AN INVESTIGATION ON USE OF COIR FIBER REINFORCED COMPOSITE WITH ABS PLASTIC

A PROJECT REPORT

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT

FOR THE AWARD OF THE DEGREE OF

BACHELOR OF TECHNOLOGY

IN

MECHANICAL ENGINEERING WITH SPECIALIZATION IN AUTOMOTIVE ENGINEERING

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CANDIDATE'S DECLARATION

We hereby certify that the work which is presented in the Major Project-II entitled 'An investigation on use of Coir fiber reinforced composite with ABS plastic' in fulfilment of the requirement for the award of Degree of Bachelor of Technology in Mechanical with Specialization in Automotive Engineering is submitted to the Department of Mechanical Engineering, Delhi Technological University, Delhi is an authentic record of our own, carriedout during a period from January to May 2021, under the supervision of Dr Navriti Gupta.

The matter presented in this report has not been submitted by us for the award of any other degree of this or any other Institute/University. The work has been accepted in a peer reviewed Scopus indexed conference with following details:

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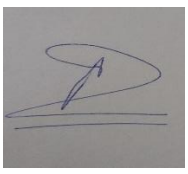

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SUPERVISOR CERTIFICATE

To the best of my knowledge, the above work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere. I, further certify that the publication and indexing information given by the students is correct.

Place: Delhi

Date: 25.05.2021

Dr. N. Gupta
SUPERVISOR

ABSTRACT

Natural fibres are increasingly being used in the polymer industry to create biocomposites for a variety of uses, including textiles and other industries. Natural materials in the polymer industry are gaining popularity due to their renewability, low cost, and low abrasiveness. Furthermore, there is a growing demand for high-performance applications, as well as increased environmental concerns.

Natural fiber-based synthetic polymer composites have advanced dramatically in all major sectors due to low manufacturing costs and advanced properties such as lightweight and durability. Biobased polymers and biobased materials are growing rapidly these days. Biobased biodegradable composites are becoming a hot topic because natural fibres are biodegradable and reusable.

The usage of biodegradable plastic is increasing day by day. In this experimental investigation a study is done to compare the physical hardness characteristic of coir based ABS plastic. A coir fiber or commonly known as coconut husk is a naturally occurring fiber that is mainly famous for its strength inducing properties. In this experiment an ABS plastic composite infused with coir fiber using plastic injection molding process was fabricated. Various operations are carried out to carefully obtain the composite.

Experiments were performed on coir reinforced composite and ABS plastic to compare their hardness properties and derive conclusive results. Shore D hardness test is implemented in this study to analyze both the test pieces and determine the changes occurring when coir fiber is infused with ABS plastic. The paper aims to provide a durable and environment friendly alternative to the conventional ABS plastic that is used in the automobile industry. This paper opens new research avenues for further research for the usage of coir induced ABS.

ACKNOWLEDGEMENT

The successful completion of any task would be incomplete without acknowledging the people who made it all possible and whose constant guidance and encouragement secured the success.

We are deeply indebted to our supervisors, Dr. Navriti Gupta and Dr. Singari M.S, Department of Design for incorporating in us the idea of a creative Major Project. Also, helping us in undertaking writing of research paper and for being there whenever we needed his assistance.

We feel proud and privileged in expressing our deep sense of gratitude to all those who have helped us in presenting this project.

Lastly, we thank our parents for always being supportive.

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LIST OF ABBREVIATIONS

Sl. No	Abbreviation	Explanation
1	ABS	Acrylonitrile Butadiene Styrene
2	NFRP	Natural Fiber Reinforced Polymer
3	GFRP	Glass Fiber Reinforced Polymer
4	CFRP	Carbon Fiber Reinforced Polymer
5	Shore D	Shore Durometer
6	SAN	Styrene Acrylonitrile

CHAPTER 1

INTRODUCTION

In this chapter, the background of proposed work, an overview of the work, the motivation of the project report and forecasting techniques used in the report have been discussed.

1.1 BACKGROUND

With ever increase demand for plastic polymers and their seemingly endless supply there is a stark need to prevent their production and induce innovation at large scale to improve the environmental scenario.

One such innovation is through reinforcing existing polymers with natural fibers to obtain a new composite with novel properties. This method is being increasingly used to obtain composite mixes to ensure sustainability and innovation in this sector .

