7. Plastic reinforced by agro fiber fact sheet, Agro Technology & Food innovation.

8. Jute re-inforced polyolefins of ind, application,;Process Up-scaling for commercialization,Aziz pipes Bangla Desh, Birla Corpn, India.

9. Short Jute Fibre Reinforced Polypropylene Composites – AK Rana, A Mandal, K Jayachandran; IJIRA, Kolkata.

10.Jute Fibre Reinforced Polyester Composites – B Govardhan Reddy, VVS Prasad, D Nageswara Rao, NRMR Bhargava; Department of Mechanical Engineering, Andhra University, Vishakapatnam.

ABOUT THE CORRESPONDANCE AUTHOR:

*Author is a Post Graduate student, pursuing his M.Tech programme in Production Management at the prestigious B.V.B. College of Engineering and Technology at Hubli, located in the northern part of the state of Karnataka. He is having a vast experience of about 25 Years in Industry as well as in teaching. He has rendered his services in many National and Multi National industries. Also worked as Lecturer, H.O.D of Mechanical Engineering Department and Principal in Polytechnic Institutions. He has published articles and papers in conferences and journals both national and international. He also conducts personality development and motivational classes for both students and for professionals. He is also a registered and qualified hand writing anlysist. He may be contacted at ayubgulbarga@gmail.com