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Analysis of Test Results for Coffee Peeler Machine with a Capacity of 40 Kg/Hour

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ABSTRACT

During the long-term development until now, industrial machinery products have shown very rapid progress, both in terms of volume and variety of products produced. The development of this product is not only marked by the fulfillment of the interests of the community, but also leads to the ability to enter exports to increase the country's foreign exchange. reference books, literature complements the theories in this report. (2) The method of consultation, with the final project supervisor, as well as the workshop person where the author completed this design. (3) Conducting field surveys, by viewing and comparing existing appropriate technology machines. The main components of the coffee peeling machine analyzed include: - Motor power - Belt (V-belt) - Shaft - Bearing - Peeler Capacity From several tests that have been carried out, the following conclusions can be drawn: (1) The production speed of the tool is 60 minutes with tool efficiency 93%. (2) The rotational speed used is 478 rpm (3) The planned load capacity is 40 kg (4) The driving motor power Hp. (5) The transmission system used is belt and pulley. There are several factors that cause coffee cherries to not be peeled by the peeler, including: - Young (green) coffee cherries - Irregular shape - Sleeping paring teeth -The distance between the peeler teeth and the bruising plate is far apart. Suggestions in this research are: (1) It is better to take care of the components of this tool because it is easy to corrode. (2) Check the tool before operation.

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1. INTRODUCTION

During the long-term development until now, industrial machinery products have shown very rapid progress, both in terms of volume and variety of products produced (Ginting, 2009). The development of this product is not only marked by the fulfillment of public interest, but also leads to the ability to enter exports to increase the country's foreign exchange (Zulpan, 2009). Agricultural commodities in Indonesia are quite abundant. Indonesia is one of the coffee producers in the world (Miranza, 2009). This depends a lot on the nature of the plant and the ability of farmers to handle their crops (Hariyanto et al., 2022). For this reason, post-harvest handling of plantation products must be maximized, with a view to reducing damage and shrinkage which is closely related to the quality and quantity of processed or final products to be marketed. Along with the advancement of appropriate technology, many tools are found technology created to process agricultural products

(Prasetyo, 2012). This is due to the increase in agricultural yields so that the idea arises to process these agricultural products before being marketed, the aim is none other than to ease the work (Pranata & Mahadi, 2019). The coffee peeler machine is an important thing and increases observations in the use of coffee products, this machine can make it easier for consumers to use it (Dirmansyah, 2020). At this time there are many ways to peel coffee, which are generally limited, such as the following: (Hariyanto et al., 2022): (1) Stripping by hand (manual) (2) Stripping by machine. In this case the processing of coffee beans takes a long time and the results obtained are very limited (Edy & Mindarta, 2019)**.** Seeing and reviewing the problems faced by users, the author makes a more useful and efficient equipment to facilitate the processing of coffee beans (Jani & Sugiono, 2014).

The objectives of designing a coffee bean peeler machine are: (1) To realize a peeler machine that has a simple, inexpensive system, easy to operate and maintain, and can increase the use of the machine tool (Sudarman et al., 2015) (2) Motivation for coffee farmers to optimize the use of this tool (Lailida et al., n.d.). This final report is expected to be useful for: (1) To support the development of appropriate technology for small and medium-sized industries (Mukhyi & Mujiyana, 2008). (2) For students who want and are interested in developing from this tool.(Minarni et al., 2019). (3) Adding insight into the process of making a coffee skin peeler and applying the knowledge gained during lectures which is used to design a coffee hulling machine (Wahyu Lestari, 2014).

2. RESEARCH METHOD

2.1 Method of Collecting Data

The data collection methods used by the author in completing this final report are (Hutajulu & Supriyanto, 2013): (1) Literature study, namely studying reference books, literature complements the theories in this report. (2) The method of consultation, with the final project supervisor, as well as the workshop person where the author completed this design. (3) Conducting field surveys, by viewing and comparing existing appropriate technology machines.

2.2 Coffee Peeler Machine Capacity Planning

The capacity of the peeler machine is planned to be able to accommodate 40 Kg/hour. Coffee beans to be peeled with a toothed shaft shaft model. To move the motor rotation to the drive shaft, it is planned to use a belt and pulley transmission system and be adjusted to their needs. In the planning of this paring machine, it is planned that the final rotation is 478 rpm. This is taken from the motor speed of 1434 rpm which is transmitted by the pulley in a ratio of 1: 3.

3. RESULTS AND DISCUSSIONS

The main components of the coffee peeler machine analyzed are: - Motor power - Belt (V-belt) - Shaft - Bearing - Capacity of the Peeler.