The automotive and aerospace industries are increasing their demand for natural fibre composites (NFC). In terms of mechanical, thermal, and acoustic properties, natural fibres may compete with synthetic glass fibres. Natural fibres are both biodegradable and recyclable, making them environmentally friendly and appropriate for both circular economy and sustainable growth. The NFCs that are being considered here are the assembly of natural fibers and polymeric matrices. If the polymer matrix is also bio-based, the NFC can be also called a green composite.

1.2 ABS

1.2.1 Introduction

Acrylonitrile-butadiene-styrene (ABS) is a tough thermoplastic that is resistant to weather and a few synthetic compounds and is well-known for vacuum-formed parts. It's an inflexible plastic with elastic-like properties that provides it a lot of effect resistance. It is mostly used in the automotive industry to make dashboards and covers for automobiles [1]

1.2.2 Synthesis

ABS is a graft copolymer, which means it is a large molecule made up of polybutadiene chains derived from a styrene-acrylonitrile copolymer (SAN) backbone chain without pendant polybutadiene. Polybutadiene is dissolved in fluid acrylonitrile and styrene monomers, and the monomers are polymerized in the presence of free-revolutionary initiators [2].ABS is also produced via an emulsion cycle in which polybutadiene is set up as a fluid latex into which styrene and acrylonitrile are introduced for copolymerization. The exact measures of every copolymer, polymer chain lengths, and extent of interlink age of chains can be

adjusted according to the necessity. The butadiene units produce a remarkable quality effect, the acrylonitrile units condition the warmth blockage, and the styrene units give the copolymer its hard nature. ABS is also a good engineering plastic because of its ability to be injection-molded, blow-molded, or extruded. [2].

1.3 COIR FIBER

Coconut husks are processed to extract organic components before being used to produce coir fibre, which is a by-product of the coconut industry. While coir fibres are typically used for combustion or fertilization, some research has focused on using them to create bio insulating materials.

Coir fibre is a natural fibre obtained from the coconut husk. The thickest and most durable of all commercial natural fibres is coir. The ability to make durable goods with a low decomposition rate is a key advantage. Coir fibre ropes from the early 1800s have been found.

Coir fiber's exceptional strength has been the fundamental cause for rope production for decades. Brown fibre from mature coconuts and finer white fibre from immature green coconuts that have been soaked for up to ten months are the two types of coir fibre available. Coir is one of the most lignin-rich natural fibres.

As a result, the coir industry has expanded to become the main employment in many sections of coastal India, with approximately 400,000 people employed in fiber processing, coir yarn spinning, and coir fabric manufacture. All along the shoreline, drying and spinning takes place.

1.4 MOTIVATION

India taking a higher ground tries to go through a way which is 'cleaner' than the one taken by other nations in the past, by taking the responsibility to ensure a reasonable Human Development Index (HDI) to better the economic condition of its huge population. If the world wants these investments to be nature friendly, it can study the opportunities produced from investments made by India. Here economic advancements can be attained with lower levels of emissions by putting new techniques to use and also by providing finance for attaining minimum carbon growth.

First world countries can surely decrease their emission intensity by controlling their consumption, and by utilizing their finances more efficiently. Thiscan be done by employing such investments for development activities in countrieshousing a vast majority of people living at minimal support level. The ratio of everydollar invested for avoiding emission and economic advancements gained would be relatively more preferable for financial investments made in countries like India.

1.5 PROPOSED WORK

The proposed project involves synthesis of a new natural fiber reinforced composite using injection molding process. This method allows for mass production of component material with efficient timing.

The proposed material is then tested for hardness against pure ABS plastic to obtain conclusive result and pursue a comparison analysis methodology.

CHAPTER 2

LITERATURE REVIEW

In this chapter, an overview review of literature, natural fiber reinforced plastics, shore D hardness test and injection molding .

2.1 NFRP (Natural Fiber Reinforced Polymer)

A number of investigations and researches have been conducted on natural fiber reinforced plastics. All experiments are conducted solely for the purpose of determining the qualities of the new material in order to develop superior engineering materials alternatives. The coir reinforced plastic has a higher impact strength than the original sample, according to a study on coir/carbon-fiber reinforced epoxy based hybrid composite polymer. [3] Similar studies have been done on Glass Fiber reinforced composite and its tensile strength, flexural strength and flexural modulus has been compared to that of natural FRC.

