Development, Characterization and Abrassive Wear Behavior of Thermoplastic Blend Hybrid Composites

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Abstract- *Most of the engineering materials are made of composite materials. Composite materials are those, which are made of atleast two components which are insoluble in each other, having different chemical properties. Composite materials exhibits better strength, toughness, young's modulus compared to the individual pure metals used in making them. The present study helps to manufacture hybrid thermoplastic composites using different resin materials like polypropylene, polyvinylchloride and nylon along with suitable additives and colorants. Thermoplastic are the type of bioplastic and easily recyclable materials. Because of its light weight and high strength composites found huge application in medical fields for making teeth, bones , prosthetic hands ,legs, storage devices , automobiles, toys, aerospace parts, shipping , sports and military applications. The various thermoforming process helps to obtain the specimen in a desired shape without necking and cracking. These composites are easily melted, molded and remolded and it can be recycled.*

Keywords- Composite materials, Strength, Toughness, Young's modulus, Thermoplastic, Polymer resins, Thermoforming process

I. INTRODUCTION

Composite materials are the type of materials which are made of atleast two different materials, which are insoluble to each other and having different chemical properties. Fiber reinforced materials are the materials which gives high strength and stiffness and require low maintenance cost. Fiber reinforced polymer composite (FRPC's) material mainly consists of fibers of specific strength and stiffness bonded with polymer matrix. FRPC's have found huge application in chemical handling equipment's, spacecraft applications,, submarines, aircrafts, satellites, automobiles, civil engineering applications, medical fields and for making electronic devices. Comparing to some metallic alloys for example steel and aluminium the FRPC's are used as important materials in many applications because for its light weight, high impact strength and toughness, gives good chemical and fatigue resistant property and easily recyclable. And also FRPC's have good aesthetic properties, gives better thermal and mechanical properties, because of this they are used in many applications in place of metals particularly when weight saving of the material is needed.

Wear of the material is one of the most common problem encountered during many industrial applications leading to the replacement of components and assemblies in engineering, and the others effect of being corrosion and fatigue. Many tribological components such as driving wheels, impellers, gears, nuts, seals, cams, bolts, brakes, bearings and bushes are used in machinery. Work done in overcoming friction in bearings and other mechanical components and heat dissipated during process and its reduction will lead to an increase in overall efficiency. The energy losses in these tribological components can be reduce considerably by good tribological designs. Therefore research in tribology will lead to better performance of machines. For weight carrying applications in materials, designers are effectively carrying research for using polymers in thermoplastics as well in thermosets, instead of commonly used materials like metals.

II. THERMOPLASTICS

These are the plastic materials which are softened when heated and becomes hard during cooling. Thermoplastics hybrid materials are the type of composites materials made of a polymer resins and additives, which provide superior mechanical and thermal properties compared to the basic thermoplastics. Because of some eco-friendly characteristics thermoplastic usage increasing day by day irrespective of high cost, less heat resistance properties compared to thermosetting plastic. Thermoplastic polymers have the advantages of low specific gravity, requires low energy for manufacturing and fabrication compared to some metallic and thermosetting plastics. Hybrid materials are those in which two or more materials having different chemical and physical components are combined to form a material characteristics different from the original components.

III. BENEFITS OF THERMOPLASTICS OVER OTHER MATERIALS

1. Durable

Compared to some metals, thermoplastic can have long life span because of their material characteristic properties. Thermoplastic don't absorb any dust, radiation because of this they exhibits good rust proofing, water proofing properties. Thermoplastic can lasts for long time in terms of hours of use, number of operation cycles carried on that.

2. Chemical and Stain Resistant

Metals is affected by chemicals very rapidly when it is exposed to open source and results in corrosion as a result metal loses their properties, life span and it is not possible in case thermoplastic. Because thermoplastic doesn't involved in any oxidation process when they are exposed to open source.

3. Integral Coluresand Effects

Thermoplastic can have good aesthetic properties in terms of their look. The addition of different colorants to the thermoplastic during raw material preparation results in getting different colured thermoplastic, which are used for many household, office, automobile parts.

4. Fulfill human requirements

Thermoplastic composites have high strength and toughness property to its weight ratio, and proper mixing of additives to thermoplastic results in getting good materials. Thermoplastic don't emits any harmful gases during heating because of this they are very kind to meet human requirements.

5. Environmental Solution

Thermoplastic are the bioplastic materials, they can be easily recyclable whereas thermosetting plastic are not recyclable. As plastic affects environment research is going to use the ecofriendly bioplastic materials.

ADVANTAGES of THERMOPLASTICS

- Good surface finish.
- Easily recyclable
- There is no emission of harmful gases.
- Resists humidity and harsh environment.
- High impact strength

DISADVANTAGE of THERMOPLASTICS

- Limited service temperature performance.
- Soften when heated.
- Expensive than thermosets.

