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# Evaluation of Mechanical and Electrical Properties of GPG Hybrid Laminates

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**Abstract—***In the present work, Palm fibre reinforced polymer composites are prepared by hand-lay-up technique. Mechanical and Electrical tests are carried out for tensile strength, electrical breakdown strength at normal atmospheric conditions on the normally prepared samples and also on the samples soaked in sea water for a period of 12 hours. The tests are carried out in a high voltage laboratory of JNT University, Kakinada. Leakage current is measured by electrical tests are conducted to find out the insulation properties. To find out the Resistance, current is measured by applying a voltage of 500kV between the terminals connected to the specimens (GPG composites) of different volume fractions. It is observed that the leakage current increases with increasing fibre volumes. Breakdown voltage decreases with increasing fibre volumes.*

**Keywords:** *PFRP composite, hand-lay-up technique, weather conditions.*

## 1. INTRODUCTION

Natural fibres have high work of fracture (~$10^5$ J/m$^2$) resulting in composites to have high resistance to crack propagation. In addition, these fibres are non-toxic to work with. Additional benefits such as friendly processing for both men and machine and high stiffness per unit weight have lead to extensive research in the last two decades mainly in European automotive industry [1, 7], wherein Chopped banana fibre (25 wt%) polyester composites are prepared by hand lay-up practices which are being used for car interior parts, shipping industry, etc. Various mechanical properties of the laminates with and without accelerated weathering tests (ASTM D570) have been evaluated [4]. It was found that the composite had a specific modulus of 2.39, about the same order as that of glass fibre plastics, while impact strength is about 10 x $10^3$ J/m$^2$. After weathering tests, it is observed that chopped fibre polyester composites showed 8%, 13% and 26% reduction in modulus, ultimate tensile strength and flexural strength, respectively. On the other hand, banana fibre – cotton fabric polyester composite on accelerated weathering revealed little change in modulus, tensile and flexural strength. Literature is available on the production, and mechanical behavior of composites obtained by reinforcing epoxy with fibre of glass, boron, carbon silicon carbide etc. Many researchers in the past have developed composites with natural fibres such as sisal henequen, jute, banana, cotton, etc., but the work on the palm reinforced plastic composites, palm reinforced oriented plastic composites and glass-palm-glass reinforced plastic hybrid composite (GPG), is not available in the literature, even though palm has reasonably high values of 'high work of fracture'.

## 2. FABRICATION OF COMPOSITES

GPG laminates are prepared by using hand-lay-up techniques. Laminates with approximately 10%, 20%, 30% and 40% of the fibre volume fraction are prepared. For the laminates with volume fraction 50% above it is observed that wetting of the fibre is not proper and there is not much an improvement in strength. The glass fibre is placed over the top of first layer, resin is coated and palm fibres are placed over it. Laminates with 20%, 30% and 40% of the fibre volume fraction are prepared (GPG).

## 3. MECHANICAL TESTS

As per ASTM standards the specimen are prepared to the required size of 250mmx25.5mmx4mm with $0^o$, $45^o$, $90^0$ of fibre orientation. GPG samples are tested on tensile testing machine; UNITEK-95100 under a load of 25KN and with a cross head speed of 20mm/min.The specimens is held by flat grooved grips.

## 4. ELECTRICAL TEST

The electrical break down strength of any material depends on the following parameters and conditions : i). The geometry and surface conditions of the specimen. ii). The wave shape and magnitude of the applied voltage. The two factors decide the intensity of the electrical field at various points which is a significant factor in the electrical breakdown strength. In the present study the electrical break down strength of the specimens is also studied considering it as an important property or parameter. As per ASTM-D3039 standards, specimens are prepared in 250 x 25.5 x 4 mm size with $0^0$, $45^0$ and $90^0$ of fibre orientations. The present test is designed to measure the leakage current between two points when a high voltage is applied at the ends of the specimen fastened to conducting clips. Leakage test is conducted using a Cascade transformer, 100 kVA, 500 kV, 200 µA to provide high voltage and an ammeter is connected to measure the leakage current. Resistance is calculated using the Kirchoff's law (V=I R) at constant voltage as shown in fig 3.1. Specimens are subjected to tests under normal condition and also under wet condition by way of soaking the normal and soaked in sea water for 12hrs. Breakdown voltage are found out on these specimens.

**Specifications of the transformer:**

Instrument : CASCADE transformer 100kVA, 500kV, 200µA
Voltage : Power frequency, 50Hz, AC voltage
Current : 200µA (Max.)
Ammeter : 0-200 µA
Wet Temp : $25^0$C
Dry Temp : 28 $^0$C
Pressure : 740 mm of Hg.
The above facilities are available with Jawaharlal Nehru Technological University, kakinada, India .