In the search for a superior alternative engineering material, a variety of natural fibres such as jute, banana, coir, hemp, and sisal have been employed to make composites. [4]. Keerthi et al. [5] found a rise in fibre volume fraction and thickness panels of Jute and Banana fibre reinforced composites. Egg shell composites have also been tested, and it was discovered that increasing the percentage of eggshell powder in the composite increased the composite's tensile, flexural, and impact strength. [6]. Complimentary research has been conducted to evaluate the mechanical and surface characteristics of Palmyra/glass fiber hybrid composites [7], banana empty fruit bunch fibre rein-forced polyester composites [8], sisal–jute–glass fiber reinforced composites [9], sisal/jute reinforced glass fiber epoxy composites [10], jute and banana fiber reinforced epoxy hybrid composites [11] Palmyra Palm Leaf Stalk Fiber/jute fiber reinforced hybrid polyester composites [12].

2.2 INDUCTION MOLDING

The importance of injection moulding in mass production and plastic product optimization was discussed by Prashanth et al. [13]. Plastic injection moulding is a difficult procedure that is influenced by four primary factors: the moulder, the material, the injection machine, and the mould. The mould and injection machine are the most technically diverse of the four. Injection moulding is also regarded as a highly efficient method of producing plastic components. Industry users frequently try to optimise this process using various ways in order to get the most of it. The heavy machinery is illustrated in Fig.1

Fig1. Plastic Injection Molding Machine

P.K et.al [14] showed the various techniques adopted to optimize the injection molding process. In this study, determining optimal process parameter settings critically impacted the cost, productivity and quality in the plastic injection molding (PIM) industry. To identify the ideal parameters for the moulding process, production engineers formerly employed the trial and error method or Taguchi's parameter design technique. The trial and error method, on the other hand, is costly and time consuming, and so is not recommended for usage in the complicated equipment business.

2.3 SHORE HARDNESS TEST

After obtaining both the sample and test plastic components important part is the testing process. Due to COVID-19 it was very difficult to conduct ongoing strength tests, however, shore hardness test which involves the use of shore durometer as seen in Fig. 2 were conducted. In the case of silicones, rubbers, plastics, and plastic-based composites, shore hardness is an important test that may be used to monitor material parameters during the moulding process, process optimization, and quality control [15]. A shore durometer is a tool for determining the hardness of plastics, elastomers, and rubber.

Fig.2 Digital Durometer

Durometer measures the depth of the indentation generated by a given force on a standardised presser foot, similar to most other hardness measurements. The depth of the indentation is determined by the material's hardness and surface characteristics. The durometer has various scales for determining material

hardness. Type A and Type D scales are the two most frequent scales. A needle with a blunted point is used to perform the Shore A test on softer elastomers. The shore D test, on the other hand, is performed on tougher elastomers with a needle that has a 30-degree point angle and is not blunted, as shown in Fig. 3.

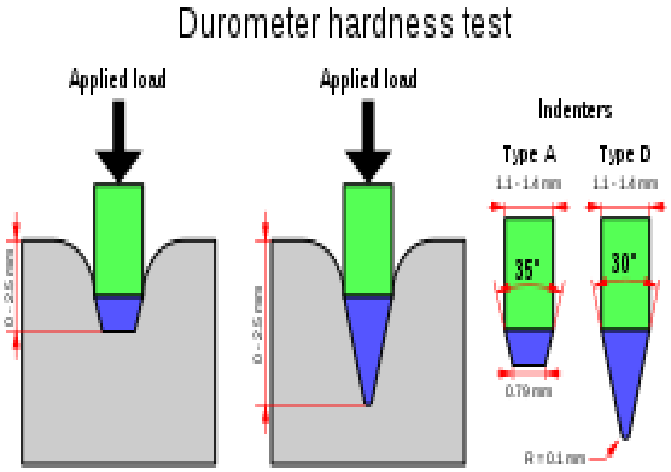

Fig.3 Shore A and Shore D Test

2.4 RESEARCH GAP

In the minor report an analysis of different types of applications of polymers were studied in the automobile industry.

Problem Statement: In this report we do comparison analysis of two materials with hardness being the core indicator for comparison. The research does not cover other aspects of physical characteristics of material like rigidity, turgidity, torsional activity, ductility and malleability.

