Abstract

Natural fibers, such as sisal, flax and jute, possess good reinforcing capability when properly compounded with polymers. These fibers are relatively inexpensive, originate from renewable resources and possess favorable values of specific strength and specific modulus. Thermoplastic polymers have a shorter cycle time as well as reprocessability despite problems with high viscosities and poor fiber wetting. The renewability of natural fibers and the recyclability of thermoplastic polymers provide an attractive ecofriendly quality to the resulting natural fiber-reinforced thermoplastic composite materials. Common methods for manufacturing natural fiber-reinforced thermoplastic composites, injection moulding and extrusion, tend to degrade the fibers during processing.

Development of a simple manufacturing technique for sisal fiber, sugarcane bagasse-reinforced polypropylene composites, that minimizes fiber degradation and can be used in developing countries, is the main objective of this study. Combination of sisal and sugarcane bagasse fibers possesses good reinforcing capability when properly compounded with polymers.

Keywords: Sisal and Sugarcane fibers, Fabrication, Mechanical performance.

Introduction

The fibre was washed thoroughly with water and dried in an air oven at 80°C for 6 h, before being chopped into 6 mm length for fibre treatment and the preparation of the composites. Toluene- 2,4-disocyanate (TDI) and polypropylene glycol (PPG) of molecular weight 1000 were supplied by the Aldrich Chemical Company, USA. Dibutyl tin dilaurate was obtained from Scientific and Industrial Supplies Corporation, Mumbai. Potassium permanganate, sodium hydroxide and maleic anhydride used in the present study were of chemically pure grade [1]. The chopped fibres were taken in a stainless steel vessel. A 10% solution of NaOH was added into the vessel and stirred well. This was kept for 1 h with subsequent stirring. The fibres were then washed thoroughly with water to remove the excess of NaOH sticking to the fibres. Final washings were carried out with distilled water containing a little acid. The fibres were then air dried [2]. Sugar cane biogases, the fibrous solid residue left over after juice extraction from Sugar cane (S. Officinarum) – designated “B” – was supplied by the Montebello distillery (Petit-Bourg, Guadeloupe). Sugar cane bagasse fibers were obtained by milling using a laboratory blender.
At elevated temperature there is 33% higher moisture absorption for 40% sisal-coir fiber reinforced composites. The moisture absorption results in this investigation show Fickian behavior at room temperature and non-Fickian at boiling temperature [10].

**Composites**

Composites are formed by combining materials together to form an overall structure that is better than the individual components. Composite materials are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter or less expensive when compared to traditional materials.

**Green composite elements**

Compositing is the combining of visual elements from separate sources into single image often to create the insulation that all those elements are parts of same scene. The parts are,  
- Natural fiber  
- Resins  
- Filler materials  

**Natural fiber**

Vegetable fibers are generally based on arrangements of cellulose, often with lignin, examples include cotton, hemp, jute, flax, ramie, sisal and bagasse.

- Sisal fiber  
- Sugarcane fiber  

**Sisal fiber**

Sisal fiber made from the large spear shaped tropical leaves of the Agave Sisal and plant. Fine fiber available as plaid, herringbone and twill.

**Sugarcane fiber**

Bagasse is one of the most eco-friendly resources suitable for various applications; bagasse fiber is extracted from sugar cane.

**Resin**

Resin in the most specific use of the term is a hydrocarbon secretion of many plants, particularly coniferous trees.
Epoxy
Epoxy is both the basic component and the cured end product of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resins, also known as poly epoxides are a class of reactive pre polymers and polymers which contain epoxide groups. The mixing ratio is based on the composite weight percentage. Thoroughly mixed peroxide treated sisal and sugarcane fiber as shown in figure.

Filler materials
Fillers are particles added to material (plastics, composite material, and concrete) to lower the consumption of more expensive binder material or to better some properties of the mixture material.

Rice husk
Rice hulls (or rice husks) are the hard protecting coverings of grains of rice. In addition to protecting rice during the growing season, rice hulls can be put to use as building material, fertilizer, insulation material, or fuel. Rice hulls are the coatings of seeds, or grains, of rice.

Pre-treatment
Particularly focused on the modification of filler surface in order to improve the interfacial adhesion between filler particles (hydrophilic) and polymer macromolecules (generally hydrophobic) and their dispersion in the matrix. The overall comment which can be drawn is that the green composites can achieve greater stiffness.

Various Pre-treatment techniques
- Untreatment
- NaOH treatment
- Benzylation
- Acrylation
- Peroxide
- Permanganate

Fabrication process
Mould preparation
The Mould for the Hand Lay-up method was made with the help of steel and mica sheet as shown below.

Mixing Ratio
The manufacturing of the specimen is based on the Hand Lay-up process. In this process the sisal fiber and sugarcane fiber, rice huskers, epoxy resin and hardener are mixed in the beaker and is then moulded by hand using some pressure. The pretreated fibers are cut into small size of 3-5mm. Then both sisal and sugarcane fibers are mixed together along with rice husk.