## 5. BREAKDOWN VOLTAGE TEST

In general the electrical breakdown strength of any solid dielectric is governed by the imperfections in the structure of the material, such as the cavity or air bubbles, surface factors etc. Further, the electrical breakdown strength also depends on electrical conductivity which in turn depends on wet conditions and salinity of the water along with the level of impurities like suspended particles, (both inorganic and organic) fibourous materials and the size and the number of air bubbles etc. There are theories which explain the breakdown strength of solid dielectric materials based on all the irregularities and geometry. In the present case, certain electrical breakdown tests are conducted on the prepared samples.

## 6. TEST PROCEDURE

The required specimen is cut to the sizes conforming to the ASTM standards. Test voltage is applied across the specimen via suitable test gear as shown in fig 3.1.

The applied voltage is gradually increased till the specimen exhibits fire or flashover. The applied voltage at that instant is considered as the break-down voltage of the test specimen. In this way, the specimens under several conditions as indicated below are tested and the results thus obtained are shown in the form of plots in fig3.3 to3.4.

**Test conditions-1:** The specimens are tested for breakdown voltage under normal atmospheric conditions as shown in fig 3.2.

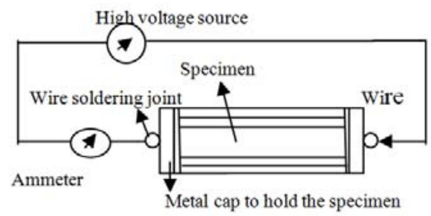


**Fig. 3.2: Break down voltage test rig.**

## 7. RESULTS AND DISCUSSIONS

Figs. 3.3-3.4 show the effect of palm fibre contents on the current for unidirectional, palm-glass-palm hybrid and glass-palm-glass hybrid composites.

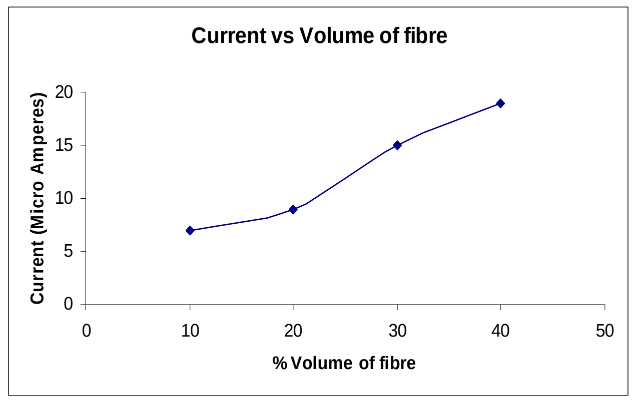


**Fig. 3.3: Effect of palm fibre volume on current, unidirectional composite**

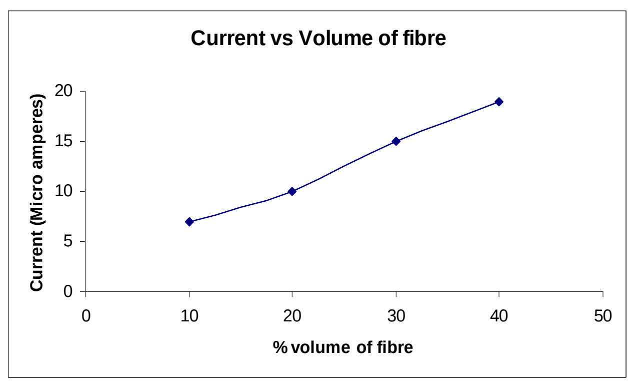


**Fig. 3.4: Effect of palm fibre volume on current, GPG hybrid composite.**

**Table 1: Palm Unidirectional Composites**

| Sample no (%Vf) | Applied Voltage (V) KV | Current (I) µA | Resistance R=V/I (MΩ) |
|---|---|---|---|
| 10 | 10 | 7 | 1428 |
| 20 | 10 | 8 | 1250 |
| 30 | 10 | 9 | 1111 |
| 40 | 10 | 10 | 1000 |

**Table 2: GPG hybrid composites**

| Sample no %Vf) | Applied Voltage (V) KV | Current(I) µA | Resistance R=V/I (MΩ) |
|---|---|---|---|
| 10 | 7 | 7 | 1000 |
| 20 | 7 | 9 | 777 |
| 30 | 7 | 15 | 466 |
| 40 | 7 | 19 | 368 |

The curve depicts increased current values with increasing fibre volumes. The increase in current indicates an increase in electrical conductivity and will be further accentuated by the presence of voids and other discontinuities.

