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Design Of A Coconut Shell Charcoal Briquette Mixer Machine With A Capacity Of 50kg

Asep Rachmat *[1], *Gilang dwi Saputra* [2] , *Alwi Albaar*[3]

[1,2,3] *Mechanical Engineering, University Majalengka, Majalengka, Indonesia*

email:[1] aseprachmat@unma.ac.id , [2] gilangdwisaputra21@gmail.com

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ABSTRACT

Coconut shell waste has not been optimally utilized, despite its potential to be processed into charcoal briquettes with higher economic value. One of the critical stages in briquette production is the mixing process, which requires an efficient and reliable mixing system to ensure homogeneity. This study aims to design a coconut shell charcoal briquette mixer machine with a capacity of 50 kg. The design methodology includes determining the mixer drum capacity, frame dimensions, and shaft specifications, followed by mechanical analysis to evaluate the torsional load acting on the shaft. Simulation analysis was conducted to assess the structural performance of the machine. The results indicate that the maximum stress due to torsional loading is 1.714×10^5 Pa, while the resulting deformation is 3.306×10^{-5} m. These results demonstrate that the designed mixer machine meets the required safety criteria and is capable of operating effectively in the briquette mixing process. The proposed design is expected to improve efficiency and consistency in coconut shell charcoal briquette production.

1. INTRODUCTION

Coconut shells are a common waste product found in traditional markets. They are often discarded, but they can also be quite valuable. One way to process coconut shell waste is to make coconut shell charcoal briquettes. This coconut shell waste can be utilized by communities to build small-scale businesses, as coconut shells are a readily available raw material. Coconut shell waste can also be used as a substitute for fuels such as cooking gas.

The frame is one of the components that must be considered in designing a product or tool, because the frame will accommodate or hold all the loads of each component so it must be considered, according to Angga Restu Pahlawan et al (2021), the existing load on the frame system will affect the deflection that occurs in the frame structure, so that it can cause cracks and even breaks. So when designing a frame, careful and precise calculations must be made to reduce the possibility of damage to the frame. In processing coconut shell charcoal, there are several stages, one of which is the process of mixing briquette materials, adding a transmission system with a shaft as a power transmitter so that the mixing process

*) Corresponding Author : aseprachmat@unma.ac.id

occurs, and producing a mixer machine that is capable of mixing briquette components that are easy to operate, a mixer machine design process is needed to determine various aspects, such as design, type of material used, diameter of the shaft used and others [1].

Mixing relatively large quantities requires a long mixing time, so a mixer is needed to speed up the mixing process.Uneven mixing and feed mixing occur due to manual mixing of large quantities [2]. Large-scale mixing operations require a long time, so a mixer is necessary. This mixer is specifically designed to facilitate faster and more efficient mixing, thus streamlining the mixing process [3].

Stirring is an action that triggers movement within the material being mixed. The goal of stirring is to achieve a good mix. Mixing here serves to overcome differences in conditions, temperature, or other characteristics present in a material.The mixing process is inextricably linked to the use of a shaft as a component. Several shafts are used in the mixing process. One shaft drives the mixer blades, while the other drives the cylinder or container.During the mixing process, the shaft is subjected to a load, known as a torsional load. A torsional load is a force that causes a twisting moment, resulting in torsion. Torsion is the rotation of an object due to the resulting torque [4].

The shaft is a crucial component in the design of a rice husk grinding machine. Therefore, an analysis will be conducted to measure the stress levels that cause torsional moments in the material and its safety factor to prevent shaft fatigue, which can lead to plastic deformation. Based on the discussion mentioned, the author feels compelled to conduct research on a coconut shell charcoal mixer machine using a hollow blade with the title "Design of a Coconut Shell Briquette Mixer Machine with a Capacity of 50 Kg" [5].

2. METHOD

The research method used in the DESIGN OF A 50KG CAPACITY COCONUT SHELL CHARCOAL BRIQUETTE MIXER MACHINE follows the stages explained in the sub-discussions which will be explained as follows through the diagram:

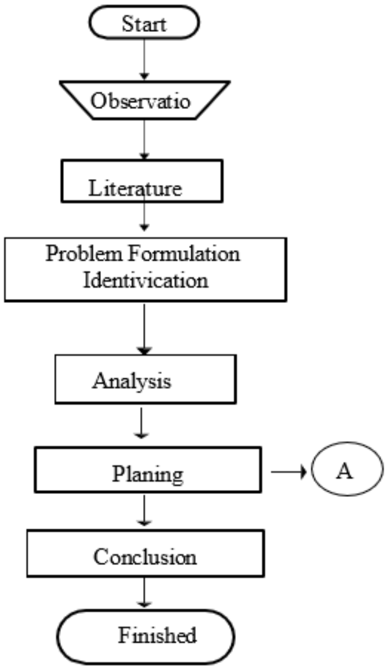

Figure 2.1 Research Flowchart

• Observation

Conducted observations on the mixer machine being used in the briquette mixing process at PT. Briket HD Tasikmalaya, West Java. During this activity, we observed the elements used in the mixer machine and asked the operator directly about how to operate the machine.

