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Characterization of Mechanical Properties of ABS/Glass Fiber Polymer Matrix Composites

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ABSTRACT

The PMC's are the widely used advanced materials now a days and are replacing the conventional materials. PMCs have wide variety of applications in almost all the fields of engineering. Glass fibres (GF) are the reinforcement agent used in most of the thermoset and thermoplastic based composites, as they create a good balance between properties and cost. However the final properties of the composites are mainly determined by the strength and the stability of the polymer fibre interphase. Thermoplastic ABS material (Acrylonitrile Butadine Styrene) used as matrix and glass fibre as reinforcement agent. They are prepared by injection moulding process. The mechanical properties of the ABS changes gradually and drastically by addition of glass fibres in it. This work provides an evidence for such variation in the mechanical characteristics, such as tensile, flexural, hardness and wear for polymer matrix composites. The tests are conducted according to the ASTM standard for pure ABS and glass fiber ABS. The obtained results are tabulated and compared.

1. INTRODUCTION

The development of composite material and related design and manufacturing technologies is one of the most important advances in the history of materials. Composites are multifunctional materials having unprecedented mechanical and physical properties that can be tailored to meet the requirements of a particular application. Many composites also characteristics provide the mechanical engineer with design opportunities not possible with conventional monolithic materials, ceramics in applications for which monolithic version are unsuited because of their great strength scatter an poor resistance to mechanical and thermal shock. Further, many manufacturing process for composites are well adapted to the fabrications of large, complex structures, which allows consolidation of parts, reducing manufacturing cost.

1.1 Composite materials

Composite are material consisting of two or more chemically distinct constituents, on a macro scale, having a distinct interface separating them. One or more discontinuous phase are, therefore, embedded in a continuous phase to form a composite. The discontinuous phase is usually harder and stronger than the continuous phase and is called the reinforcement, whereas, the continuous phase is termed as the matrix. In general, fibres are the principal load carrying members while the matrix keeps them at the desired location and environmental, damages. The primary functions of the matrix are to transfer stresses between the reinforcing fibres and to protect them from mechanical or environmental damage whereas the presence of fibres in a composite improves its mechanical properties such as strength, stiffness etc. The objective is to take advantage of the superior properties unavailable from the individual constituent materials, while the wide variety of matrix and strengthening materials allows the designer of the product or structure to choose an optimum combinations.(7)

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In present work, composites were manufactured with different weight fractions of reinforcement and with different weight percentages of different fibres. These specimens were tested according to the procedure mentioned in ASTM standards. The effect of glass fibre reinforcement on ABS composite was studied and mechanical properties were analyzed. [1] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller.This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased

2. MATERIALS

2.1. Acrylonitrile Butadiene Styrene (ABS)

ABS is called an engineering plastic due to its excellent combination of mechanical properties. ABS is a two-phase terpolymer, one phase being the hard co-polymer styrene (C8H8) - Acrylonitrile (C3H3N), while the other phase is styrene (C8H8) – Butadiene (C4H6) co-polymer that is rubbery. The name of the plastic is derived from the three starting monomers, which may be mixed in various proportions.

The ABS properties essentially depend on the properties of each component: acrylonitrile enhances hardness and chemical resistance, butadiene acts as plasticizer while increasing impact strength and styrene improves thermal and processing properties. Thus, high hardness and impact strength, high chemical and thermal resistance, negligible creep as well as easy processing are the most significant advantages of ABS while relatively low fatigue strength is a disadvantage.

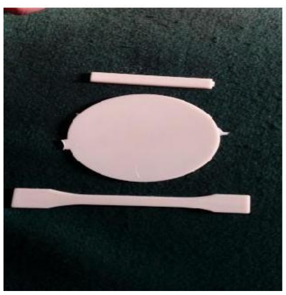
2.2. Glass fibres

The glass fibers are made of various types of glass depending upon the fiberglass use. These glasses all contain silica or silicate, with varying amounts of oxides of calcium, magnesium, and sometimes boron. To be used in fiberglass, glass fibers are made with very low levels of defects. Fiberglass is a strong lightweight material and is used for many products. Although it is not as strong and stiff as composites based on carbon fiber, it is less brittle, and its raw materials are much cheaper. Its bulk strength and weight are also better than many metals, and it can be more readily molded into complex shapes. Applications of fiberglass include aircraft, boats, automobiles, bath tubs and enclosures, swimming pools, hot tubs, septic tanks, water tanks, roofing, pipes, cladding, casts, surfboards, and external door skins.

3. EXPERIMENTAL PROCEDURES

3.1. Specimen Fabrication

Before processing, ABS and glass fibers granules were dried in a vacuum oven for 2 hrs at 60°C. Composites containing 5, 10, 15, and 20 wt% GF were prepared by melting and mixing in a single screw plastic extruder. The ABS granules and glass fibers were fed from the main feeders. The molten composite obtained from the die of the extruder was water cooled and pelletized. Thus we obtained granules of processed ABS (PABS) and GF composite.



