STUDY OF MECHANICAL PROPERTIES OF WHEAT STRAW FIBER REINFORCED POLYSTYRENE COMPOSITES

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Abstract- In this study, the effect of the wheat straw with different fiber concentration (5 to 25% by weight) on the mechanical properties of the polystyrene composites were studied. The polystyrene composites of wheat straw were prepared by Haake Rheocord 9000 twin screw extruder machine. The standard test specimens were molded on compression moulding machine. Mechanical properties were determined using these test specimens. It was found that with the addition of wheat straw as filler in polystyrene composites, tensile strength, impact strength and hardness are found to increase with increase in wheat straw concentration.

Keywords- Polystyrene, Wheat Straw

I. INTRODUCTION

In recent years, polymer composites reinforced with natural fiber such as wood, flax, hemp, and wheat straw have become popular, thanks to their renewable, recyclable, and biodegradability. These composite products are characterized by a unique combination of excellent durability, superior dimensional stability, high rigidity, and relatively low density. Ming-Zhu Pan[1] et.al studied effect of wheat straw concentration and coupling agent on the mechanical properties of wheat straw fiber-polypropylene composites. The tensile modulus and strength of the composites increased linearly with increasing wheat straw fiber content up to 40%. With increasing MAPP concentration, the composites showed an increase in tensile strength. Flexural modulus of the composites increased gradually, as wheat straw fiber content increased from 0 to 40%.

There is increase in tensile strength, flexural, impact strength and hardness of reinforced polyethylene wheat straw composites with increase in wheat straw concentration up to 30% for both fine and coarse. Fine (WS) particles sample showed better, then coarse (WS) when addition for HDPE as fiber to produced composite material K. F. Al-Sultani[2] et.al. The potential of wheat straw fibers prepared by mechanical and chemical processes as reinforcing additives for thermoplastics was investigated by S. Panthapulakkal[3]et.al. The fibers prepared by chemical process exhibited better mechanical, physical and thermal properties. Wheat straw fiber reinforced polypropylene composites exhibited significantly enhanced properties compared to virgin polypropylene. However, the strength properties of the composites were less for chemically prepared fiber filled composites. Preparation of polypropylene hybrid composite consisting of wheat straw and clay as reinforcement materials was investigated by C. Ravindra Reddy[4] et.al. The composition of constituents of hybrid composite such as percentages of wheat straw, clay and maleic anhydride grafted polypropylene as a coupling agent was varied in order to investigate their influence on water absorption and flexural properties. The results of the study indicated, that the increase in wheat straw and clay content in a composite increases the flexural modulus and reduces the resistance for water absorption. The increase in PP-MA coupling agent also increases the flexural modulus and resistance for water absorption.

II. EXPERIMENTAL

MATERIALS: Wheat straw fibers were obtained from the local farms of Ujjain, (Madhya Pradesh) India. Polystyrene (SC 206) with an MFI 12 gm/10 minutes (210^0C, 2.16 kg) was obtained from Supreme Petrochem Limited, Mumbai, India. Sodium Hydroxide (NaOH) for alkali treatment of wheat straw fiber was obtained from Thomas Baker, Mumbai, India.

Compounding

Before compounding wheat straw was treated with sodium hydroxide (NaOH 10%). Polystyrene and wheat straw were compounded in the counter-rotating twin screw extruder HaakeRheocord 9000 with 16 mm diameter and L/D 25:1 ratio. The extrudate is quenched in water at a temperature of about 20-30^0 C. The compounding is carried in twin screw extruder.

Fabrication of composite

The granules of the extrudate were compression moulded for preparing specimen to test for Impact, and Tensile properties. Test specimens were prepared as per ASTM standards. Dumbbell shaped for tensile test (ASTM D638M-91), notched Izod impact strength (ASTM 256).