CHAPTER 3

POLYMERS IN AUTOMOBILE INDUSTRY

3.1 INTRODCUTION

Automotive sector is of one of the leading and multidisciplinary industrial sectors in major world economies. In any emerging economy, this industry is an important source of employment. A lot of research is being done right now to make the automobile more efficient, lightweight, and cost-effective. Research has shown that every 10% reduction in vehicle weight results in a 5% to 7% reduction in fuel usage. This led to continuous innovative usage of materials as polymers in the development of an automobile.

In 1950, thermoplastics made their foray into automotive sector. ABS was the first polymer utilized, followed by polyamide, polyacetal, and polycarbonate. The era of polymer/composites innovation in the automobile sector began with the blending of different polymers. Researchers developed light weight yet robust polymers such as poly urethane and polypropylene in response to the demand for fuel efficient vehicles. Polymers account for roughly 33% of all automotive parts. Polypropylene, polyurethane, polyamide, and PVC are the four key polymers that make up more than 70% of the plastic used in autos.

Aside from that, polymers offer a slew of other advantages, including durability, toughness, elasticity and flexibility, high strength, corrosion resistance, and design ease, all for a fraction of the cost of metals and alloys. According to studies, the average world use of plastic is 120kg/vehicle, however the Indian car uses roughly 60kg/vehicle, while having a total vehicle body weight of 1500kg.

Because of its high strength, eco-friendly aspect, and recyclability, natural fibres or Bio-fibers, as well as synthetic fibres, are successfully used in the automobile sector. The thermoplast-reinforced composite created from natural fibres such as jute and cellulose fibres is successfully employed in the US car sector. Also Kenaf fibre is also used as reinforcement with synthetic polymers because of its robust mechanical properties. They are successfully used as a substitute for glass composites.

The greatest advantage of using polymers is they are mostly recyclable. The research study shows that recycling of automobiles is one of the major industry in US, which generates $5 billion in revenue.

Door trims, dashboards, glass holder trays, bumpers, instrument panels, electrical insulations, headlight lenses, engine cover, wiper arm, and wheel coverings are among the different sections of an automobile where these polymers and composites are used.

With the invention of electric autos, there is a greater emphasis on reducing vehicle weight, which leads to a greater emphasis on replacing heavy parts with light weight ones, if possible, using composites and polymers. As a result, polymers are increasingly being used in the design of automobiles.

3.2 GLASS FIBER REINFORCED POLYMER (GFRP)

Glass fiber strengthened polymer is the most generally utilized FRP material, in view of its minimal effort and since quite a while ago settled accessibility on the market

Fiber reinforced polymer (FRP) is a composite made up of a plastic gum network, glass fibre reinforcement, and other additives. Although the network does not provide any quality on its own, it serves as a bond for the strengthening glass fibres [16]. The Glass fiber (GF) fortification and polypropylene (PP) grid framework is a regularly utilized material blend, because of its high accessibility at low acquisition costs [17].

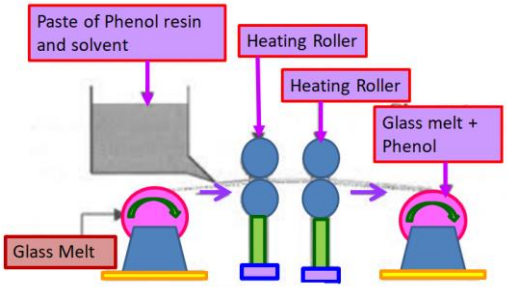

Figure 4: Formation of Glass Fiber Reinforced Polymer (GFRP)

3.3 CARBON FIBER REINFORCED POLYMER (CFRP)

CFRPs are one of the stiffest and lightest composite materials available, making them far more useful in a variety of sectors and applications [18]. Because of their low formability, these composites are only used in limited situations. The addition of nanoparticles to these composites improves their mechanical characteristics [19].

As the name recommends, Carbon Fiber Reinforced Polymer (CFRP) is made out of carbon strands embedded in a polymer tar , in which the carbon fibers fill in as the stronghold material and the polymer gum as the matrix strand .

