Design and Construction of 15 Kg/Hour Capacity Cocopeat and Cocofiber Machines

Suparno*, Andri Kurniawan†, Ferry Bayu Setiyawan‡, and Risky Setiyadi§
1Departement of Mechanical Engineering, Politeknik Negeri Samarinda, Samarinda, Indonesia
2Departement of Chemical Engineering, Politeknik Negeri Samarinda, Samarinda, Indonesia

Abstract. Indonesia is one of the largest coconut producers, which in turn produces a lot of waste, especially coconut coir waste which can cause flooding if carelessly dumped in the river or carried by flood currents. Coconut coir waste that is no longer used can be reprocessed into a variety of finished and semi-finished products that have a high selling value. These products include coir fiber (Cocofibre), coir powder (Cocopeat), solid coir powder (Cocopeatbrick) cocomesh, cocopot, cocosheet, coco fiber board (CFB) and cococoir. This research aims to plan and design a machine that can process cocofiber into raw materials for its derivative products like making handicrafts such as doormats, etc. In planning and designing this machine, solidwork software and the calculation analysis method of the Sularso Machine Elements book guide were implemented. This machine is equipped with a sieve as an automatic separator between cocopeat and cocofibre in the form of a hexagonal cylinder. The machine produces cocopeat at 15 kg/hour and cocofiber at 5 kg/hour which is more time efficient and more effective compared to the traditional method or the existing similar machine. This study will be beneficial for small and middle-class industries.

1 Introduction

Indonesia is a tropical country with very abundant natural products, one of which is a coconut producer, one example is in Kutai Karta Negara District, Sanga-sanga District, which is located in East Kalimantan Province with a coconut plantation area of 8,300.00 ha. The parts of the coconut fruit are 65% by weight of the kernel (part of the shell, flesh and water) and 35% by weight of coconut fiber. In the country itself, many coconut coir processing is still traditional, so it is very inefficient and takes a long time. This necessitates a technological renewal in agriculture, namely by creating a tool for disentangling coconut coir into cocopeat where the tool is equipped with a disentangling mechanism as well as a sieving mechanism simultaneously from the engine rotation. Unfortunately, the processing of the coconut fruit industry in Indonesia has not been going well. Whereas later this coconut coir can be...
developed into various products, including cocopeat, cocofibre, cocomesh, cocopot, cocofiber board and cococoir. These materials are raw materials in the mat industry, pots, dry compost and so on [1].

If we look at neighboring countries, coconut has become an export commodity that supplies the world's needs, which is around 75.7 thousand tons in 1990. Even though Indonesia is the country with the largest coconut producer in the world, the market price of each is very low. If you look at the increasing trend in the need for coconut fiber, it is hoped that industries will be able to develop processed coconut fiber, especially the domestic industry itself. The by-product of processing coco fiber is in the form of granules of coco coir, known as cocopeat.

Coconut coir that has been crushed into a fine powder will also be called cocopeat. Meanwhile, coconut fiber is obtained from coconut fiber that has been crushed first. Besides being economical, cocopeat is an environmentally friendly planting medium because it is made from the epidermis of coconut shell which is renewable (organic). As the name implies, cocopeat comes from coconut, the layer or part of coconut that can be made into cocopeat is called mesocarp, this part of the mesocarp is completely powdered and mostly on the coir and sticks to the shell [2].

In the design of this machine, it will use a 16 PK Diesel Engine which will be connected to a pulley-belt that will move the shaft of the blade of the coconut fiber cutter [3]. With the help of this tool, it is hoped that it can help middle to lower coconut coir processors to be able to process or treat coconut waste to the maximum and have a high selling value.

The purpose of making this tool is to make a coconut coir disentangling machine to be able to improve the quality and quantity of its production which is more efficient and economical. By using an electric motor, the resulting machine is in the form of a tube as a place for the disentangling machine. Inside there is a parsing knife in a cross position and has a door, a channel for entering and leaving the unraveled coir. With this coconut coir disentangling machine, the products obtained are of higher quality, the fibers are finer so that the selling price becomes more economical.

1.1 Utilization of coconut coir/cocofiber

Continuous innovation in the use of coconut coir continues. One of them is Rubberized Coir. This product is arguably recently produced in Indonesia. China is the largest producer of this gold-valued coir business, it's time to become Indonesia's mainstay. The term that is common in Indonesia for this product is Sabutret (rubber coir fiber) (Fig. 1). This blend of coir and natural rubber produces superior products of high quality. The advantages of Sabutret product include having a light weight and being porous because it has a cavity with wide pores. Then the sabutret has good air circulation so it doesn't cause heat to the user, even if it's been occupied or slept for a long time. This condition causes products such as cocomatras to be very good for improving sleep quality and avoiding the occurrence of back pain. The good air circulation in cocomatras is very good for baby mattresses, this will also help to absorb the smell of urine from the baby's urine. The flexible nature of the sabutret makes this product special, so it is durable, does not collapse or bend as long as it is not heated more than 90 °C.