Measurement .Dumbbell shaped specimens were obtained by compression moulding. Tensile strength of the virgin polymer samples was evaluated according to ASTM D 638 M-91using Universal

Tensile Tester LR50K [Lloyd Instrument Ltd., U. K.] The crosshead jaw speed of 50mm/min was maintained for testing and a load cell of 5 KN was used. Rectangular bars of dimensions 63×12×12 (length× width × thickness in mm were compression moulded. The notch was cut on rectangular bar specimen using a motorized notch-cutting machine [Polytest Model 1, Ray Ran U.K.]. Impact strength was measured using Avery Denison's pendulum type, Impact Strength Tester; [model 6709].The results reported are average values of at least 5 test specimens.

III. RESULTS AND DISCUSSION

Tensile Strength

It is seen from figure 1 that tensile strength of wheat straw fiber reinforced polystyrene composite increased with increase of weight percentage (wt %) of wheat straw fiber in the composite. This is due to increased reinforcement of wheat straw fiber in composite.

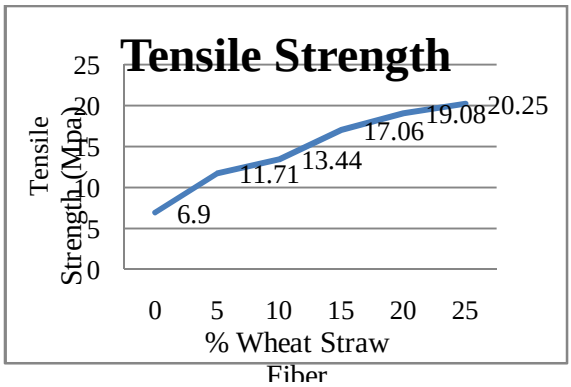


Fig. 1 Tensile strength of wheat straw fiber reinforced polystyrene composites

Impact Strength

With increase of wheat straw fiber content from 5% to 25%, impact strength of wheat straw fiber reinforced polystyrene composite increased. Impact strength of wheat straw fiber reinforced polystyrene composite is also higher than pure polystyrene. It is concluded that addition of wheat straw fiber results in increase of toughness of composite. Due to this impact property of composite get improved.

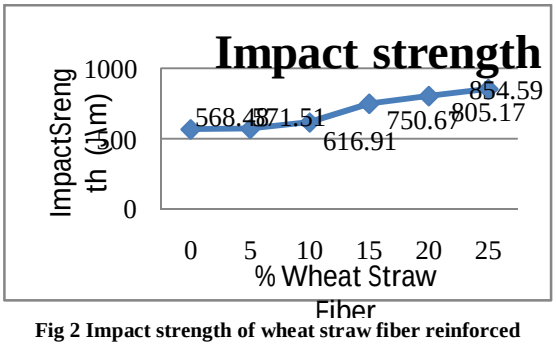


Fig 2 Impact strength of wheat straw fiber reinforced polystyrene composite

Hardness

From fig3 it is illustrated that the hardness of composite increased with increase of wheat straw fiber wt % in composite from 0% to 25%. This is attributed to increased resistance of composite to indentation due to improved stiffness of composite with addition of wheat straw fiber in composite.

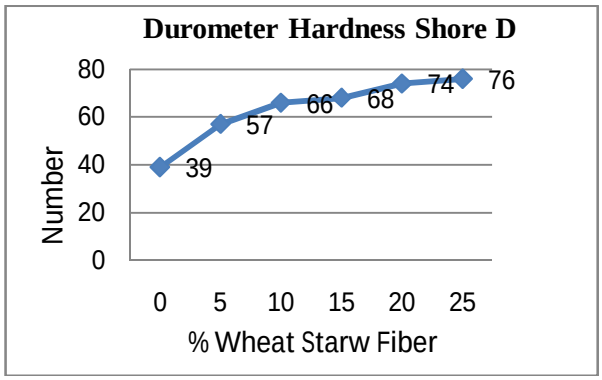


Fig. 3 Shore D hardness of wheat straw fiber reinforced polystyrene composite

Water absorption properties

The percentage (%) water absorption of pure polystyrene polymer, and 5 % to 25 % treated wheat straw fiber reinforced polystyrene composite are illustrated in figure 4 and figure 5. The water absorption test is carried out for 2hr and 24hr. It was observed that as percentage of fiber is increases the water absorption is also increases. Hence, it is concluded that NaOH treatment lowers % water absorption capacity of fiber. It is also observed that the % of water absorption of composite is increased with increase of wt % loading of wheat straw fiber but it is within an accepted limit.