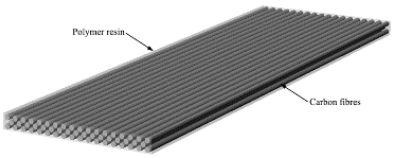

Figure 5: CFRP based laminates

Carbon filaments are strands that contain at least 90% and up to 100% carbon by weight. Polymeric precursor materials, such as polyacrylonitrile (PAN), cellulose, and polyvinylchloride, can be used to distribute them. Through a series of warming and tensioning treatments, these antecedents are transformed into carbon filaments [20].

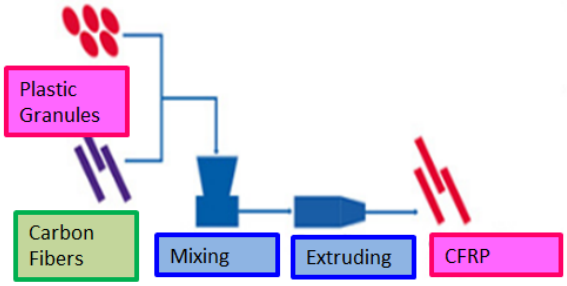

Figure 6: Synthesis of CFRP

3.4 ADVANTAGES OF USING POLYMERS AND PLASTICS IN AUTOMOBILES

The usage of polymers and plastics in the automobile industry has offered several advantages:

1. Design Flexibility: The plastics are easier to mold into desirable shapes and hence they can be used to aid design flexibility. For example, bumper can be designed in various shapes because of usage of plastics.
2. Weight reduction: The plastics and polymers are responsible for the overall weight reduction of the automobile. However, the balance between weight and strength has to be maintained.
3. Fuel Efficiency: Because of weight reduction, the fuel efficiency has been increased.
4. Less Pollutants Emission: Because of lower fuel consumption, there has been significant decrease in the emitted pollutants.
5. Cost Reduction: The usage of Polymers and plastics also helped in reduction in the cost of automobile.
6. Recycling of Polymers and Plastics: The plastics and polymers used are recyclable, and hence it will help in controlling the polymers and plastics usage.
7. Corrosion Resistance: Since polymers and plastics are corrosion free, it will help in reduction of corrosion.

3.5 DISADVANTAGES OF POLYMER AND PLASTICS

The usage of polymers and plastics is useful in many aspects, but it also poses several challenges. Some of the major disadvantages are:

1. Strength reduction: The polymer and plastics are less strong than metal and their alloys. It is the critical decision taken by automobile design engineer, where to use plastics and where to use metals?

   Solution: Now a days designer are using metal-polymer composites, which are actually possessing both strength and lightweight. Example Carbon nano tubes are being mixed with metals as Iron etc. to produce composites.

2. Fire Hazard: Since polymers and plastics are more prone to catch fire, special care has to be taken to provide housing to the bare wires. Now a days, all electrical wiring and hose connections are made up of polymers and plastics.

CHAPTER 4

METHODOLOGY

In this chapter the methodologies of the different methods used by us in order to get the desired objective have been discussed.

The main objective of the report is to test the comparative hardness of two substances, one of which is an entirely new product formed by reinforcement of coir fiber in ABS (Acrylonitrile Butadiene Styrene) plastic. The formation process is done through injection molding that has been explained in the previous chapters. Now we will cover the experimentation part of the project.

4.1 EXPERIMENTAL SETUP

The schematic diagram of the plastic injection molding machine for forming ABS component is illustrated in fig. 7. The machine is fed with plastic granules of ABS to form a pure ABS fan component. The granules make way into the machine through the hopper after which they are heated to very high temperature. The liquid plastic is now sent into the mold where it cools down to form the desired shape.