3.1. Motor Power Calculation Analysis

The motor power used to drive the stripper shaft needs to be taken into account. The power on the stripping shaft is the power required on the drive motor divided by the efficiency of the mechanism. In the planning specifications, the capacity of the peeler (m) is 40 kg and the shaft rotation is 478 rpm, the angular velocity of the vessel can be calculated as follows:

$$\omega = \frac{2.\pi.478x0,6}{60} = 30,01 \text{ rad/s}$$

rad/s

For the price s can be attached The diameter of the planned peeling shaft is 4 cm = 0.04 m, then the amount of torque can be calculated as follows: torque can be calculated as follows:

$$T = \frac{4 \times 0{,}04}{2} = 0{,}08 \text{ kg.m}$$

The amount of power on the drive shaft can be calculated using the following equation:

$$P = \frac{0{,}08 \times 30{,}01}{102} \times 2{,}0 = 0{,}047 \text{ kW}$$

So the amount of power on the drive shaft (P) is 0.047 kW The power of the driving motor can be calculated using the following equation:

$$P_m = \frac{0{,}047}{0{,}1836} = 0{,}25 \text{ kW}$$

Total mechanism efficiency 0.1836 kW
So the magnitude of the driving motor power (Pm) = 0.25 kW/1.33 = 0.18 Hp Thus the motor power used is in accordance with the plan, namely Hp (according to what is marketed).

3.2. Cooling Occurs When The Fan Is Attached To The Fin Unit

3.2.1. Linear Velocity At Pulley 1

$$V = \frac{\pi dp \ . \ n_1}{60 \ . \ 1000} \ldots \quad (1)$$

Where :
V = Linear speed of belt {m/s}
Dp = diameter of drive pulley {mm}
1 n = drive pulley rotation {rpm}

3.2.2. Linear Velocity At Pulley 1

The tensile force that occurs in the V belt is:
Pd = (T1 - T2)V1

$$T_1 - T_2 = \frac{P_d}{V_1} \quad (2)$$

$$\frac{0{,}28125x1000}{9{,}5}$$

= 29.6 N
= 3.02 kg

3.2.3. Contact Angle Between Belt And Drive Pulley

$$\theta = (180 - 2\alpha).\pi/_{180}.\pi a$$

$$\sin\alpha = \frac{(D-d)/2}{374}$$

$$= \frac{(381-127)/2}{374}$$

sinα = 0.339
= 19,810
So :

$$\theta = \frac{(180-2x19{,}81)\pi}{180}.$$

= 2,448 Rad
Belt tension

$$\frac{T_1}{T_2} = e^{\mu\theta} \quad (3)$$

Where :
T1 = belt tension {kg}
T2 = belt slack side tension {kg}
e = natural number
= coefficient of friction between belt and pulley

$$\frac{T_1}{T_2} = e^{0{,}3x2{,}448/\sin 40/2}$$

$$\frac{T_1}{T_2} = 8{,}56$$

T1 = 8.56 T2
If equation 2 is substituted into equation 1 then we get the tensile force that occurs on the V-belt
T1 – T2 = 3.02 kg
8.56 – T2 – T2 = 3.02 kg
7.56 T2 = 3.02 kg
T2 = 0.39 kg
T1 = 8.56 T2
T1 = 8.56. 0.39
T1= 3.3384 kg
The cross-sectional area of the V-belt is:
A = 16.5 . 11 – (tan 20. 11)
= 177.5 mm

$$\tau = \frac{T_1}{A}$$

$$\tau = \frac{3{,}3384}{177{,}5}$$

$$\tau = 0{,}018 kg/mm^2$$

$$\tau = 0{,}176 N/mm^2$$

The length of the belt used to connect the drive pulley to the pulley driven are:

$$L = 2C + \frac{\pi}{2}(D + d) + \frac{1}{4C} + (D - d)^2 \quad (4)$$

So :

$$L = 2 \times 374 + \frac{\pi}{2}(381 + 127) + \frac{1}{4.374} + (381 - 127)^2$$

L = 1588.68 mm
The distance between the axes of the two pulleys is:

$$C = b + \sqrt{\frac{b^2 - 8(D-d)^2}{8}}. \quad (5)$$

b = 2.L – (D + d)
b = 2 × 1588.68 – (381 – 127)
= 1582.24 mm
So :

$$C = 1582{,}24 + \sqrt{\frac{1582{,}24^2 - 8(381-127)^2}{8}}$$

= 374 mm

3.3. Axis

3.3.1. Shaft Strength Analysis on Motor Drive

The shaft on the drive motor is 15 mm in diameter. The shaft material is estimated from S30C carbon steel with tensile strength (σ B) = 48 kg/mm2, then a is:

$$\sigma_a = \frac{\sigma_B}{Sf1 \times Sf2} = \frac{48}{6 \times 2} = 4 \text{ kg/mm}^2,\ \tau_a = 0{,}5 \times 4 = 2 \text{ kg/mm}^2$$