• Literature Review

The author conducted a literature review by searching for research journals related to coconut shell charcoal briquette mixing machines and conducting a review to support this research.

• Problem Identification and Formulation

The problem encountered during the production of coconut shell charcoal briquettes in the Faculty of Engineering workshop at Majalengka University was that the resulting briquettes were cracking, a result of the imperfect mixing process.

• Analysis

The analysis involved creating a model for a 50 kg capacity coconut shell charcoal briquette mixer machine. This model will be used in the design process, which will then be included in the modeling sketch and so on.

• Design Process

The design process for this 50 kg coconut shell charcoal briquette mixer machine involves several steps, including initial design, modeling, material selection, assembly, and analysis.

• Conclusion

The author will gather data from a series of design processes to arrive at a conclusion

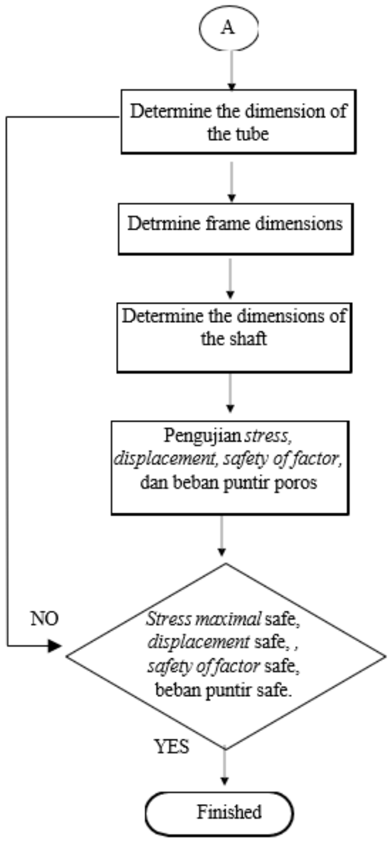

Figure 2.2 Research Flowchart process

• Determining the cylinder dimensions

The process of determining the cylinder dimensions is to determine the appropriate size for the desired volume capacity through calculations, followed by initial design sketches and 3D modeling.

• Determining the frame dimensions

The process of determining the frame dimensions is carried out to ensure the frame is capable of supporting all existing loads. To ensure the frame is capable of supporting all existing loads, a sketch is created and followed by 3D modeling.

• Determining the shaft diameter

Determining the shaft diameter is carried out to minimize shaft failure, as the shaft will later function as a rotating cylinder, under load. To prevent excessive deformation, the shaft diameter is determined.

• Testing

In designing this coconut shell charcoal briquette mixer machine, several tests are conducted, such as stress testing, displacement testing, safety factor testing, and torsional load testing on the mixer cylinder shaft. These tests are conducted to ensure safety during construction and use. If there are any design irregularities, redesign is carried out to achieve safe test results.

3. RESULTS AND DISCUSSION

In the process of creating technology, the first step is to design the machine elements to be created. Design is the first step in a series of technological development activities. The first stage in the design process is creating an initial design plan.

3.1. Design Process

3.1.1 Mixer Tube

This mixer tube is a place used as a place for the mixing process of all briquette components, made using stainless steel plate material, this material is superior in its anti-corrosion properties which will increase its service life longer.

• Calculating the Mixer Tank Capacity

Tube volume

$V = \pi r^2 . t$ (1)

$V = 3{,}14 \times 25^2 . 40$

$V = 3{,}14 \times 625 . 40$

$V = 78.500\ cm^3$

Volume of a truncated cone

$V = \frac{1}{3}\pi . t . ((r_1^2) + r_1 . r_2 + (r_2^2))$ (2)

$= 18{,}626\ cm^3$

Volume Total

$V_{total} = V_{Tabung} + V_{Kerucut\ Terpancung}$ (3)

$V_{total} = 78.500\ cm^3 + 18.626{,}125\ cm^3$

$V_{total} = 115.752{,}25\ cm^3$

Tube dimension

So the density of coconut shell charcoal briquettes is 0.777g/cm3. To find out the maximum capacity that the cylinder can accommodate,

$\rho = \frac{m}{v}$ (4)

$m = \rho . v$

$m = 0.777 x 115{,}752.25$

$m = 89{,}953.59\ g$

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So, the maximum capacity that the cylinder can hold is 89,953.59 g, or 89.95 kg.

