



FABRICATION OF LOW COST PLATE MAKING MACHINE USING BIODEGRADABLE COCONUT SHELL AND FIBRE

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Abstract: Coconut shell and fibre is non-edible part of coconut drupe which is one of the hard agricultural wastes which is commonly disposed. With the growing popularity, industries have begun using eco-friendly materials for production of various products particularly disposable tableware. Most plastic utensils, coated paper plates, and styro-foam carrying containers are used once for a few hours and then left in a landfill for hundreds of years before they degrade. Efforts have been made to develop a machine that could fabricate a biodegradable plate which can be recycled. This project aimed to design and fabricate a machine for biodegradable plate that uses coconut shell and fibre as raw materials. Several trials and testing's were conducted for the biodegradable plate, and the result of the biodegradable test is it took 12 days for the plate to degrade. The other results of the testing are also detailed in this study.

Keywords – Coconut shell, Fibre, Binding agents, Biodegradable reusable plates, eco-friendly, waste utilization.

I. INTRODUCTION

In this sustainable world, biodegradable is a decomposer, that can be taken again to the earth naturally and it does not damage the surroundings. Nowadays, plastic food packaging is considered a supply of environmental hassle wastes, as it takes a very long time to decompose. To address this hassle, bio-materials have obtained a good deal attention due to short decomposing times and renewable individual. India is set third biggest manufacturer of coconut, approximately eleven. Five million metric tons wherein 1.7 million of coconut shell are wasted. This waste has the ability to serve as a supply of uncooked cloth for making green fabric. By focusing on the impact of polluted surroundings and to utilize plant waste the concept of the gadget is been evolved. It also concentrates on recycling method which blessings the manufacturers and clients.

1.1 COCONUT SHELL AND COCONUT SHELL POWDER:

India has made unrivalled progress in coconut cultivation within the closing 4 years and now it has come to be one of the leading countries in coconut production and productivity. Coconut shell is an outer hard cowl of a coconut fabricated from super call for. It is non-food part that's one of the hard agro wastes and a high ability cloth due to its excessive energy and modulus residences. Coconut shell, generally, is known for its high toughness, outstanding sturdiness characteristics, increased abrasion resistant residences and longer lifestyles. The chemical composition of the shell is quite similar to hard wood aside from higher lignin content and decrease cellulose content material. Once the coconut has been used for his or her flesh, water, oil, however 99% of the shells are generally discarded and burned.

This contributes to CO₂ and methane emissions. Coconut Shell Powder is a product made from coconut shells, taken into consideration to be appropriate and cheap filler compared to others. Coconut Shell Powder, as the name implies, is made from the most organic and flexible a part of the coconut – the shell. Coconut shell powder exhibits admirable houses as compared to different materials including low value, renewable, high unique power to weight ratio, low density much less abrasion to device and environmental friendly. Coconut shell powder is made from matured coconut shells. Most of coconut shell powder production industries are an organized enterprise in India. It is favored to other alternate substances to be had in the market inclusive of bark powder, furfural and peanut shell powder because of its uniformity in first-class and chemical composition, higher homes in recognize of water absorption and resistance to fungal attack. It is straightforward to manufacture and effects in sizable fee-addition.

1.2 COCONUT FIBRE (OR) COIR:

Coir is a natural seed-hair fibre received from the outer shell or husk of the coconut. Coir is light, elastic and water-resistant and additionally immune to mechanical put on. Coconut fibre is used as extra uncooked fabric because the natural fibres are eco-friendly, proof against thermal conductivity, very difficult, ductile, long lasting, renewable and inexpensive. Coir is the fibrous material discovered among the difficult, internal shell and the outer shell of a coconut. It has the benefits of now not sinking so can be used in deep water due to its stiffness. Coconut fibre is used as additional raw fabric due to the fact the herbal fibres are eco-friendly, very tough, long lasting, renewable and less expensive etc.

There are forms of coir, brown and white. We choose mature brown coir fibre, which contains greater lignin and less cellulose, are more potent, much less flexible and high abrasion resistance. Normally coconut fibre takes twenty years to decompose however this does not generate any harm for our surroundings. So using product by using use of natural coconut fibre is likewise proper for our surroundings additionally. This Lingo-cellulosic nature of coir makes it biodegradable. The machine allows in melt and dispose of the final strains of pith on the fibre and the processed fibre comes out smooth & parallel. The fibres are then rolled, which can be used for spinning, the impacts on physical and mechanical houses. Biodegradation of the materials & the coating were additionally investigated to select the high-quality coating that would benefit making this Biodegradable Plates.

