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Evaluation of Wear Properties of Jute Reinforced Polypropylene Composites

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Abstract:- **The composite materials are manmade materials made of using diffent natural fibers(rice husk, carbon fiber, Glass fiber etc) which are used in variety of industrial applications. A relatively newer concept is to consider natural fiber as a reinforcing material. Both thermoplastic and thermoset matrices are used for development of natural fiber reinforced composites. Trying to achieve different tribological properties, the natural fiber, jute is reinforced in polypropylene composites. In the present work wear behaviour of polymer composites at different loads and at varied sliding velocities were studied. The composites were prepared using injection moulding machine by varying fiber weight percentage(5%, 7.5%, 10%, 12.5% and 15%). To study the wear behaviour of composites pin on disc wear testing machine was used. The coefficient of friction and wear loss are plotted against varied loads and at different sliding velocities(50cm/sec, 75cm/sec and 100cm/sec)**

Keywords: Jute fibres (white jute, Corchorus capsularis), thermoplastic, tribological properties

1. INTRODUCTION

Today the worldwide researches are being motivated on the studies of using natural fibers as a reinforcement in polypropylene composites. The regulation of the government and ease of availability of natural fiber made the researches to try for fiber reinforced polypropylene composites. With low cost, ease of manufacturing and high mechanical and tibological properties, natural fibers represents a good alternative to the most of the common composites. With the help of composites large variety of materials can be made. By appropriate usage of these natural fibers physical and mechanical properties of the polypropylene materials will be enhanced.

Large variety of reports have been on the use of materials such as minerals and inorganic oxides (alumina and silica) mixed with polymers like polypropylene[1, 2] and polyethylene[3, 4]. Very few studies have been made to use natural fibers in preparing natural fiber reinforced polymer composite. To study the natural fiber reinforced composites for tribological applications many attempts have been made[5 6]. Hard powders are reinforced in epoxy matrix[7].Wear resistance of three types of composite materials containing epoxy resin matrix, epoxy filled with silica, epoxy filled with tungsten carbide powder have been investicated and observed that the matrix filled with tungsten carbide powders have highest wear resistance. Flue dust is reinforced in unsaturated polyster and studied wear behaviour [8]

The wear resistence of material is an important requirement for many of the components. In the present work wear behaviour of jute reinforced polypropylene composites were studied.

1.1 Jute fiber

Jute which is known as "golden fiber" extracted from the bark of white jute plant (Corchorus capsularis) comes under the family malvacea. Jute fibres are composed primarily of the plant materials cellulose (major component of plant fibre) and lignin (major components of wood fibre). The cells of jute fiber vary from 0.05—0.19 inch in length and 20--22µ in thickness. Owing to the high price of composites, the user industries also demand a lower price for production of fiber components and at the same time improvement in quality. To achieve this natural fibers can be used[1-3]. In these categories jute is the vegetative natural fiber which yields a better tribological behaviour when it is reinforced with matrix polypropylene. The raw jute fiber is reinforced in polypropylene composites to enhance the tribological properties .

Fig 1(a): Jute fiber

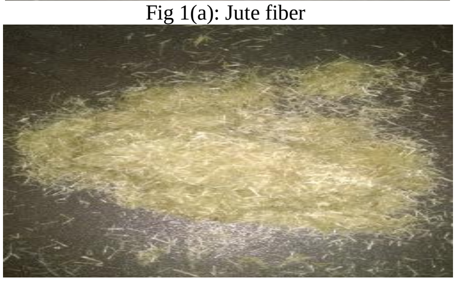

Fig1(b): Natural fiber - Jute of 3mm length

2. EXPERIMENTAL PROCEDURE

2.1.Materials used

The natural fiber Jute is gathered from Eluru. The jute fiber is made into 3-5mm size are reinforced into polypropylene to prepare the composites. Matrix material consist of polypropylene(H110MA) supplied by reliance industries limited, Hyderabad, India.

2.2.Fabrication of composite specimens

Proper proportion of fibres (0, 5, 7.5, 10, 12.5 and 15%) by weight and polypropylene pallets were then properly mixed to get a homogeneous mixture. The mixture was then placed in a 2.5 tonne plastic hydraulic Injection Moulding Machine, Model JIM–1 HDB, supplied by Texair Plastics Limited, Coimbatore as shown in fig2. At a temperature of 210 ^{0} C and at pressure of 1100 kgf/cm^2, all the specimens were developed for each weight friction of jute fiber composites. Percentage of fiber in the composite is maintained by its weight fraction.

Fig2: Injection moulding machine

Fig 3(a) Specimens Fig(b) After cutting to size

Wear test have been conducted in the Pin-on-disc type Friction and Wear monitor (DUCOM; TL20) with data acquisition system which was used to evaluate the wear behavior of the composites. It is versatile equipment designed to study wear under sliding condition only. Sliding generally occurs between a stationary specimen Pin and a rotating disc against hardened ground steel disc (En-32) surface roughness (R_a) 0.5 µm . The disc rotates with the help of a D.C. motor; having speed range 0-2000 rev/min with wear track diameter of 100 mm. Load is to be applied on pin (specimen) by dead weight through pulley string arrangement.

