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Investigation in to Erosive wear Performance Of Hybrid Composites Using Taguchi Approach

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ABSTRACT

Over the last century, polymers have emerged as one of the most indispensible components used in everyday life, epoxy or poly-epoxide being one such example. Several research efforts have been put to studied the effectiveness of natural fiber based materials on the Erosive wear behavior of epoxy composites, focusing mainly on fibers and their weight percent's within the composites. Different types of natural fiber are used to reduce the traditional fiber in composite fabrication due to their innate properties when compared to other materials. A new hybrid composite with combination of traditional and natural fibers reinforced in to epoxy polymer were prepared. Erosion wear behavior of Hybrid composite (silk-jute-glass) was studied using dry silica sand as an erodent. A plan of experiments based on the Taguchi technique was used to acquire the data in a controlled way. The objective was to investigate the erosion wear resistance of natural fiber over traditional fiber and also the variation of wear resistance as the silk fiber percentage increases. It was found that as the percentage of silk fiber increases the wear resistance increases. It was also found that the wear resistance of natural fiber is 90 % of the traditional fibers given..

Keywords - **Erosion wear, Hybrid composite, Taguchi, S/N ratio**

I. INTRODUCTION

Resent trends in the field of composite materials all the researchers showing interest in using the waste material as a filler material. All shows interest in developing the new natural fiber instead of traditional fibers because of their low cost, combustibility, lightweight, low density, high specific strength, renewability, non-abrasivity, non-toxicity, low cost and biodegradability. Still yet many challenges to overcome in order to become largely used as reliable engineering materials for structural elements. However, their use is steadily also increasing and many large industrial corporations are planning to use, or have yet commencing to use, these materials in their products [1].Natural fibers are renewable and biodegradable material and are largely available in the nature in worldwide [2].pineapple leaf [3], oil palm fiber [4] Hemp, sisal, jute, kapok [5], jute [6], rice husk [7], bamboo [8] and wood[9] the fibres most commonly used as reinforcing natural fibers in polymer matrix. Silk is one of the most attracted materials which have more strength due to main content of cellulose and lignin. Jute and glass also have the greater strength. It is also established that erosive wear resistance of reinforced polymer composite is usually higher than unreinforced polymer matrix [10]. Many researchers studied the tribological and mechanical properties of hybrid composites; they had taken different stacking sequences and different parameters for erosion test [11],[12].

In order to achieve the accurately and repeatedly of the certain values of the erosion rate, the parameters which influence of the process have to be controlled accordingly. Generally such parameters are too large and the parameter-property correlations are not always known, statistical methods can be employed for precise identification of significant control parameters for optimization. In recent years the Taguchi method has become a widely accepted methodology for improving productivity. This methodology consists of a plan of a minimum number of experiments with the objective of acquiring data in a controlled way, executing these experiments, and analysing data, in order to obtain information about the behavior of a given process. One of the advantages is that optimum working conditions determined from the laboratory work can also be reproduced in the real production environment [13]. Precisely, Taguchi's design is a simple, efficient, and Systematic approach to optimize designs for performance, quality, and cost [14],[15][16][17][18].

Hence, in this work, the Taguchi experimental design method was adopted to investigate the effects of the silk fiber on the erosion wear resistance of hybrid (silk-jute-glass) composite and also the

comparison between the traditional and natural fiber erosion resistance..

II. EXPERIMENT DETAILS

2.1 **Specimen preparation:** New layered Hybrid Composite slabs are prepared with 150×60×5 mm^3 by using high strength E-glass fiber, jute fiber and waste silk fiber with Epoxy as a matrix by hand lay-up technique. Different set of composites are prepared those are given in table 1.the E-glass fiber, jute fiber, waste silk fiber and Epoxy possesses a density of 2.56 gm/cm3,1.4 gm/cm3,1.34 gm/cm^3 and 1.1 gm/cm3 respectively. Composites were prepared by using resin to hardener ratio as 10:1. Samples were cut in a standard size of 20×20×5 mm3 and polished before testing on an Erosion tester.