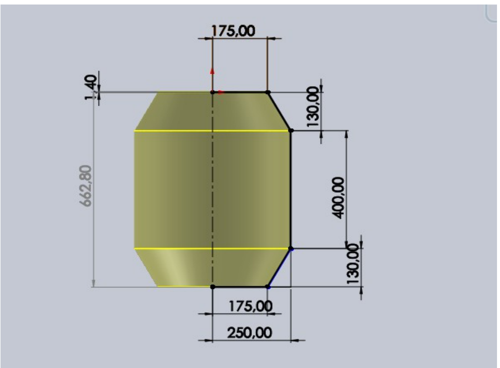

Figure 3.1 Mixer Tube

3.1.2 Drive Motor

The drive motor used in this mixer design is an electric motor with specifications of 1 hp, 1400 rpm, 0.75 kW, and 220V (single-phase).
Where the torque of this motor is not yet known, the following calculation is carried out:

$$T = \frac{5250.HP}{n} \quad (5)$$

$$T = \frac{5250.1}{1450}$$

$$= 3{,}75 \text{ Nm}$$

So the torque on the drive motor is 3.75 Nm.

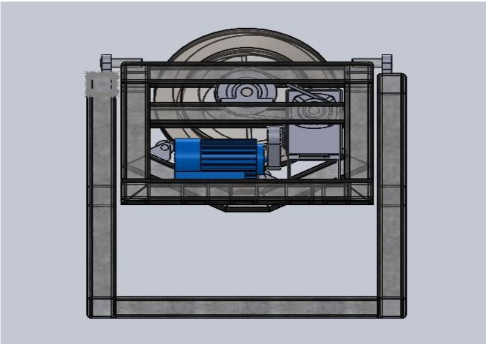
Figure 3.2 Position of the Drive Motor on the Mixer Machine

3.1.3 Gearbox

This gearbox is used to change the speed of the drive motor. The gearbox used in the design of this mixer machine has a ratio of 1:40.

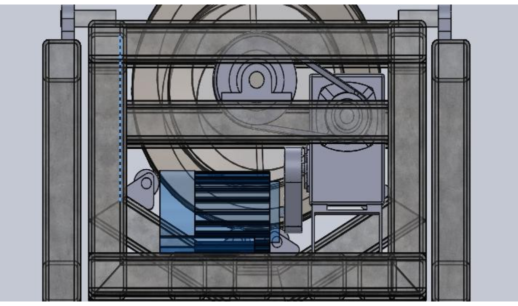
Figure 3.3 Gearbox Position on Mixer Machine

3.1.4 Transmission System

The transmission system used in this mixer machine design utilizes four pulleys, each with different dimensions: one pulley with a diameter of 3 inches, one pulley with a diameter of 6 inches, and two pulleys with a diameter of 2 inches. The following calculations were performed to design these pulleys:

Given:
n_1 = 1400 rpm (putaran motor)
d_1 = 2 inci = 50,8 mm (*pulley* motor)
d_2 = 2 inci = 50,8 mm (*pulley in gearbox*)
d_3 = 3 inci = 76,2 mm (*pulley out gearbox*)
d_4 = 6 inci = 152,4 mm (*pulley ass*)
n_3 = 35 rpm (putaran *out gearbox*)

Asked
n_2 = ?
n_4 = ?

answer

$$n_1.d_1 = n_2.d_2 \quad (6)$$

$n_1 = n_2 \cdot \frac{d_2}{d_1}$
= 17,5 rpm

• Pulley Contact Angle

Given:
$d1 = 2inci = 50.8\ mm$
$d2 = 2inci = 50.8\ mm$
Distance (c) = 112.01 mm

Asked: Belt length (L)

$$L = 2c + \frac{\pi}{2}(d_2 + d_1) + \frac{1}{4c}(d_2 - d_1)^2 \quad (7)$$

= 411,532 mm
θ = 179,5°

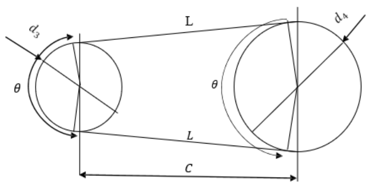

Figure 3.4 Pulley Contact Angle

3.1.5 Shaft

There are several things that must be considered and taken into account when designing the mixer tube drive shaft, including the following:

Power to be transmitted	*fc*
Average power required	1,2-2,0
Maximum power required	0,8-1,2
Normal power	1,0-1,5

$$d_s = [\frac{5,1}{\tau_a} \text{ x } K_t \text{ x } C_b \text{ x T }] \quad (8)$$

= 22,11 mm

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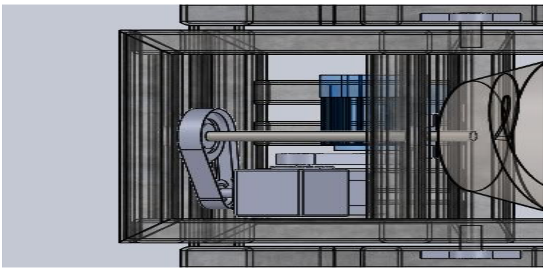

Figure 3.5 Position of the Mixer Tube Drive Shaft

3.1.6 Frame

Simulation

This simulation was conducted to determine the stress, displacement, and safety factor values that occur in the frame and axle when rotating.