1.2 Utilization of coconut powder/cocopeat

Trends in the use of organic compost showed a significant increase. Its use for agricultural crops or ornamental plants is increasingly loved, because it can increase soil fertility. Likewise, cocopeat as a planting medium to replace soil is now increasingly popular for ornamental plant hobbies. The advantage of cocopeat that it is able to absorb 3 times more
fertilizer and water than the soil, makes cocopeat a suitable alternative for plant media. The use of cocopeat usually still has to be mixed with fertilizer. But now, Cocopeat is available in ready-to-use dough in the form of Cocopeat Organic Fertilizer. Cocopeat Organic Fertilizer is made from a mixture of cocopeat (coconut coir powder), manure, EM4, roasted husks, pulp and molasses bran. Various mixtures of Cocopeat organic fertilizer enrich the nutrients in the media. This fertilizer is not yet known for each nutrient element, but it has been used for the purpose of planting plants for mine reclamation as shown in Fig. 2.

![Sabutret mattresses and pillows](wordpress.com)

**Fig. 1.** Sabutret mattresses and pillows (wordpress.com)

![Powder](image)

**Fig. 2.** Powder

### 1.3 Coconut coir disentangler machine

Coir Disentangler Machine is a machine that functions to disentangle or separate coconut fiber from a layer of sponge or powder, so that the two products produced can be utilized as desired. The working principle of this coconut coir disentangling machine is to beat the fiber and powder parts of the coconut which has been fed to the intake of the coco-coir disentangling machine.

The disentangling process in coconut coir processing aims to separate the coco fiber from the outer skin of the coconut fruit (coco peat), where each type of material has its own function and selling point. The processed products are in the form of coir and outer shell that have been disentangled, but the product is still mixed together.

### 2 Methodology

The research method was a series of steps carried out in a planned and systematic manner in order to get answers to these problems. In addition, the research methodology was the basic
framework for logical thinking for the development of this thesis to be able to draw conclusions. In this manufacturing process, it is explained how the process of materials that have been prepared is made and assembled in such a way as to become a coconut coir disentangling machine according to the design made (Table 1).

Table 1. Tools and Materials Used

<table>
<thead>
<tr>
<th>No.</th>
<th>Tools</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Welding machine</td>
<td>Diesel Engine 8 Pk</td>
</tr>
<tr>
<td>2.</td>
<td>Wrench</td>
<td>Dimmer</td>
</tr>
<tr>
<td>3.</td>
<td>Roll meter</td>
<td>Pulley 8 inch</td>
</tr>
<tr>
<td>4.</td>
<td>Lime</td>
<td>Small Pulley</td>
</tr>
<tr>
<td>5.</td>
<td><em>Cutting wheel</em></td>
<td>Pillow block UCP 208</td>
</tr>
<tr>
<td>6.</td>
<td>Vernier calipers</td>
<td>bearing Ball</td>
</tr>
<tr>
<td>7.</td>
<td>Apron</td>
<td>V-belt</td>
</tr>
<tr>
<td>8.</td>
<td>Welding mask</td>
<td>Spring</td>
</tr>
<tr>
<td>9.</td>
<td>Welding gloves</td>
<td>Plate 5mm</td>
</tr>
<tr>
<td>10.</td>
<td>Hammer</td>
<td>Plate 2mm</td>
</tr>
<tr>
<td>11.</td>
<td>iron grinder</td>
<td>Iron elbow 5x5mm</td>
</tr>
<tr>
<td>12.</td>
<td>Brush</td>
<td>Shaft S4SC</td>
</tr>
<tr>
<td>13.</td>
<td>L Wrench</td>
<td>Pegs</td>
</tr>
<tr>
<td>14.</td>
<td>Hammer</td>
<td>Bolts, nuts and washers</td>
</tr>
</tbody>
</table>