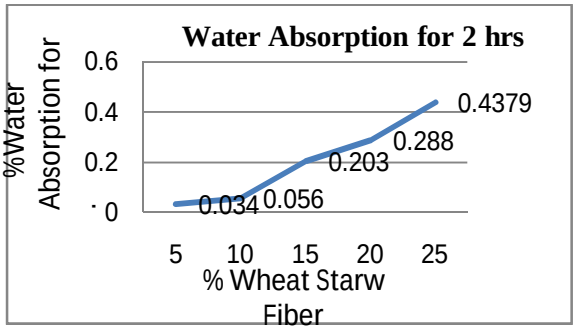


Fig. 4 Water absorption for wheat straw fiber reinforced polystyrene composite for 2 hrs

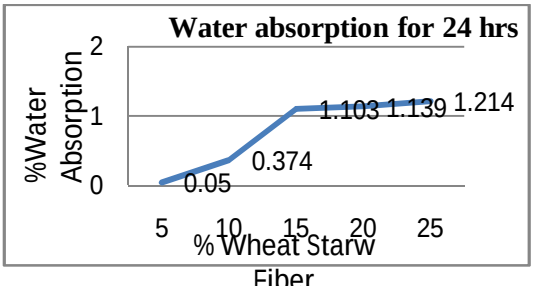
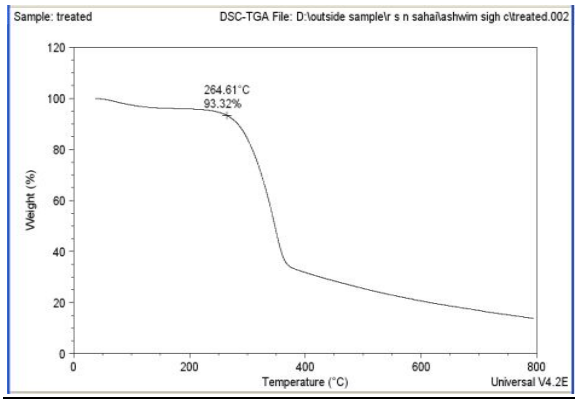
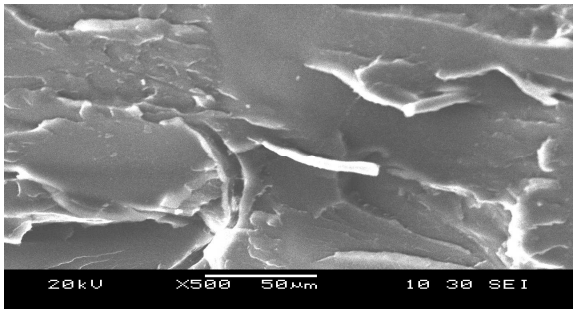


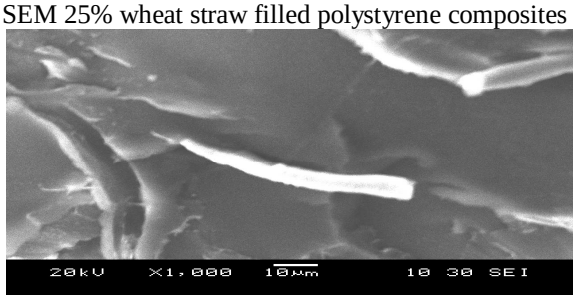
Fig. 5 Water absorption for wheat straw fiber reinforced polystyrene composite for 24 hrs

TGA of Wheat Straw Fiber





SEM 25% wheat straw filled polystyrene composites



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