Fig 4 Wear test rig with data acquisition system

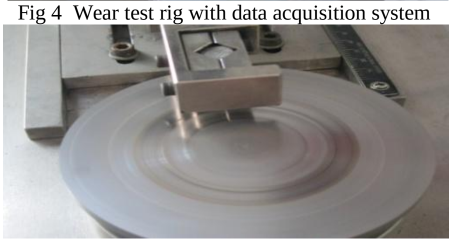

Fig 5: Wear test rig with specimen

2.2.Testing

Initial weight of the specimen is recorded with electronic digital balance weight scale. The sample is mounted on the arm of the tribometer. The load is applied by a pully arrangement on the sample. The loads may vary from 4kg , 6kg and 8kg . The motor which is provided with an electric transmits the energy in to rotary motion of the disc.The disc speed has to be changed to maintain required velocity.

Initially 50cm/sec sliding velocity is selected & the disc is made to rotate for the sliding distance of 1500m. For every 3min of intervals the friction of specimen due to wear is recorded using data accusation system, and average value is taken for calculating coefficient of friction. The weight of the specimen is again recorded after the test was completed. The difference between the initial weight and the final weight gives weight loss. The same test will be carried out for 4kg, 6kg and 8kg loads and at different sliding velocities 50cm/sec, 75cm/sec and 100cm/sec. The testing process is continued for 75cm/sec and 100cm/sec sliding velocity also.

3. RESULTS & DISCUSSION

3.1 Wear

Table 1 shows the coefficient of friction of composite between the rotating disc and the stationary specimen in the case of jute reinforced polypropylene at different loads and at 50cm/sec sliding velocity. Fig 6 represents the graphical representation of results. From the graph it is observed that with the increase of load the coefficient of friction decreases. It also observed that the addition of filler increases the coefficient of friction up to 12.5%. Further addition of filler i.e at 15%, coefficient of friction decreases. Fig 7& 8 represents the coefficient of friction at 75cm/sec & 100cm/sec respectively. The coefficient of friction decreases with increase in load and increases with addition of filler at 75 cm/sec & 100cm/sec sliding velocities.

	0%	5%	7.5%	10%	12.5%	15%
4kg	0.37521	0.38541	0.39884	0.42122	0.44125	0.43111
6kg	0.35121	0.35189	0.36445	0.37545	0.40121	0.39118
8kg	0.33254	0.35245	0.36554	0.35229	0.39785	0.38215

Table 1: coefficient of friction at different loads and at 50cm/sec sliding velocity

	0%	5%	7.5%	10%	12.5%	15%
4kg	0.38145	0.39857	0.41251	0.45124	0.46154	0.47114
6kg	0.36454	0.36459	*0.36512*	*0.37545*	0.41325	0.45125
8kg	0.33468	0.36449	0.36554	0.35322	0.40121	0.42312

Table 2: coefficient of friction at different loads and at 75 cm/sec sliding velocity

	0%	5%	7.5%	10%	12.5%	15%
4kg	0.38740	0.40110	0.42154	0.45456	0.46154	0.47245
6kg	0.37454	0.37462	0.37512	0.37545	0.41325	0.46154
8kg	0.35415	0.36449	0.36154	0.36325	0.40129	0.0.43451

Table 3: coefficient of friction at different loads and at 100 cm/sec sliding velocity

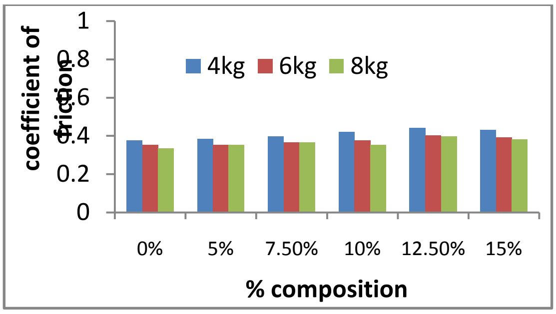

Fig 6: coefficient of friction at different loads and at 50cm/sec sliding velocity

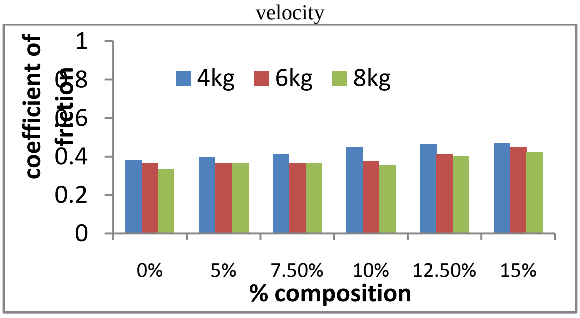

Fig 7: coefficient of friction at different loads and at 75cm/sec sliding velocity