1.3 APPLICATION OF BIODEGRADABLE PLATES (COCONUT SHELL AND FIBRE):

Most of those biodegradable plates are crafted from bagasse. The substances which include coconut shell and fibre which can be used on this plate has its very own benefits, in which the shell and fibre are used in making distinct kinds of gadgets like biodegradable plates and greater. As its miles an eco-friendly fabric it keeps foods faraway from dangerous poisonous materials which play a vital role in human fitness. These plates could also provide high power efficient and offers freshness to the meals. Other than these homes, this plates are smooth composting, safe to apply with microwave, waterproof, reduces environmental pollutants, acts as a waste management product and many extra.

1.4 BINDING AGENTS:

A binding agent, or binder, is a material used to form materials into a cohesive whole, as a method of providing structural stability. Binding dealers harden chemically or mechanically, and inside the technique bond fibres, filler powder and other substances together. Here we use natural binding sellers like Agar-Agar and Gelatin to bind the substances of the plate and to make several trying out and trials in the plates to study the residences and fine of the plates.

II. OBJECTIVES

The objectives of the project is to

- Design and develop a portable machine for the production of reusable plates using coconut fibre and coconut shell powder which is water resistant, toxin free, completely natural and eco-friendly.
- Compare the physical properties with other biodegradable disposable plates.
- Minimize environmental pollution through reduction of disposal and promote reuse of products.

III. METHODOLOGY

3.1 CONSTRUCTION DETAILS:

The design of the fabricated machine is made by considering all aspects and has been constructed in a way that the design is easy to handle and the system functions accordingly. The design is separated into three phases as it contains many processes in it. The cost of design and fabrication of the machine is reasonable. The first phase is the design of the inlets i.e. hopper which is made of sheet metal and they are parted into three inlets namely inlet 1, inlet 2 and inlet 3 respectively, were inlet 1 and 2 is cover with a lid which is made using the same material. Raw materials are fed in the inlets 1 and 2 and an AC motor of 230v 3000rpm (with speed adjustment) assembly is fixed as shown in the Figure 3.1 below to the inlet 2, which is connected to the power supply. The motor is covered with a frame made of sheet metal, and the grinding process takes place. The second phase is the bottom of the hopper where iron pipes are attached separately to each of the respective inlets and then fixed to the mixer section in the center. The mixer section in the middle is fixed with blades which also gets the same power supply, in which the blending process is done. And for the final phase an iron pipe is welded at the bottom of the mixer section, where a valve mechanism is fixed at the end of the iron pipe. This is attached to the tool die setup with a handle in which the plate gets compressed. The tool die is fixed with a balance stand with four legs made of iron pipes along with each ring washers in it. So that the total fabricated machine can stand with a balanced position in the surface.

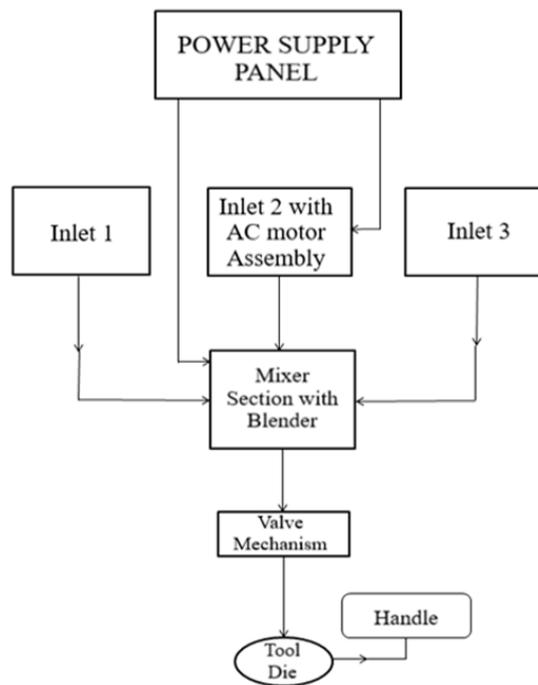


Fig.3.1 Block Diagram of Plate Making Machine

3.2 FABRICATION OF BIODEGRADABLE PLATE MACHINE:

This machine is designed for the purpose of making biodegradable plates using coconut shell and fibre which can be a great use for the small scale industries and for the environment as it is made of natural materials which act as a waste utilization product. The fabrication and design of the machine is done effectively in an appropriate manner. The process of the machine starts from the raw materials (coconut shell powder, coconut coir, binding agents) as shown in the Figure 3.2 below, which are fed into the hopper separately in its respective inlets i.e. (inlet 1 – coconut shell powder, inlet 2 – coconut coir, inlet 3 – binding agent), the coir which is fed in the inlet 2 is grinded until it becomes a fine powder using an AC motor fixed in the inlet with a given power supply panel.