The process of making the main frame of the coconut coir disentangling machine, among others, as follows.
- Provide 4 pieces of elbow iron with a length of 700 mm for the frame legs.
- Provide 2 pieces of 1100 mm long elbow iron for frame construction.
- Provide 5 pieces of elbow iron with a length of 500 mm for the lower skeleton and also the upper frame so that the frame can be square.
- Next, make 2 holes on the top of the elbow iron as much as 2 holes on the left side and 2 holes on the right side as bolts for fastening the pillow block.
- Provide 2 pieces of angle iron with a length of 600 mm for the upper frame and make 4 holes for the locking bolts for the blade cover.
- Then connect the angled iron that has been cut by welding so that the frame is square.
- After the main frame has been formed, then provide 2 pieces of elbow iron along 550 mm for the motor mount. Then cut the center of the angle iron along 200 mm with a width of 10 mm for the locking bolts and motor adjustment.
- Do welding again to connect the angle iron to the end of the frame as a motor mount.
Here are the steps to make a blade cover:
- Provide an iron plate 650 mm long and 550 mm wide with a plate thickness of 2 mm.
- Provide 2 pieces of angled steel with a length of 600 mm to connect the blade cover to the frame, drill 4 holes in both of them as a place for fastening bolts.
- Cut at the end of the square plate with a length of 180 mm and a hole width of 150 mm as a coconut coir entrance hole.
- Provide an iron plate with a length of 200 mm and a width of 100 mm, cut the iron plate into 4 parts as an entrance funnel. Then do the welding of 4 parts of the iron plate in the holes that have been made in the blade cover plate.
- Provide 34 pieces of AISI 4340 Carbon steel with a length of 515 mm which serves as a cocopeat outlet and blade protector. Do the carbon steel welding on the upper frame. Arranged with a distance of each iron as wide as 10 mm.
- Provide an iron plate with a length of 633 mm and a width of 50 mm which serves as a barrier in the disposal of the cocopeat so that it does not fall apart. Perform welding on the underside of the frame.
- Cut a plate with a length of 470 mm and a width of 633 mm as a cocopeat holder.
- Cut the plate in the shape of a trapezium as many as 3 pieces which will later serve as a cocopeat holder and a separator between fibers and cocopeat.
- Making a safety iron plate for this knife blade is useful for holding the coconut fiber from being thrown out and the separator between the cocopeat and coconut fiber so that it does not mix.

The following are the steps for making the blade shaft
- Provide 40 mm diameter AS S45C steel 560 mm long for the blade shaft.
- Provide bearing pillow block diameter 40 mm.
- Turn the right side of the shaft with a diameter of 30 mm along 160 mm. Make a 7 mm hole at the end of the shaft as a spi pulley holder as a connector for the electric motor. Install the bearing pillow block on the right and left of the axle that has been completed.
- Then install the blade shaft in the finished frame.

Here are the steps to make the blade:
- Provide a steel strip that will later be used as a blade. Cut the carbon steel that has been provided with a length of 240 mm and a width of 70 mm by 15 pieces.
- Provide a plate with a thickness of 5 mm with a length of 200 mm and a width of 140 mm as many as 3 pieces for the coconut coir exhaust fan.

Steps for making pulleys
- Provide 2 inch and 3 inch type pulleys
- Turn the 3 inch pulley with a diameter of 30 mm according to the shaft, and the 2 inch pulley with a diameter of 19 mm according to the drive motor shaft
- And use a v-belt type A52 length 1550 which functions as a connector for the motor drive pulley with the blade shaft drive pulley.
- Assembly is the last stage in the process of designing and manufacturing a machine or tool, where a method or action is to place and install parts of a machine that are combined from one unit according to their partner, so that it will become a machine assembly that is ready to be used according to the planned function.

Before assembling, you should pay attention to the following things:
- The components to be assembled have been completed and the size is in accordance with the initial planning.
- Standard components ready to use or even installed.
- Knowing the quantity to be assembled and knowing how to install it
- Knowing the place and order of installation of each component to be used.
- Prepare all tools for the assembly process.

The components of this machine are as follows:
- Diesel Engine 8 Pk
- Disentangler Blade
- Pulley
- Bolts & nuts
- Pillow block

The steps for assembling the coconut coir disentangling machine are as follows:
- Install the paring knife in the bearing and then install it at the top of the frame then tighten it using nuts and bolts
- The propulsion engine is installed at the bottom of the frame and adjusts to the holder, then tightening it using nuts and bolts and pulleys on the diesel engine section and the shaft pulley is installed
Basic operation of coconut coir disentangling machine (Fig. 3):
- Dry the coconut coir until the water content ± 20%.
- Make sure the equipment to be used is available and ready to use. (It is recommended that the operator wear a mask).
- Turn on the disentangling machine by turning on the driving motor first.
- Enter the coconut coir into the disentangling machine through the input hopper slowly.
- Coconut coir will break down into cocopeat and cocofiber.
- The cocofiber will exit through the cocofiber output hopper and the cocopeat will exit through the cocopeat output hopper after going through the filter.
- After the disentangling process is complete, turn off the motor, clean the machine and place it in a safe place.