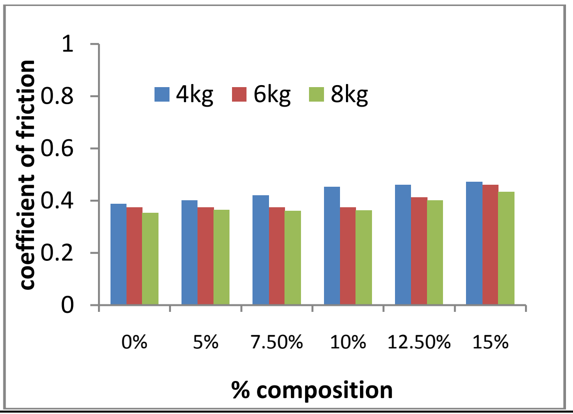

Fig 8: coefficient of friction at different loads and at 100cm/sec sliding velocity

Table 4 shows the weight loss of composite without NaOH treatement between the rotating disc and the stationary specimen in the case of jute reinforced polypropylene at different loads and at 50cm/sec sliding velocity. The weight loss of composite at 50cm/sec sliding velocity shown in the graph which was plotted against the % composition and weight loss in grams. As the load increases weight loss decreases with the addition of filler material the weight loss increases gradually. The graph in fig 9 and fig10 shows the weight loss at 75cm/sec & 100cm/sec sliding velocities.

	0%	5%	7.5%	10%	12.5%	15%
4kg	0.02	0.003	0.003	0.004	0.004	0.005
6kg	0.001	0.002	0.002	0.003	0.003	0.004
8kg	0.001	0.001	0.001	0.002	0.002	0.003

Table 4: weight loss at different loads and at 50cm/sec sliding velocity

	0%	5%	7.5%	10%	12.5%	15%
4kg	0.004	0.004	0.005	0.005	0.006	0.006
6kg	0.002	0.003	0.004	0.004	0.005	0.005
8kg	0.002	0.002	0.003	0.003	0.003	0.004

Table 5: weight loss at different loads and at 75cm/sec sliding velocity

	0%	5%	7.5%	10%	12.5%	15%
4kg	0.004	0.005	0.006	0.006	0.006	0.006
6kg	0.004	0.003	0.004	0.004	0.005	0.005
8kg	0.002	0.002	0.003	0.003	0.004	0.004

Table 6: weight loss at different loads and at 100cm/sec sliding velocity

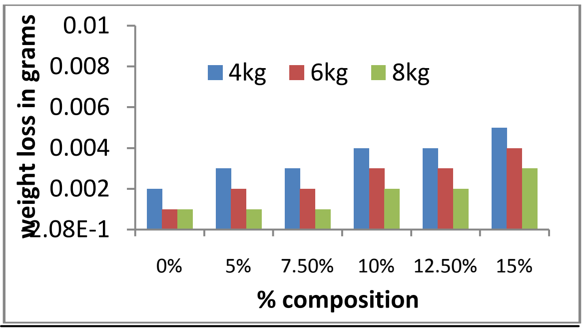

Fig 9: weight loss at different loads and at 50cm/sec sliding velocity

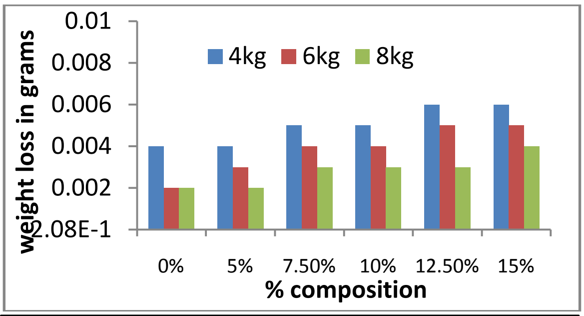

Fig 10: weight loss at different loads and at 75 cm/sec sliding velocity

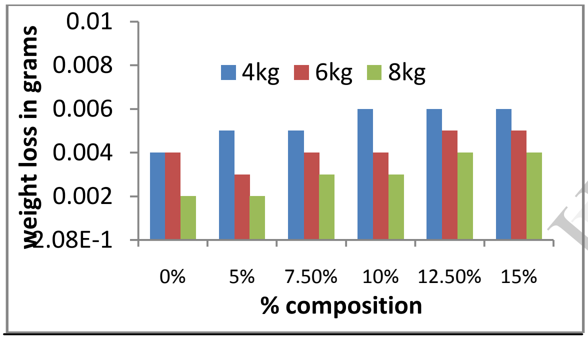

Fig 11: weight loss at different loads and at 100 cm/sec sliding velocity

4. CONCLUSIONS

The conclusions has been given by conducting the above test and obtained graphs

1. Wear loss and coefficient of friction of jute reinforced composites decreases with increase in normal loads.
2. The coefficient of friction is increased up to 12.5% and then decreased with the addition of filler at sliding velocity of 50Cm/Sec.
3. The coefficient of friction is increased with the addition of filler at sliding velocity of 75Cm/Sec & 100 Cm/Sec.
4. The coefficient of friction is decreased with increase in normal loads. The coefficient of friction at 4Kg is 0.38541 at 6Kg is 0.35189 & at 8kg is 0.33254.
5. The weight loss is decreased with increase in sliding velocity and increased with increase in addition of filler material.

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