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Mechanical Properties of Jute/E-glass Fiber Reinforced Polymer Composites influenced by Hygrothermal Effects.

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Abstract: During service, almost all materials suffer degradation in their properties when subjected to different conditions such as high temperature and moisture. Composite materials are no exception to this general degradation. Here it is proposed to study jute/E-glass fiber reinforced polymer composite at different temperatures with varying humidity conditions. The composite materials are tested for tensile and flexural properties at ambient conditions and in wet-hot conditions. Influences of these variables on microstructure of these composite materials are studied using scanning electron microscopy (SEM). It is found that tensile strength of the composites that have undergone treatments mentioned above is reduced which assigns the absorption of water molecules on the surface which weakened the composites.
Key words: Environmental degradation, Moisture, Tensile, scanning electron microscopy (SEM), Jute, E-glass fiber

I. INTRODUCTION

Irrespective of nature of material, whether it is a metal or non-metal, it will fail if the conditions are severe-it may be high pressure or high temperature or adverse chemical environment or fields (electric or magnetic) which may cause damage to the material. This phenomenon is common in everyday life, since human beings always drive for weight reduction. They are led to explore light weight structures. As we know generally metals are heavier, there has been an intensive research to find alternative materials such as ceramics and polymers. Even in these two materials, polymers (plastics) are tough competitors to the ceramics as the former is lighter and could easily be fabricated into any kind of complicated shapes at very low temperatures, whereas ceramics need high temperature facilities to manufacture into products. An extensive research on different materials has clearly shown that it is an advantage to have composite materials consisting of two or more constituents (phases) with distinct physical and chemical properties. Therefore we have undertaken to study composite materials based on fiber reinforced composites- Jute fiber reinforced by E-glass fiber. With this background, it is supposed to study involving the composites consisting of FRC's. Effects of temperature and moisture on Jute/E-glass fibers are studied and micro structural correlation is also formulated.

II. MATERIALS

The material is Jute fiber reinforced by E-glass fiber composite. The materials are purchased from Ram composites Pvt. Ltd, Hyderabad. Jute/E-glass composites were prepared in square shape samples of size 25mmx25mmx3mm by the conventional hand layup process.

III. EXPERIMENTATION

Samples that are used in this investigation are by Hand layup process and the samples areof square shape of size 25mmx25mmx3mm. These samples are subjected to hygrothermal treatment in an environmental chamber at 71^0C ± 2 ^{0}C and 85% ± 4 % Relative Humidity. Later these samples were tested for mechanical properties like tensile and flexural tests. A photograph of the wet-hot testing machine is shown in Fig.1. After that the specimens were subjected to micro structural characterizations.

Fig 1. The wet-hot testing machine

A. *Weight loss/ gains:* Samples were removed from the test chamber after 48 hours, 72 hours, 96 hours and 120 hours that were kept at in water and after 48 hours, 72 hours, 96 hours and 120 hours for specimens placed in hot temperature, in order to evaluate the weight changes under each exposure condition**.** Some tests were done to specimens that were placed at 24 h in relative humidity and 24 h in 50^0c and continuing the same for 3 cycles and weight is observed.

B. *Tensile Tests*: Square shaped specimens 25mm x 25mm x 3mm were tested in tension and the data obtained was analysed for determining the properties.

C. *Flexural Tests:* ISO14125[6] testing procedure is used for flexural tests to find out the retrogression, influenced by different exposure conditions

D. *Surface morphology:* Surface morphology is studied using scanning electron microscope (SEM) and ascertained the influence of environmental treatments on microstructure.

IV. RESULTS

A. *Weight loss/ gains*

The absorption of materials depends upon its chemical composition and period of curing of the polymer matrix. Therefore measurement is done for weight loss/gain with the time and temperature and the data is tabulated in table 1.