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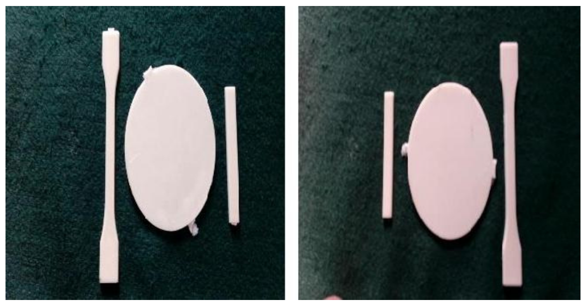
ABS+5% GF ABS+10% GF



ABS+15% GF ABS+20% GF

Fig1. ABS/GF samples.

The specimens for the mechanical characterization were moulded using a hydraulic press machine at 220°C and sheets were formed. The hydraulic press machine used in this study was a hot press hydraulic press. The principle of the operation is that the preweighed (about 26 g) raw material is loaded into the die of 100x100x2mm size placed between two support plates. Then the plastic granules are allowed to melt between hot plate presses machines for 15 min, once the material is melted supply of water is done to allow its cooling. [7] proposed a principle in which another NN yield input control law was created for an under incited quad rotor UAV which uses the regular limitations of the under incited framework to create virtual control contributions to ensure the UAV tracks a craved direction. Utilizing the versatile back venturing method, every one of the six DOF are effectively followed utilizing just four control inputs while within the sight of un demonstrated flow and limited unsettling influences. Elements and speed vectors were thought to be inaccessible, along these lines a NN eyewitness was intended to recoup the limitless states. At that point, a novel NN virtual control structure which permitted the craved translational speeds to be controlled utilizing the pitch and the move of the UAV. At long last, a NN was used in the figuring of the real control inputs for the UAV dynamic framework. Utilizing Lyapunov systems, it was demonstrated that the estimation blunders of each NN, the spectator, Virtual controller, and the position, introduction, and speed following mistakes were all SGUUB while unwinding the partition Principle.

3.2 Testing of composites

The mechanical testing are carried out for fabricated materials by different instruments as per the ASTM standard.

Tensile and flexural strength: The tensile test is generally performed on flat specimens. The commonly used specimens for tensile test are the dog-bone type and the straight side type with end tabs. During the test a uni-axial load is applied through both the ends of the specimen. The ASTM standard test method for tensile properties of fiber resin composites has the designation ASTM D638. The length of the test section should be 165 mm. The tensile test is performed in the universal testing machine (UTM) Instron 1195 and results are analyzed to calculate the tensile strength of composite samples. It is a 2-point bend test, which generally promotes failure by inter-laminar shear. The test is conducted as per ASTM standard (ASTM D 790) using the same UTM. Span length of 125 mm and the cross head speed of 13 mm/min are maintained.

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Hardness test: This method covers two procedures for testing the indentation hardness of plastics and related plastic electrical insulating materials by means of the Rockwell hardness tester. A Rockwell hardness number is a number derived from the net increase in depth of impression as the load on an indenter is increased from a fixed minor load to a major load and then returned to a minor load.

A large ball indenter will distribute the load more evenly and decrease the range of test results. The sensitivity of the instrument decreases with an increase in the dial reading and becomes very poor for readings of 100 and over due to the shallow indention of the steel balL It is desirable to use the smallest ball and highest load that is practical because of this loss of sensitivity. Rockwell hardness readings over 115 are not satisfactory and shall not be reported. Readings between zero and 100 are recommended, but readings to 115 are permissible.

3.3 Friction and Wear Tests

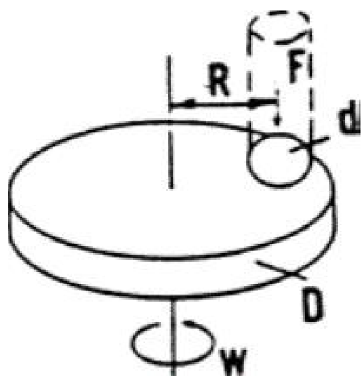

Fig 2. Pin on disc tester

The Tribometer uses a pin-on-disk system to measure wear. It consists of a pin on disc, loading panel and friction & wear monitor. The sliding wear of pure ABS and Glass fibre filled ABS are carried out with different loads by varying time and sliding distances. To evaluate the performance of these composites under dry sliding and lubrication conditions, wear tests will be carried out in a pin-on-disc type friction and wear monitoring test rig as per ASTM G 99-95a. The counter body is usually a disc made of hardened ground steel. The specimen is held stationary and disc is rotated while a normal force is applied through a lever mechanism.

4. CONCLUSION

This paper presents the fabrication of ABS filled with glass fiber composite material by extrusion and injection moulding process. The tensile strength of the ABS/GF composite is higher than the pure form of ABS sample. As the percentage of glass fiber increased the tribological properties such as friction and wear properties are improved. Besides the above all this work introduced a new class of polymer composite that find most suitable for tribological applications.

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