IV. LITERATURE SURVEY

N. Svensson, etal. [1]Yarn provides good properties as it reduces the flow distance of the molten matrix in impregnation and consolidation process. Yarns provide good fabric structures. [1].

Liyong Tong, et al. [2]Stitching of 3D laminates helps in obtaining good properties. 3D carbon fibers help to replace high temperature metallic alloys in rocket motor components because of its light weight properties [2].

MladenSercer, et al. [3]The study on wood thermoplastic helps to find deformation characteristics, parameters of injecting moulding. Wood plastics are well suited to use in loudspeakers boxes [3].

Adel Zaki El-Sonbati [4]It is observed that the addition of fiber reduces thermal conductivity in case of pure PP and also studied that degree of crystallization affect cooling rate [4].

AlirezaAshori, et al. [5]The incorporation of organic waste materials and glass fiber in polypropylene matrix helps to improve mechanical properties compared to individual use of bagasse fiber. [5].

Ann Livingston Peters [6]Study on fabrication methods for thermoplastic helps us to improve design specification. As thermoplastic processed at high temperature compared to thermosets care has to be taken during high heat applications.

HemanthRajashekaraiah, et al. [7]The mixing of TCE and PTFE shows good abrasion rate and lower wear rate while compared composition of TCE, PTFE, SGF and ceramic fillers hybrid composites.

T. S. Creasy and Y. S. Kang [8]Equal Channel Angular Extrusion Process helps to refine the microstructure of metals and alloys, due to this metal strength improved.

BehnazBaghae [9]After combining hemp and lyocell with nonwoven PLA composites, improves impact, tensile, flexural strength compared to pure hemp/PLA composites.

B. V. Lingesh, et al. [10]Hybrid composites have high specific strength, and the flexural strength which is increased by 104% compared to the blend due to hybrid effect of fibers,

and hybrid fibers have 20% reduced strain rate compared to pure blends during bending.

Pravinkumar R. Meda, et al. [11]Bonding of thermoplastic helps in manufacturing of aerospace composites. The bonding is due to the polymer polymer interface healing involves carbon fibers as reinforcement materials.

TaiserAttia [12]Jute fibers have better tensile strength, impact strength and stiffness. Fiber content affects negatively on impact strength and positively on stiffness.

By referring above literature and papers, an attempt is made to manufacture a hybrid composite materials by using thermoplastics. Our work is to use reduce the time and cost involved during manufacturing of eco-friendly hybrid composite materials. Further an attempt is made to manufacture a light weight, corrosion resistant thermoplastic hybrid composites of high strength and stiffness.

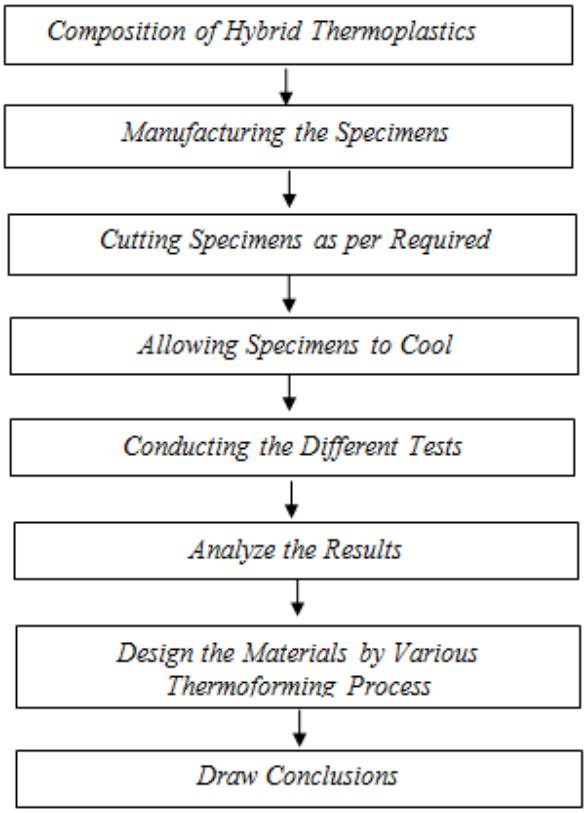
V. OBJECTIVES OF THE WORK

The main objective of carrying this work is to fabricate and hybrid thermoplastic composites by using polymer resins, colorants and additives. In the present study different volume fractions of hybrid thermoplastics have been taken to study the various mechanical and physical properties of composites. Different hybrid thermoplastics are manufactured using different resin material.