Table 1: Experimental results for weight changes:

S.No	No of Hours of retrogression	Initial weight (gms)	Final weight when subjected to moisture (gms)	Final weight when subjected to Temperature at 90^0 (gms)	Final weight when subjected to wet and hot conditions (gms)
1	36	25	25	24.8	24.5
2	48	25	25.2	24.4	24.9
3	60	25	25.4	24.4	24.6
4	72	25	25.6	24.2	24.3
5	84	25	25.9	24	24.5
6	96	25	26.1	23.9	24.8
7	120	25	26.4	23.8	24.7

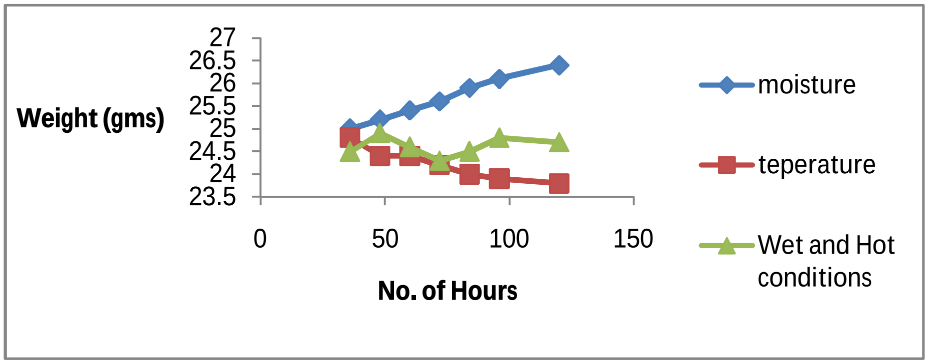


Fig 2: Graph showing change in Weight with respect to No of hours.

B. Mechanical Properties evaluation

The specimens have been exposed to moisture and hot conditions are subjected for tensile and flexural strength tests and the data have been compiled in table 2 and 3 respectively.

Table.2: Experimental results for exposure of specimens at different temperatures and tensile strength.

S.No	No of Hours retrogression	Initial tensile strength (Mpa)	Final tensile strength when subjected to moisture (Mpa)	Final tensile strength when subjected to Temperature at 90^0 (Mpa)	Final tensile strength when subjected to wet and hot conditions (Mpa)
1	36	80	94	78	77
2	48	80	92	72	76
3	60	80	82	70	65
4	72	80	78	67	58.5
5	84	80	72	65	50
6	96	80	68	60	49.2
7	120	80	66	58	38.7

Tensile strength of the specimens is plotted for no. of hours of retrogression in Fig 3. It shows a download trend of the strength with respect to time for all kinds of conditions.

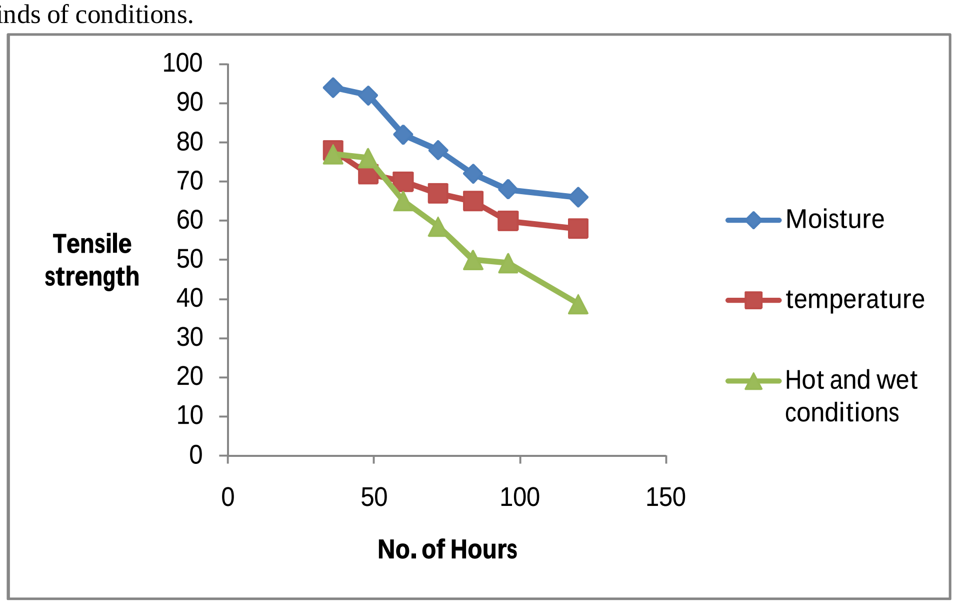


Fig3: Graph showing change in tensile strength w.r.to No of hours.