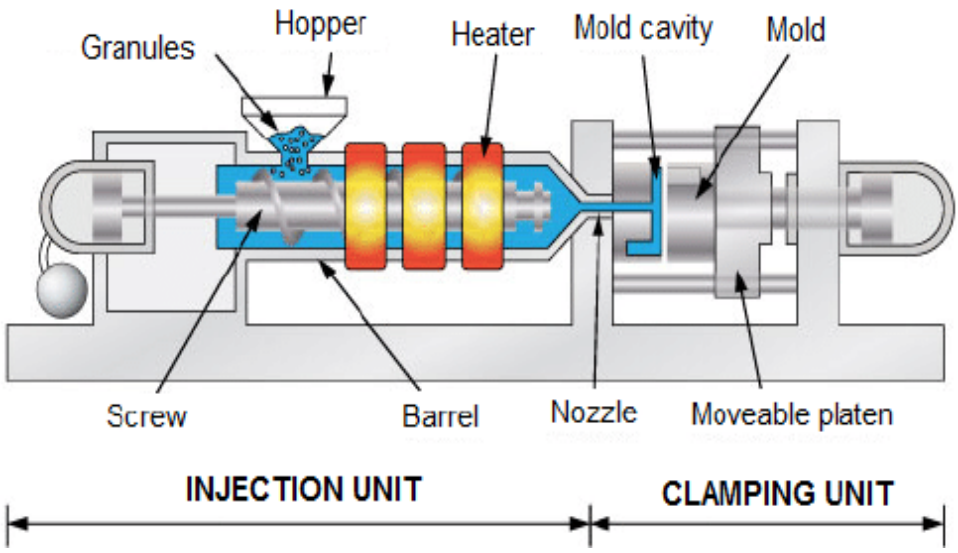

Fig 7. Injection Molding Machine Schematic Diagram

Fig.8 and Fig 9 shows our final composite and raw material used to form composite. Fig 8 shows the final ABS component formed after the plastic injection molding operation. The cooling process takes around 10-15 seconds after which the product is inspected for fracture and failure through naked eye and then segregated accordingly. For this current product 250gm barrel was filled up completely with ABS plastic granules.

Fig 8. ABS plastic component

Fig 9. Plastic Composite Mix

In forming this plastic composite the following steps were followed. The coconut husks from around 5 to 6 freshly dried coconuts were taken and sun dried for 5-6 days. Then they were carefully crushed them into small granules with the help of a strong blending mixer. The again the small particle husk/coir were dried again to form the powdered coconut husk which is ready to be mixed with the ABS granules. From fig. 8 it can be seen that the obtained mix which contained powdered coconut husk which is 5% (12.5gm) by weight of the total mix (250gm). The obtained plastic composite mix is further mixed with a certain plastic oil. This oil helps in settling down the powder with the solid granules of ABS so that it does not fly off during the process of injection molding.

The mix is then lifted up and poured through the hopper. Repeating the similar procedure as done for the previous ABS component, we obtain a new plastic composite component after the injection molding process as seen in the Fig 10.

Fig. 10 ABS and coconut husk reinforced plastic component

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 RESULT

Through the research and experimentation, we conclude we reach the following results –

- In this original research work, 12.5gm and 237.5gm of coir and ABS were mixed respectively to form a new composite.
- The shore tests were conducted and the hardness of composite was found 85 units, and for ABS it was 77.5units.
- There was a 9.67 % increase in the hardness of composite, which clearly proved its supremacy.

5.2 CONCLUSION

The 5% reinforced ABS plastic is superior in the hardness characteristic as compared with the normal ABS. The new composite formed can be used to replace the unadulterated ABS in places where durability plays a key factor in material selection of the product. For example, dustbins, decorator objects and flower pots can use coir infused ABS as its raw material as they require high strength and durability.

5.3 FUTURE SCOPE

The future scope of this composite revolves around its physical characteristic properties. Suppose 10% plastic is replaced in 100gm object, for 1 kg it became 100 gm. If this will be implemented for say 10,000 kg, it means, 1000kg coir. In this way plastic percentage can be decreased and coir percentage can be increased depending on the functionality of objects. This will result in huge savings in terms of less plastic usage and encouragement towards bio-degradable plastics. This composite is open to further research and studies so as to highlight its hidden potentials.

5.4 FUTURE SCOPE OF POLYMERS IN AUTOMOBILES

The future scope of polymers and their composites in industry is very promising. The concept of lightweight and high-speed vehicles has prompted the designers to make outer body of automobiles from body of carbon fiber which has high strength and also very lightweight.
Not only automobile industry, but also the aviation sector is using light weight and high strength composites as Aluminum, and its composites to increase strength and simultaneously reduce the weight of structure.

Asia Pacific has been the most dominant market as it accounted for nearly 50% of the total market volume in 2016 according to major research reports. Industry growth is positively influenced considering the shift in landscape of production

towards emerging economies of Asia-Pacific which include China, India, Thailand, Vietnam and Indonesia.