The solid particle erosion experiments were carried out as per ASTM G76 standard on the erosion test rig shown in Figure 1 to minimize the set of experiments a standard Taguchi experimental plan with notation L9 was chosen and the details are listed in Table 1. The 5 and 10 % silk fiber hybrid composite is eroded at different impact angles (i.e., at 300, 600, 900angle), standoff distances (120,150 and 180) at different impact velocities (i.e., at 48, 70 and 82 m/s) with the erodent Particles

Table 1. Composite sequence and names

Sl .no	Composite sequence	Name eroded surface	Name eroded surface
1	Jute+5% silk+ glass	GS1	JS1
2	Jute+10% silk+ glass	GS2	JS2

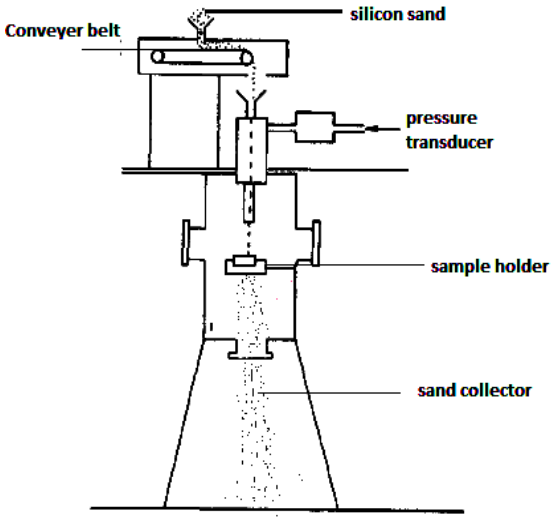

Figure 1. Semantic diagram of erosion test rig

The numbers of experiments are very high with all these parameters so we designed a set of experiments by using a taguchi method L9 the set and the erosion results are shown in Table 2.

Table 2. Experimental lay out and erosion test results

Sl. no	Angle of impact (degree)	Impact velocity (m/s)	Stand of distance (mm)	Erosion rate (gm/gm) GS1 X 10^{-5}	Erosion rate (gm/gm) GS2 X 10^{-5}	Erosion rate (gm/gm) JS1 X 10^{-5}	Erosion rate (gm/gm) JS2 X 10^{-5}
1	30	48	120	7.3	5.3	25.52	16.5
2	30	70	150	8.2	14.32	29.3	22.48
3	30	82	180	29	16	41.3	32.5
4	60	48	150	10.6	8.65	23.3	13.5
5	60	70	180	20.1	16.2	29.2	23.1
6	60	82	120	31.1	25.3	39.9	34.1
7	90	48	180	15.9	14.36	38.9	31.24
8	90	70	120	33.5	22.9	52.9	44.52
9	90	82	150	42.5	28.46	61.6	51.52

Table 3. S/N ratio of different test conditions

Sl. no	Angle of impact (degree)	Impact velocity (m/s)	Stand of distance (mm)	SNRA GS1	SNRA GS2	SNRA JS1	SNRA JS2
1	30	48	120	82.7335	85.5145	71.8624	75.6503
2	30	70	150	81.7237	76.8811	70.6626	72.9641
3	30	82	180	70.7520	75.9176	67.6810	69.7623
4	60	48	150	79.4939	81.2597	72.6529	77.3933
5	60	70	180	73.9	75.8	70.6	72.7

				361	097	923	278
6	60	82	120	70.1 448	71.9 376	67.9 805	69.3 449
7	90	48	180	75.9 721	76.8 569	68.2 010	70.1 058
8	90	70	120	69.4 991	72.8 033	65.5 309	67.0 289
9	90	82	150	67.4 322	70.9 153	64.2 084	65.7 605

III. RESULTS AND DISCUSSION

Figure 2 illustrates the trend of erosion wear rate with different test conditions, as obtained in Table 1. By analyzing the figure it is clearly visible that the erosion wear is less for the material exposed to traditional filler (E-glass). One of the most important observations is that as the silk fiber reinforcement increases the erosion wear rate decreases in both the traditional and natural fiber expose to impingement of particles. The curves which are obtained are very near to each other it means that the natural fiber can replace the traditional.

