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EFFECT OF INDIAN LIGNOCELLULOSIC FILLERS ON IMPACT PROPERTY OF GPPS

D.K.Verma[1*], M. A. Siddiqui[2] ,S.C.Srivastava[3]

[1]M.Tech, Department of Mechanical Engineering, Aligarh Muslim University*

deepak.vermag@gmail.com[2] Associate Professor, Department of Mechanical Engineering, Aligarh Muslim University

[3]M.Tech, Department of Mechanical Engineering, Aligarh Muslim University

ABSTRACT

Thermoplastics containing natural fillers received considerable attention in the recent past due to growing environmental awareness. The increase in environmental concern has pointed out to reduce the use of polymeric materials, not only due to their non-biodegradability, but also because their production requires large amount of oil as raw material which is not renewable. In this study, lignocellulose fillers such as rice husk, wheat straw and wood flour available in North India at negligible cost, were used with general purpose polystyrene to make composites. The effect of these natural fillers on impact property of above said composites was investigated. Fillers-GPPS composites at various filler loadings were compounded using a twin screw extruder and the test specimens were molded through injection molding machines. The Izod tests were carried out on ceast resil impactor machine. The impact strength in general was increased with the addition offillers.

Keywords: *rice husk, wheat straw, wood flour, Mangifera indica, polystyrene, impact strength.*

INTRODUCTION

Plastic industry uses inorganic fillers such as talc, calcium carbonate, mica, and glass or carbon fibers to fill and to modify the performance of thermoplastic but increasing demand and stringent performance requirements have pushed to identify new fillers. Inorganic fillers, such as glass, calcium carbonate, and silica [1] are expensive compared with natural fillers. Theprimary advantages of using organic fillers in thermoplastics can be listed as agricultural plants are a good source of raw material and readily available at low cost, which are important factors for the plastics industry when considering a filler material for thermoplastics. Several studies were conducted to manufacture thermoplastic composites using plant flour or fiber including hemp, flax, jute, sisal, andbagasse.

Over the past two decades, natural fillers have been receiving considerable attention as substitutes for synthetic fiber reinforcements. Unlike the traditional synthetic fibers like glass, natural fillers are able to impart certain benefits to the composites such as low densities, low cost, nonabrasive nature [2], possibility of high filling levels, low energy consumption, high specific properties, biodegradability, availability of a wide variety of fibers throughout theworld, and generation of a rural/agricultural-based economy [3]. Various reinforcing fillers of today are being prepared and combined with various synthetic matrix polymers in order to improve mechanical properties and to obtain the characteristics demanded in actual usage of composite materials. Today, fillers derived from agricultural waste have become a focus of attention. Rice husk and wheat straw and wood flour have been an environmental burden and waste product over the years. This fascinating source is under careful study and recent development should provide a variety of products. Much work has been done to study the potential of rice husk,wheat straw and wood flour as filler for polymeric materials. The mechanical properties of composites are the most important, because they can be influenced by parameters such as the type of filler, type of matrix, filler concentration, filler dispersion, filler particle size, and theinteraction between the filler and matrix. However, no serious attempt has been made to evaluate the use of rice husk and wheat straw and wood flour as reinforcing filler for polystyrene(PS).

So, in this work natural fillers like rice husk, wheat straw and wood flour (*Magnifera Indica)*, which are abundantly available in north India, were used as a reinforcing element in polystyrene matrix.

EXPERIMENTAL SETUP

MATERIALS USED

1. Matrix polymer

The thermoplastic polymer general purpose polystyrene (GPPS) was supplied by BASF Styrenics Pvt. Ltd. in the form of granules with a density of 1.05 g/cm^3 and a melt flow index of 9 g/10min.

2 Reinforcing fillers

The rice-husk (RH) (Fig 1), wheat straw (WS) (Fig 2) and wood flour (WF) (Fig 3), lignocellulosic materials were used as the reinforcing filler in GPPS. The rice husk, wheat straw and wood flour (Mangifera Indica) were obtained from local markets of Hathras. The original fillers were first cleaned to remove containments and each of them was ground in a food processor to reduce the size of the filler.

Figure 1:Ricehusk

Figure 2:Wheatstraw

Figure 3: Woodflour

SAMPLE PREPARATION

The RH, WS and WF were oven dried at 1000C for 24 hrs and then stored in a polyethylene bags prior to compounding. A pre blend mixture of each filler was formed by mixing base material and natural filler in a required proportion with paraffin oil. Paraffin oil was used to activate the surface of polystyrene, so granules easily attach with flour of natural fillers. A laboratory-scale twin-screw extruder (JSW 30 α extruder) was employed to compound the pre-blended mixture (Fig 4). The extruded material was quenched in a water bath and cut into small pieces of 15-25 cm long and the dried pieces were pelletized (Fig 5) by using grinding machine and stored in polyethylene bags to prevent from moisture. These composites with three different filler loadings (10, 20 and 30 wt %) were prepared for measuring impact strength properties. The impact test specimens were made through injection molding machine (Fig 6). After being molded, the test specimens (Fig 7) were conditioned before testing at 23± 2 0C and 50±5% relative humidity (RH) for at least 40hrs.