Referring to the tables 1 and 2 . It is interesting to observe that the conductivity of the samples is progressively increasing as the fibre content is increasing for the same applied voltage. This is in accordance with the natural behavior i.e. more and more fibre resistances are becoming parallel as the fibres are increased, there by effective sample resistance between the end points decreasing. This behavior is very much observed in figs.3.3 to 3.4 as the conductivity increases the breakdown strength decreases. This behavior is very well observed (affirmed) as reported in figs 3.6 to 3.8. Under salinity conditions, the breakdown voltage results for the GPG hybrid and palm reinforced composites show a very narrow range of values over the entire range of volume contents. This may be attributed to that, the lower fibre contents are good enough for sufficient soaking of the saline volumes. This property may be of interest from the practical applications in the electrical industry. However, further investigations are needed to confirm our above comments.

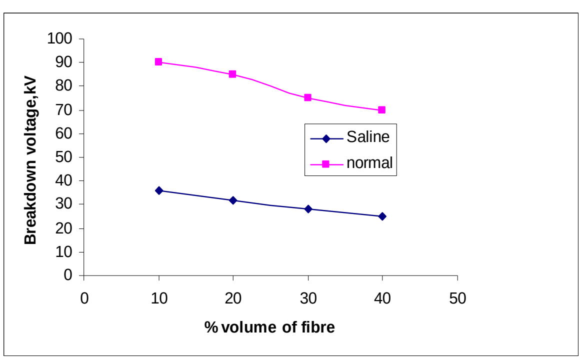


**Fig. 3.6: Effect of fibre volume on break down voltage for the sample at room conditions and after soaking in sea water. (GPG Composite).**

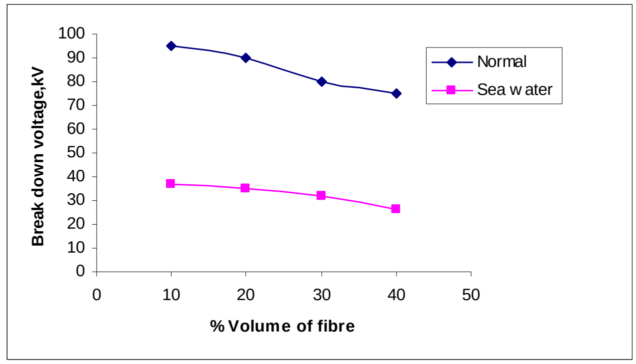


**Fig. 3.7: Effect of fibre volume on break down voltage for the sample at room conditions and after soaking in sea water. (GPG hybrid Composite**

For the salinity condition, the variation in breakdown voltage if made marginally same by suitable measure, then the break down voltage can become independent of volume of fibre.. This aspect is left for future study. The presented results lead to the following observations.

## 8. CONCLUSIONS

- Leakage current increases with increasing fibre volumes.
- Breakdown voltage decreases with increasing fibre volumes.
- Saline water soaked samples exhibit poor breakdown voltage compared to the normal samples.
- Saline water soaked samples show more or less constant break down voltage over a reasonable range of fibre volume.

## REFERENCE

[1] Pulkanszky, B., Belina, Rockenbaucer, A., and Maurer, F.H.J., *"Effects of nucleation, filler anisotropy and orientation on the properties of PP composites"*, Composites,(1994),25,pp.205-214.

[2] Govardhan Reddy, B., Rao, D.N., Bhargava, N.R.M.R. Prasad, V.V.S,. *"Damage Mechanism under tensile loading of continuous jute reinforced polyester composites"* Proc. Third International conference on 'Advances in composites' ADCOMP-2000, August 2000, Bangalore, India. Pp.24-26.

[3] McLaughlin, E.C., *"The Strength of bagasse fiber reinforced composites"*. J. Material Science 15 (April 1980) pp.886-890.

[4] Sefain, M. Z., Fedl, M. A. and Rakha, M., *"Thermal studies of hardboard impregnated with different resins"*. *Research &Industry (India)*, 29 (January 1984) pp. 39-42.

[5] Mohan, R., Master of Engineering Dissertation, Indian Institute of Science, Bangalore, 1982 78we

[6] Rijswijk, Ir.K.van, "The future of natural fibre reinforced plastics" pp 106-111., (2003). 2629 HS, Delft The Netherlands.