Reports from the industry convey that expansion of manufacturing base and multiple investments in futuristic technologies for automobile production is expected to bring about a new era for automobiles. Factors such as fuel efficiency have incremented demand for sustainable plastics across the globe. It is important for current auto manufacturers to collaborate with chemical producers to tackle performance and sustainability issues as plastic has played a major role in creating light weight fuel efficient vehicles for the auto industry [22].

5.5 ANALYZING FINANICAL AND ECONOMIC IMPACT USING PYTHON

The new coir reinforced ABS plastic composite can be used in the plastic industry to save a humongous cost while making the product more durable. From figure 11 we can see the growth rate of ABS plastic market in terms of production capacity.

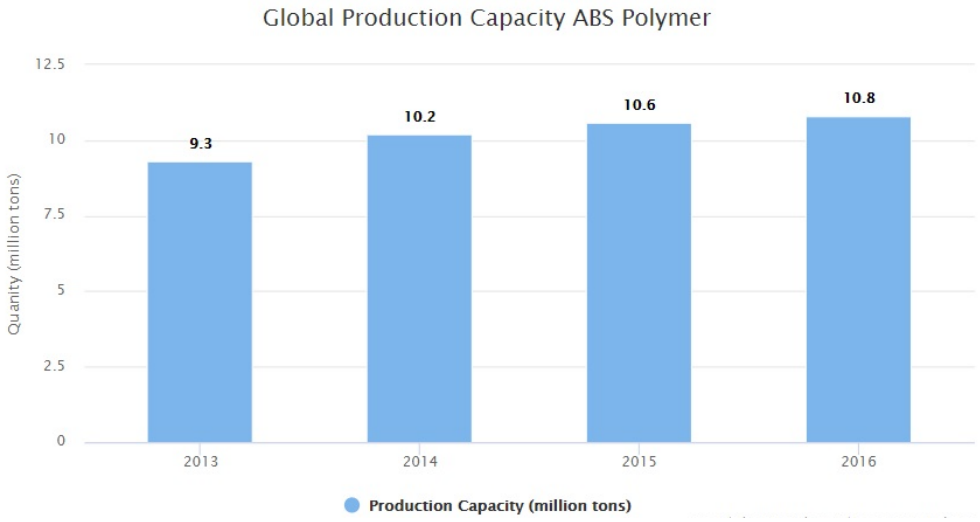

Fig. 11 Global Production Capacity of ABS polymer

Now taking the case of India for ABS production capacity, we take the data from [23] for month-wise import data for ABS plastic for the year 2017 which can be seen in the Fig 12.