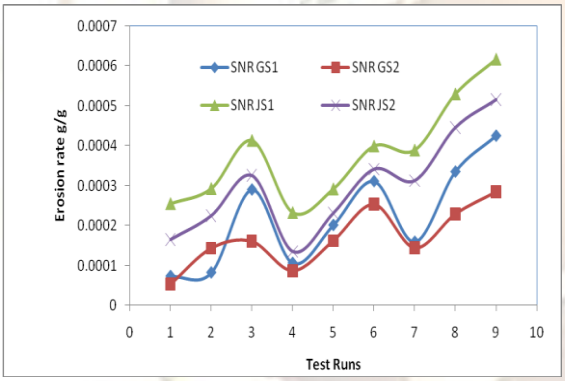

Fig.2 Erosion rate VS Test runs

Figure 3 illustrates the trend of SN ratio with different test conditions in table 3. It is observed that the SN ratio of the 10 % silk reinforced glassGS2 have highest SN Ratio than compared to the others it shows that the best erosion resistance is shown by GS2. It is also noticed that the jute and silk 10 % reinforced almost near to the GS1 and GS2 it conforms that the natural fibers also gives best erosion resistance along with the traditional fillers.

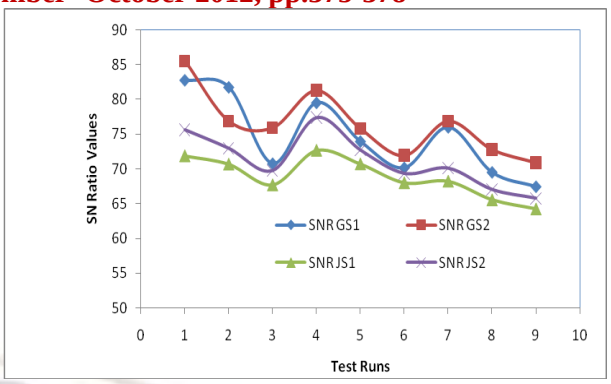

Fig 3 SN Ratio VS Test runs

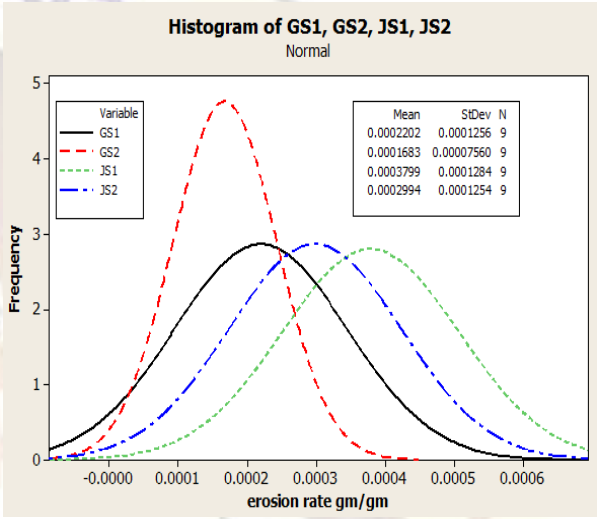

Fig 3 Histogram of all composites

From the fig 4 interpreting the results that the erosion rate is very less compared to other in GS2. This is indicated by the tabled means that the value for GS2 is very less compared to others (0.0001683), as well as the relative position of the peaks for the fitted normal distributions.

The standard deviation for other three (GS1, JS1 and JS2) are much greater than that of GS2 (0.00007560). This translates into a shorter and wider-looking fitted distribution for GS2.

IV. CONCLUSION

Erosive wear performance hybrid fiber reinforced composites were determined experimentally by using the Taguchi experimental design method and the following conclusions were drawn:.

In the initial investigation it is observed that the traditional fiber gives the best erosion resistance.

It is also observed that as the silk fiber percentage increases the erosion resistance also increases.

Results of natural hybrid fiber composites under consideration revealed that erosion wear resistance is 90% in traditional fibers given.

From the results of S/N ratio also it is proved that

the natural fibers are giving almost equal erosion resistance given by traditional fibers.

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