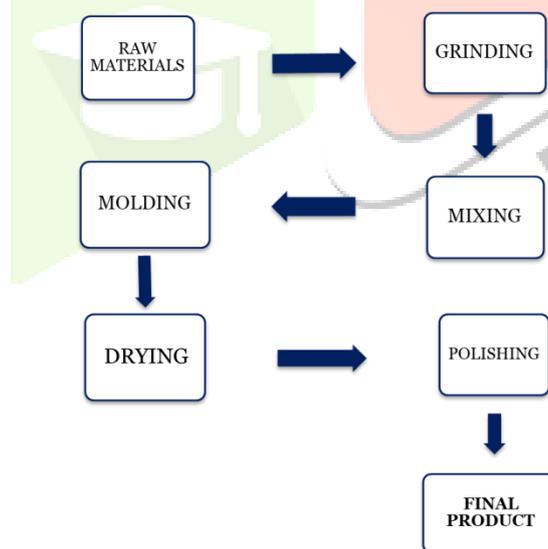


Fig.3.2 Process Flow Diagram

It is then mixed completely together in the mixer section where blades are attached for the blending process in which the same power supply is given; the blender makes the materials into a smooth pulp. This semi-finished product is moved for the moulding process. When the pulp reaches the plate mould, a valve mechanism is fixed at the end of the mixer pipe, so that the flow of the pulp can be controlled. It is then manually compressed to its required shape using the tool die. The plate is further sun dried and polished by rubbing its edges. The final product is packed and stored.

IV. RESULTS AND DISCUSSION

4.1 TRIALS TAKEN:

Considering the pandemic situation and availability of time these trials have been taken. Two types of binding agents (agar-agar, gelatine) are used in order to observe its binding capacity and properties of the plate. The results of the trials are shown in the Table 4.1 below.

Table 4.1 Trail images (Top and Bottom view) of the Biodegradable plate

TRIALS TAKEN	USE OF BINDING AGENTS	TOP VIEW	BOTTOM VIEW
1.	Plate made of agar-agar as binding agents		
2.	Plate made of gelatin as binding agents		
3.	Plate made of gelatin as binding agents with a proportion (30% CSP & 70% coir)		

4.2 TESTING RESULTS:

With the initial trials conducted, it is observed that the (trail-2) plate made out of gelatin as the binding agent gives a glossy and a smooth appearance to the plate when compared with the other plates made out of agar-agar and with different proportions. As for now the following tests were conducted for the plate and the results were noted:

1) PHYSICAL CHARACTERISTICS OF THE PLATE:

The physical characteristic of the plate was determined by calculating the weight and volume of the sample. The specific volume of the plate is calculated using the formula,

$$\text{Specific volume} = \text{volume/weight (g)}$$

$$\text{Specific volume of plate} = 384 \text{ g}$$

2) WATER ABSORPTION TEST:

Weight of the plate were noted and dipped in water for 24 hours. After 24 hours, weight of the samples were taken, the difference between the weight of the specimen before and after the absorption indicates the water absorption capacity of the plate.

$$\text{W.A (\%)} = \frac{(\text{Difference in weight})}{(\text{Original weight})} \times 100$$

$$\text{W.A (\%)} = 26.12 \%$$

3) TEXTURE CHARACTERISTICS:

The texture of the plate are generally measured manually using physical compression or by sensory evaluation. The major texture performance is done using the compression force where the plate is set under pressure to test its flexibility. The plate using agar-agar as a binding agent was rough, dry and easily breakable. By using gelatin as a binding agent, the plate gives a smooth appearance and not easily breakable.

4) BIODEGRADABLE TEST:

A small piece of plate is taken and grounded in the soil and the grounded sample is observed periodically. The number of days the sample that takes to decompose is observed and noted. As per the result of the biodegradable test, the grounded plate sample takes 12 days to degrade. The observed results of the sample are shown in the Table 4.2 below.

Table 4.2 Grounded sample images of Biodegradable Test

DAYS	1	4	8	12
GROUND SAMPLE				

V. CONCLUSION

The fabrication of low cost plate making machine using biodegradable coconut shell and fibre is portable and economically able to fulfill the increasing demand of small scale industry. The design and procedure of the fabricated machine consists of various processing sections. The plate making machine could give a biodegradable moulded plate which would benefit the domestic people and environment, as it is totally made out of natural resources. The working of the first phase of plate making machine has been attained. It was felt that the capacity of the machine to crush the materials into pulp was satisfactory. And yet the efficiency of the plate needs improvement. It is observed that different proportion and sizes of the plate can be experimented to improve efficiency. The test and trials is done at the initial level, once corrected and verified it could be validated in the market place and could be demonstrated to the labours and consumers. Use of plastics could be avoided and waste utilized eco-friendly cutlery plates could increase in its usage. This would improve the selling of reusable plates in the market and reduces environmental pollution.

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