Figure 4: JSW 30 αtwinextruder

Figure 5: Pallets of extrudedcomposite

Figure 6: Batten-fed injectionmoldingm/c

Figure 7: impact testspecimens

IZOD IMPACT TEST

Izod impact test was performed on a Ceast 6456 Izod tester. ASTM D 256 test method is used to gets the readings of specimens. A notch is cut into a specimen. Notching was carried out on the impact specimens using Ceast notch cutting apparatus (Fig 8).The angle of notch is 45 º± 1º with a radius of 0.25 mm. A total of 10 specimens were tested for each compound .The impact value is directly read from the digital display screen of Ceast Izod tester (Fig 9) in J or kg-cm. Average of 10 specimens reading were taken , to get final reading for each compounded material at different filler loadings. The impact strength is calculated as:
Impact strength = impact value obtained from the scale (J)/thickness of specimens in mm.

Figure 8: Ceast notchcuttingm/c

Figure 9: Ceast resil impactorm/c

RESULT AND DISCUSSION

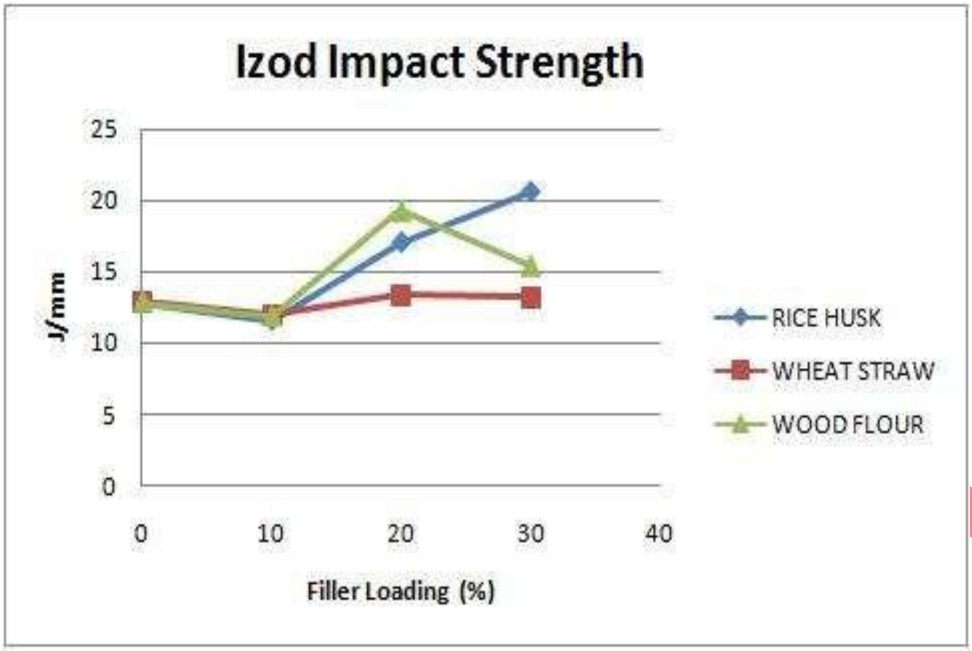

Figure 10: Effect of natural fillers on impact strength of GPPS composites

Figure 10 illustrate the Izod impact strength of RH, WS and WF filled GPPS with varying filler loading. Contrary to what would be expected the results suggested that an increase in filler loading resulted in an increase in absorbed energy especially in case of RH, WS and WF filled reinforcements in GPPS.The impact strength of the fiber reinforced polymeric composite depends upon the nature of fiber, the polymer and particle size [4]. WF at 20 and 30% filler loading offered increase impact strengths i.e. 19.29 J/mm and 15.43 J/mm compared to unfilled polymer 12.90 J/mm indicating good adhesion of WF with polymer. The impact strength of rice husk increase with increase in filler loading. An increasing trend of impact strength was observed with the increased filler loading ,which rise from 11.59 J/mm to 20.63 J/mm on 30% filler loading and was 59.9% greater than GPPS. In filled composites as the filler loading increased the tendency for agglomeration of wheat and wood at 30% also increased. As filler agglomeration increased, interfacial adhesion became weaker leading to weaker interfacial regions therefore, a reduction in Impact strength was observed. It is known that the composite materials with satisfactory mechanical properties could only be achieved if there is good dispersion and wetting of fillers that would give rise to a strong interfacial adhesion. In our study,we visually found that size of rice husk particle is more in comparsion to wheat straw and wood flour.As the particle size increased, the notched Izod impact strength slightly increased. This result was expected because the crack propagates at the weaker natural fibre-polystyrene interfaceaswellasthroughthepolymercomposite.Becauseofcrackstravelingaroundthe natural filler particles, the fracture surface area increases with increasing particle size. Therefore, more energy is required to fracture the impact specimen with larger particles [5-6].

CONCLUSION

Impact strength is a measure of energy that a sample absorbs before it breaks. Thermoplastic composites filled with (RH, WS & WF) offered slightly increased impact strengths with the rise of filler content.So overall, RH, WS and WF could be utilized as biodegradable filler at end of-use in polymeric materials to minimize environmental pollution rather than produce strong reinforcing fillers. Result of present study suggest that the dispersion is not yet optimized and further improvement of the processing conditions or use of a compatilizer is needed to find the best possible dispersion of lignocellulosic natural fillers with GPPS matrix.

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