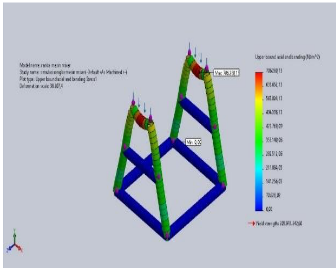

Figure 3.6 Frame Stress

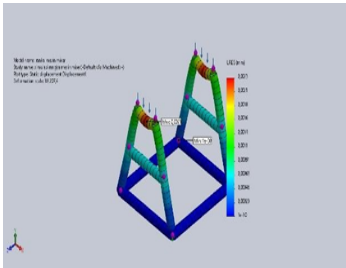

Figure 3.7 Frame Displacement

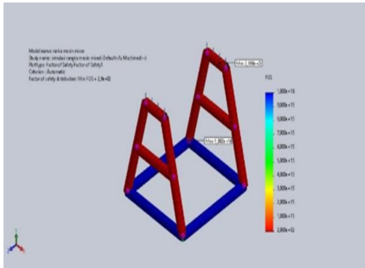

Figure 3.8 SF (safety factor)

The simulation of the torsional moment occurs in the mixer tube as follows,

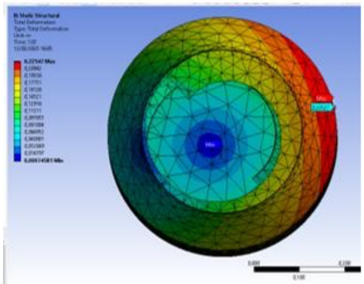

Figure 3.9 Total Deformation

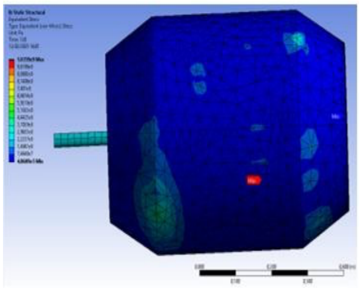

Figure 3.10 Equivalent Stress

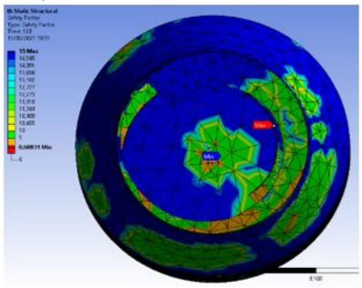

Figure 3.11 SF (safety factor)

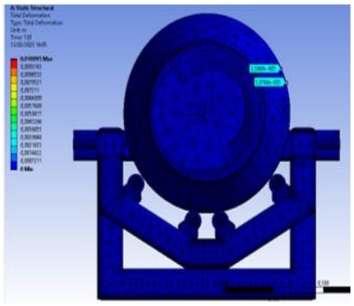

Figure 3.12 Def. Using Support

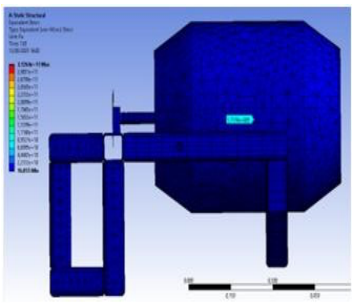

Figure 3.13 Stress Using Supports

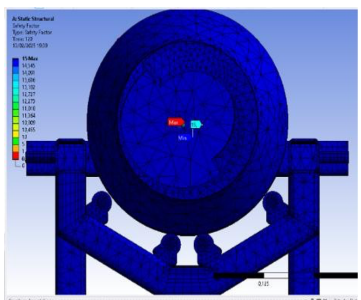

Figure 3.14 SF Using Supports

4. CONCLUSION

The conclusions of the research conducted, entitled "Design of a 50 kg Capacity Coconut Shell Charcoal Briquette Mixer Machine," are:

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1. The design process for this 50 kg capacity coconut shell charcoal briquette mixer machine resulted in a mixer tube with a height of 662.80 mm, an inlet diameter of 350 mm, and a tube diameter of 500 mm. The frame uses hollow galvanized steel with frame dimensions of 700 mm in length, 750 mm in width, and 800 mm in height.
2. By using a 30 mm diameter shaft, it is capable of withstanding torsional loads with an equivalent stress value of 1.714 x 10 Pa and a deformation of 3.306 x 10 m, as well as a safety factor value of 15.

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3. Mr. Engkos Koswara, S.T., M.T., Advisor and Chair of the Mechanical Engineering Study Program, Faculty of Engineering, Majalengka University.

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