Table.3: Experimental results for exposure of specimens at different temperatures and tensile strength.

S.No	No of Hours retrogression	Initial flexural strength (Mpa)	Final flexural strength when subjected to moisture (Mpa)	Final flexural strength when subjected to Temperature at 90^0 (Mpa)	Final flexural strength when subjected to wet and hot conditions (Mpa)
1	36	75	90	78	75
2	48	75	88	69	65.7
3	60	75	79	68	67.3
4	72	75	75	66	64
5	84	75	70	65	53.6
6	96	75	66	58	46.3
7	120	75	64	55	40

The flexural strengths of the specimens also have exhibited a similar tend of tensile strength in Fig.4.

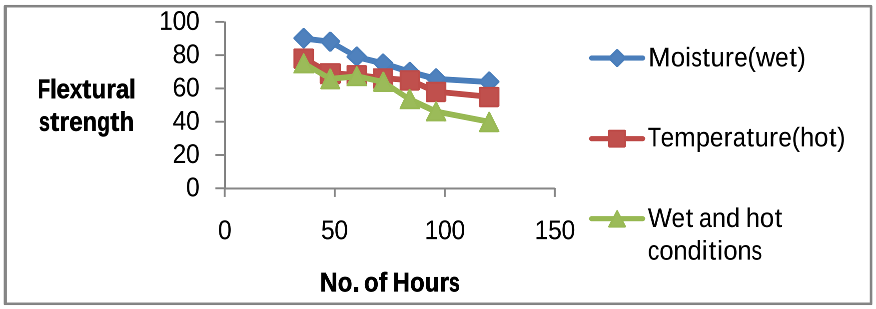
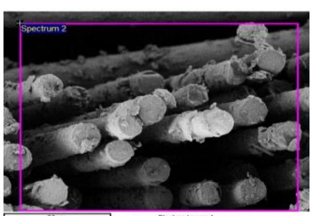


Fig4: Graph showing change in Flexural strength w.r.to No of hours

C. Surface morphology: The specimens subjected to various conditions have been observed for their micrographs by Scanning electron microscope (SEM). The moisture absorbed by specimen micrograph is given in Fig.5 while the temperature exposed and alternate wet and hot conditioned micrographs are given in Fig.6 and Fig.7 respectively.



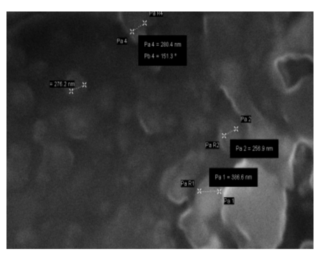


Fig.6: Temperature (Hot)

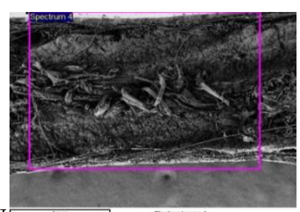


Fig.7: W

V. DISCUSSIONS

The initial weight of each specimen is 25gms and when it is subjected to moisture absorption it has increased to 26.4 gms due to absorption property of jute. Weight is lost when the specimens are subjected to alternate wet and hot conditions. The strength of specimens is reduced due to loss of loss of adhesion shown in fig.5 between fiber and polymer in case of wet conditions. While the specimen loss its weight when exposed to temperature is due to loss of binder.

The flexural strength are also reduced in them with tensile strength values due to similar kind of quality characteristic of the polymer exhibiting in all directions.

VI. CONCLUSIONS

Mechanical properties of Jute/E-glass fiber composites with effect of moisture and temperature environments are studied and following conclusions are drawn.

A. The specimens who are exposed to moisture from 36 to 120 hours have gained the weight from 25gms to 26.4gms. It can be assigned for the absorption of water particles by the jute of the composite material. But the weight reduction in the case of a) temperature exposure and b) alternate wet and hot condition are discretely low compared to the specimens exposed to moisture alone.

B. The specimens have exhibited a tensile strength of 80Mpa and flexural strength of 74Mpa in the initial normal conditions. The tensile and flexural strength of the specimen reduced as they got exposed to moisture conditions. It can be assigned due to loss of adhesion between fiber and polymers. Similarly the specimens exposed to hot conditions alone, the strength rate is reduced compared to moisture alone exposed specimens and is attributed to the loss of binder at high temperatures and matrix shattered and exhibited the brittleness.