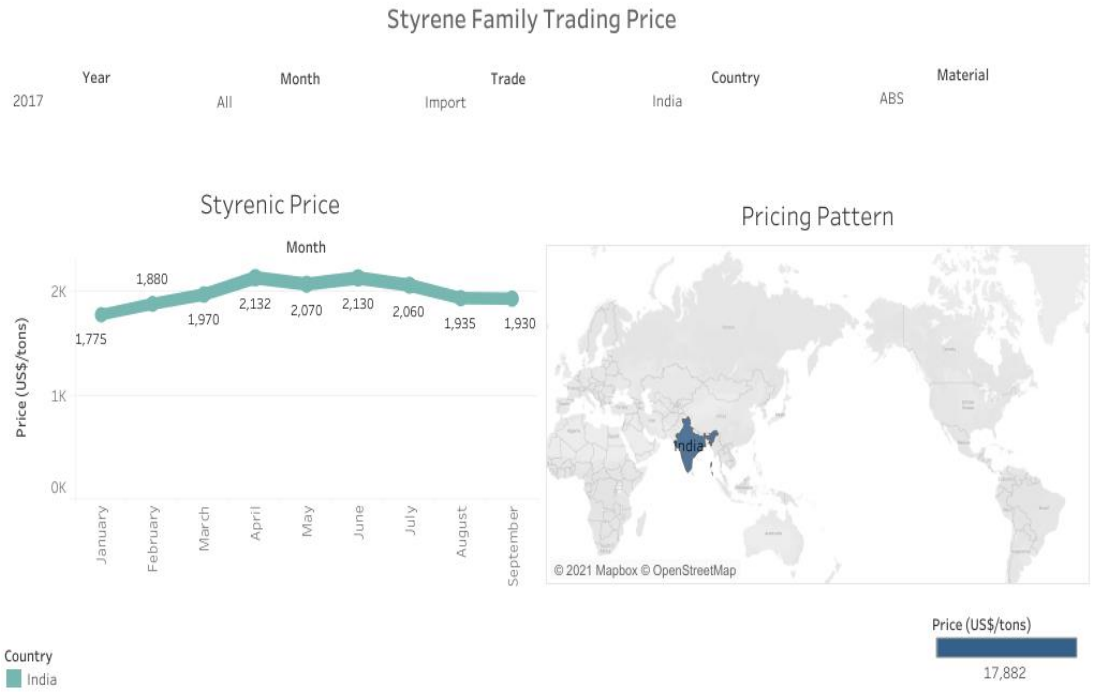

Fig.12 ABS Trading price in India

As our coir-based composite contains 5% coir fiber by weight we can deduce that we can cut the import of ABS plastic by 5%. This will further lead to saving monetary funds which can be later used for other purposes. By using data analytics and visualization techniques using NumPy and pandas module in python we can easily depict the financial resources that could have been saved in the year 2017.

For ease of calculation we will assume the average of all monthly varying prices for ABS while calculating the profit and loss of the petrochemical industry. Below is the code

```
import matplotlib.pyplot as plt

mprice = [1775,1880,1970,2132,2070,2130,2060,2935,2930]
sum=0
for i in mprice:
    sum+=i
mavg = sum/9
print("Average monthly price of ABS in 2017 in India = $",mavg) #price is per tonne
```

```
Average monthly price of ABS in 2017 in India = $ 2209.1111111111113
```

```
[2] vol1=102685 #metric tonnes #volume of ABS plastic produced
    vol2=0.95*vol1 #volume of ABS used while using composite
    profit= mavg*(vol1-vol2)
```

```
[3] print("Money saved by using coir based ABS composite = $",profit)

    Money saved by using coir based ABS composite = $ 11342128.722222224
```

```
# x-coordinates of left sides of bars
import matplotlib.pyplot as plt
left = [1, 2]

# heights of bars
height = [vol1,vol2]

# labels for bars
tick_label = ['ABS volume', 'Coir reinforced ABS volume']

# plotting a bar chart
plt.bar(left, height, tick_label = tick_label,
        width = 0.8, color = ['red', 'green'])

# naming the x-axis
plt.xlabel('x - axis')
# naming the y-axis
plt.ylabel('y - axis')
# plot title
plt.title('ABS plastic volume difference')

# function to show the plot
plt.show()
```

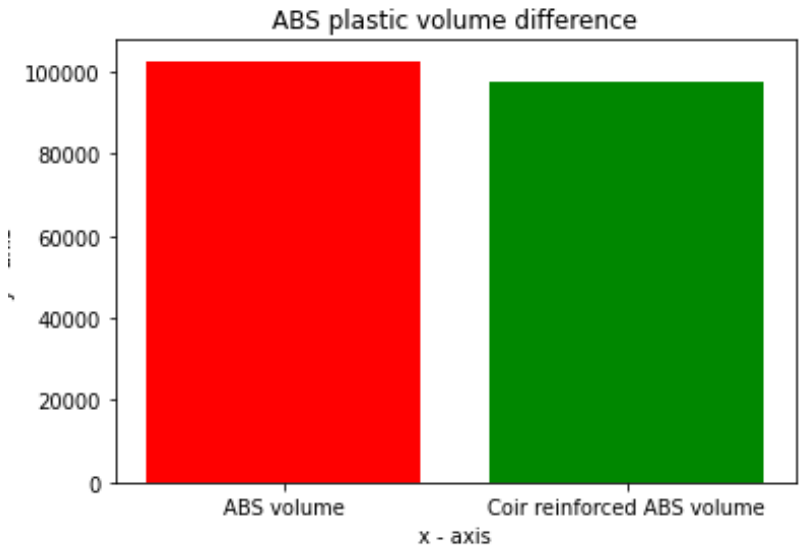

Fig.13 ABS volume difference

From above we can notice the slight dip of 5% of quantity of ABS used to manufacture plastic components. We can also conclude that a total of $11.3 million could have been saved in imports for the year 2017 if the use of ABS coir based composite was implemented.

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