The specific objectives of the work involve:

1. Development, characterization and study of abrasive of particulate filled polymer blend hybrid composites.
2. Investigation of nature and loading of filler on the polymer blend hybrid composites and their properties will be carried out.
3. Mechanical properties like tensile, compression, wear and hardness of polymer blend hybrid composites will be studied.

VI. METHODOLOGY



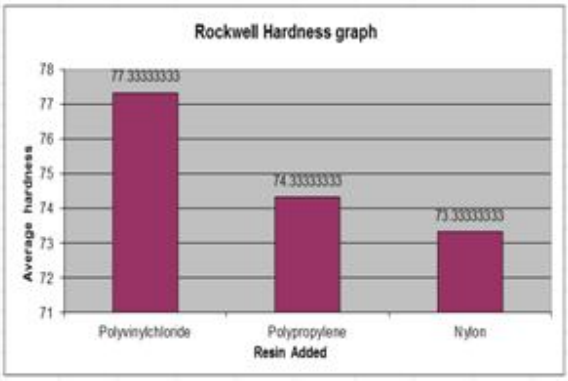
VII. RESULTS AND DISCUSSIONS

Hardness test

The hardness is carried out on a three different volume fractions of hybrid thermoplastic composites by Rockwell hardness testing machine.

Load	*100 Kgf*
Indenter	*Ball point*
Ball size	*1/16"*

1. The average Rockwell Hardness No. of polyvinylchloride based thermoplastic is found to be 77.34
2. The average Rockwell Hardness No. of polypropylene based thermoplastic is found to be 74.34.
3. The average Rockwell Hardness No. of nylon based thermoplastic is found to be 73.34.

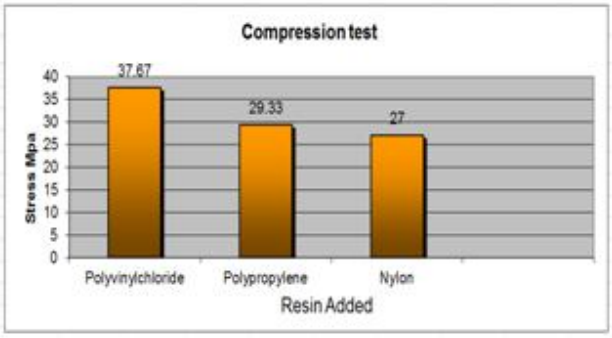


Compression Test

Test is conducted by a computerized machine on three different volume fractions of composite materials.

Sample width	*10 mm*
Sample thickness	*6 mm*

1. The average max compression stress of polyvinylchloride based thermoplastic is found to be 37.67 Mpa
2. The average max compression stress of polypropylene based thermoplastic is found to be 29.33 Mpa.
3. The average max compression stress of nylon based thermoplastic is found to be 27 Mpa.



Tensile Test

This test helps us to study the characteristic of the specimens under tensile load.

Sample width	*10 mm*
Sample thickness	*6 mm*

1. The average yield stress of polyvinylchloride based thermoplastic is found to be 45.67 Mpa.
2. The average yield stress of polypropylene based thermoplastic is found to be 36.67 Mpa.
3. The average yield stress of nylon based thermoplastic is found to be 29.67 Mpa.

Wear Test

The specific wear rate and friction coefficient values of the three different polymer resin materials are

Sample width	*10 mm*
Sample thickness	*6 mm*

1. The average specific wear rate and friction coefficient for polyvinylchloride based thermoplastic is found to be$1.11\times10^{-4}mm^3$/Nmin and 0.57
2. The average specific wear rate and friction coefficient for polypropylene based thermoplastic is found to be 1.16×10^{-4} mm^3/Nmin and 0.41
3. The average specific wear rate and friction coefficient for nylon based thermoplastic is found to be 0.74×10^{-4} mm^3/Nmin and 0.37

VIII. CONCLUSION

The following are the conclusions made based on the test results and general observations:

1. Specimen with Polyvinylchloride as the resin material is having more yield strength, followed by specimen with Polypropylene and then specimen with nylon as resin material.
2. And also results are in the same order for compression test.
3. The values of the results are in the range of 30Mpa to 50Mpa for all the three materials.
4. These values indicate that the materials can be easily used for non-load bearing walls in structural application.
5. These also can be used as cladding materials in various applications such as in auto industries, structural application and also aircraft industries as these are corrosion proof, light weight, easy to manufacture.
6. These are also weather proof and hence can be used as sign boards on roads for traffic related signs in place of metal boards.
7. As there are thermoplastics, these can be recycled. This can be done by heating and melting and injected into molding machines using injection molding and other

methods mentioned in the report. Hence this materials can be environment friendly.

8. Rockwell hardness number is 75 on average. This implies that the material is wear resistant for small impacts.
9. From all the above mentioned points one can conclude that these materials can be used in many areas such as Structural, Automobiles, and Aircraft industries.

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