C. In case of hot and wet conditions exposed specimens, the strength and flexural strength also got reduced and is thought to be due to combination of loss of binder and adhesion due to water and temperature in alternate cycles.

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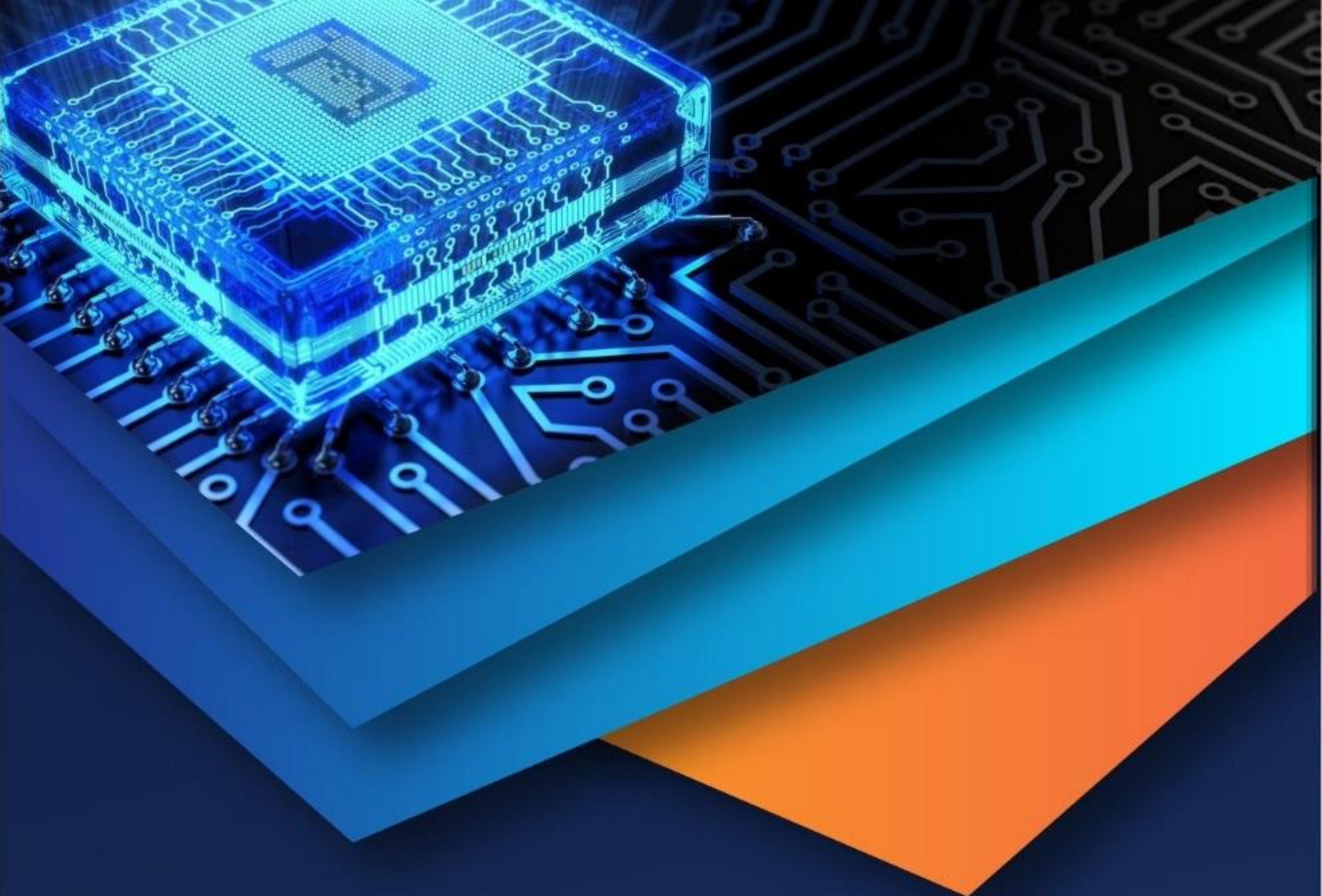

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