3 Results and discussion

The design and manufacture of cocopeat and cocofiber machines is the result of a survey conducted by the author in one of the villages of Tanah Merah, Kecamatan Samarinda Utara, Samarinda City, East Kalimantan. The process of breaking down the outer shell of coconut still uses the traditional method by pounding it. With this machine, it is hoped that it can help the process of breaking down the outer shell of coconut so that it can improve the quality of cocopeat and cocofiber. This coconut disentangling machine has several parts, namely:

- The frame of this tool is made of angle iron. The function of the frame is to support other parts of the tool. The tool frame has dimensions of Length 110 cm, width 60 cm, height 107 cm.
Diesel engine propulsion functions as a driving force. The machine used has a power of 8 Pk. and a rotation speed of 3000 rpm. The belt on this tool uses 1 belt between the driving machine and the parsing shaft using a belt type A No. 52.

- Pulley, this tool uses 2 pulleys. on the driving motor using a 2 inch pulley, on the parsing shaft using a 3 inch pulley.
- Bearing, this tool uses 2 bearings with type UCP 208 with number UC208.
- Separator setting, to adjust the distance between the blade shaft and the separation setting wall according to the average size so that the cocopeat and cocofiber are separated optimally.
- Shaft of cocopeat and cocofiber parsing blades, has a length of 560 mm and a diameter of 40 mm.
- Input funnel. Serves as a container for the outer shell of the coconut. Which has dimensions of Length 150 mm, width 150 mm, and height 220mm.
- The cocopeat output channel, serves as an outlet for the production of powdered coconut husks that have been parsed. Which has a length of 350 mm, and a width of 283 mm.
- The cocofiber output channel, serves as an outlet for the production of coconut fiber from disentangled coconut fiber. Which has dimensions of 400 mm in length, and 253 mm in width coupled with a filter found on the output channel door in the form of a conical cylinder.

The working principle of this coconut coir disentangling machine is by turning on the driving machine, the rotation of the machine continues to the peeler shaft in which there is a parsing knife cylinder and the rotation will be forwarded to the dividing shaft using a belt and pulley. To adjust the wide or narrow distance of the coconut outer shell parser, set the separator setting.

The total time of the coconut coir high rotation test is 10 minutes. To calculate the production capacity used the equation: \( Ka = \frac{Bk}{t} \) with capacity = 1 kg / 10 minutes, capacity = 0.1 kg/minute. And capacity = 6 kg/hour. The total time of the coconut coir low spin test was 13 minutes. To calculate the production capacity used the equation: \( Ka = \frac{Bk}{t} \) with capacity = 1 kg / 13 minutes, capacity = 0.08 kg/minute, and capacity = 4.8 kg/hour. Based on the results of the testing of the coconut coir decomposing machine above, the test results of this machine are able to decompose coco coir very well. So if we add up the test results of this machine, the average time obtained is 11:30 minutes with the average capacity of this machine is 5.4 kg/hour. The condition of the machine when the experiment was carried out the machine experienced vibration, so that it affected the quality of the results of the decomposition of coconut husk. This is because the engine holder is not permanently installed. Then to get good fiber quality, the decomposition process must be carried out 2 times.

4 Conclusions

The machine listed above is a coconut coir disentangling machine that has been successfully made which has several specifications. The machine that has been successfully made uses an electric motor with 8 HP power and a speed of 1,400 rpm, the maximum rotational speed of the stirring shaft is 1,000 rpm, using a pulley and a V-belt as power transmission. The capacity of decomposing coir is 15 kg/hour and has 15 blades. Meanwhile, the dimensions of the tool are 1110 mm long, 600 mm wide and 1067 mm high. The design of the coconut coir disentangling machine produces the following specifications:

- From the high rotation test of coconut coir is 10 minutes. To calculate the production capacity used the equation: \( Ka = \frac{Bk}{t} \) with capacity = 1 kg / 10 minutes, capacity = 0.1 kg/minute. And capacity = 6 kg/hour.
- From testing the low rotation of coconut coir is 13 minutes. To calculate the production capacity used the equation: \( K_a = \frac{B_k}{t} \) with capacity = 1 kg / 13 minutes, capacity = 0.08 kg/minute, and capacity = 4.8 kg/hour. Based on the results of the testing of the coconut coir machine above, the test results of this machine are able to decompose coconut coir very well.

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