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sisal Fiber</td>
<td>35%</td>
</tr>
<tr>
<td>Sugarcane fiber</td>
<td>20%</td>
</tr>
<tr>
<td>Rice Husk</td>
<td>5%</td>
</tr>
<tr>
<td>Resin</td>
<td>35%</td>
</tr>
<tr>
<td>Hardener</td>
<td>5%</td>
</tr>
</tbody>
</table>

Hand lay-up process
In the hand lay-up process, fiber reinforcement is manually inserted into a single-sided mold. Following steps are used in Hand lay-up process. The mould is cleaned and polished for easy de-moulding. Epoxy resin is mixed with its hardener with required ratio. The layer of resin is poured into the mould and spread it all over the mould surface. Then layer of mixed sisal and sugarcane chopped fiber are applied. Another layer of epoxy resin is added. Resin is forced through the thickness of the fiber mats using hand rollers, and then excess resin is removed using squeegees. The part is allowed to cure and then disassembled from the mould. The part is de-moulded and sent for finishing work. The size of finished material,

<table>
<thead>
<tr>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
</tr>
<tr>
<td>Breath</td>
</tr>
<tr>
<td>Thickness</td>
</tr>
</tbody>
</table>

Material testing
The mechanical testing of composite structures to obtain parameters such as strength and stiffness is a time consuming and often difficult process. It is, however, an essential process, and can be somewhat simplified by the testing of simple structures, such as flat coupons. The data obtained from these tests can then be directly related with varying degrees of simplicity and accuracy to any structural shape. The test methods outlined in this section merely represent a small selection available to the composites scientist. Some, such as the tensile coupon test, are widely recognized as standards.

4.1 Tensile test
Tensile testing utilizes the classical coupon test geometry as shown below and consists of two regions, a central region called the gauge length, within which failure is expected to occur, and the two end regions which are clamped into a grip mechanism connected to a test machine.

4.2 Impact test
Before looking at impact testing let us first define what is meant by 'toughness' since the impact
test is only one method by which this material property is measured.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Impact Value for 5 mm thick specimen in J</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.45</td>
<td>NaOH (I₁)</td>
</tr>
<tr>
<td>2</td>
<td>0.50</td>
<td>Benzylation (I₂)</td>
</tr>
<tr>
<td>3</td>
<td>0.25</td>
<td>Acrylation (I₃)</td>
</tr>
<tr>
<td>4</td>
<td>0.25</td>
<td>Un-treatment (I₄)</td>
</tr>
<tr>
<td>5</td>
<td>0.20</td>
<td>Peroxide (I₅)</td>
</tr>
<tr>
<td>6</td>
<td>0.10</td>
<td>Permanganate (I₆)</td>
</tr>
</tbody>
</table>

Results and discussions

Impact test results

![Figure 1 Impact test values for different specimen](image-url)
Figure 2 Comparison of stress Vs strain of specimens

Figure 3 Comparison of displacement Vs load of specimens
Table 2 Comparison Statement of Mechanical Properties

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Impact reading (J)</th>
<th>Max. Load (N)</th>
<th>Max. Elongation (mm)</th>
<th>Max. Strain %</th>
<th>Max. Stress (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0.25</td>
<td>1369.67</td>
<td>1.17</td>
<td>0.78</td>
<td>6.848</td>
</tr>
<tr>
<td>I1</td>
<td>0.45</td>
<td>2388.245</td>
<td>2.19</td>
<td>1.46</td>
<td>11.941</td>
</tr>
<tr>
<td>I2</td>
<td>0.5</td>
<td>2490.605</td>
<td>2.83</td>
<td>1.22</td>
<td>19.122</td>
</tr>
<tr>
<td>I3</td>
<td>0.25</td>
<td>1896.242</td>
<td>1.17</td>
<td>0.773</td>
<td>15.128</td>
</tr>
<tr>
<td>I5</td>
<td>0.2</td>
<td>1748.633</td>
<td>1.32</td>
<td>0.873</td>
<td>8.743</td>
</tr>
<tr>
<td>I6</td>
<td>0.1</td>
<td>369.248</td>
<td>0.84</td>
<td>0.527</td>
<td>2.984</td>
</tr>
</tbody>
</table>

Conclusion
From the above comparison of results of impact and tensile properties and SEM analysis report, Benzoylation treated composite material have the higher impact value, higher load carrying capacity which was obtained from the impact and tensile test and also have low voids and impurities that are obtained from the SEM Analysis and eventually it is evident that the material obtained from the compression moulding with banana and sisal fiber as a matrix element is the most suitable replacement in most of the modern equipment.

References
3. John Z. Lu, Quiglin Wu; ‘The Influences of fiber Feature and Polymer Melt Index on Mechanical Properties of Sugarcane Fiber/Polymer Composites’; 16.04.2006.page.no.[5608]