For Planning Power (Pd) Are:
Pd P 1. Hp =×== Hp = 28125.0375,025,05. kW
Torque (kg.mm) is:

$$T = 9{,}74 \times 10^5 \frac{0{,}28125}{1434} = 190{,}904 \text{ kg.mm}$$

The resulting shear stress:

$$\tau = \frac{5{,}1T}{d_s^3} = \frac{5{,}1 \times 190{,}904}{15^3} = 0{,}288 \text{ kg/mm}^2$$

So it can be said that the construction is safe because >τ

3.3.2. Analysis of Shaft Strength on Strip Pulley

The shaft on the stripper pulley is a 40 mm diameter peeler turning shaft. The shaft material is estimated from S45C carbon steel with tensile strength (σ B) = 58 kg/mm2, then a is:

$$\sigma_a = \frac{\sigma_B}{Sf1 \times Sf2} = \frac{58}{6 \times 2} = 4{,}83\,\text{kg/mm}^2, \tau_a = 0{,}5 \times 4.83 = 2{,}415\,\text{kg/mm}^2$$

The planning power (Pd) is:
Pd P Hp =×== Hp = 28125,0375,025,05.1. kW
Torque (kg.mm) is:

$$T = 9{,}74 \times 10^5 \frac{0{,}28125}{478} = 572{,}712\,\text{kg.mm}$$

The resulting shear stress:

$$\tau = \frac{5{,}1.T}{d_s^3} = \frac{5{,}1 \times 572{,}712}{40^3} = 0.0152\,\text{kg/mm}^2$$

So it can be said that the construction is safe because >т

3.4. Bearing Life

If it is assumed that there is no axial load (Fa), then the dynamic equivalent load is:
Pr = XVFr
For X taken 0.56 and V = 1.2 (see table 2.4)
P 0 =××= 0684.75184,102.156, kg
The speed factor can be calculated by the equation:

$$fn = \left(\frac{33{,}3}{1434}\right)^{\frac{1}{3}} = 0{,}2852$$

Age factor (fh):

$$fh = f_n \frac{C}{P} \quad (6)$$

For the value of C can be seen in appendix 10, then:

$$f_h = 0{,}2852 \times \frac{2380}{7{,}0684} = 96{,}02$$

Nominal age
(Lh): 00 2000 3/1 Lh =×= hours

3.5. Coffee Peeler Machine Capacity

Peeling machine capacity = nm
Where :
n = rotation on the stripping shaft
m = mass of coffee in this case to find the mass of coffee, namely: mass of coffee obtained from the number of 20 coffee pieces weighing 30 grams.
1 kg = 1000 grams

$$m = \frac{30}{20} = 1{,}5\,\text{gram} = 1{,}5 \text{ x } 10^{-3}\,\text{kg}$$

Then the mass of one coffee fruit = 1.5 x 10-3 kg. It can be obtained that the capacity of the peeler = nm
Where :

n is the rotation generated from the motor to the driven pulley (can be seen on the previous page on the calculation of the V-belt tensile force) so that: The capacity of the peeler machine = nm
= 478 [rpm]. 1.5 x 3 10− [Kg]
= 0.717 [Kg/min] x 60 min
= 43.02 [Kg/hour]
Coffee cherries are irregular in shape, therefore not all coffee cherries will be peeled off by the peeler's teeth. So the capacity of the peeler is assumed to be only 93% that will peel the coffee skin. Assumed efficiency = 93%. Then the capacity of the grater = 93% x 43.02 [Kg/hour]
= 40.0086 [Kg/hour] = 40 [Kg/hour]. There are several factors that cause coffee cherries to not be peeled by the peeler, including: - Young coffee cherries (green) - Irregular shape - Sleeping paring teeth - The distance between the peeler teeth and the bruising plate is far apart.

3.6. Maintenance

3.6.1. Definition and Main Purpose of Treatment

To be able to achieve the maximum amount of production, it is necessary to prepare the machine that is used as optimally as possible. In order for the machine to be ready to use and not interfere with the production system, a method called maintenance is needed. A machine may not be damaged, but its useful life can be extended by carrying out maintenance activities. Maintenance can be defined as an activity that aims to maintain and maintain each component of a machine or equipment so that it can last a long time so that it can achieve maximum production results.

The main objectives of the maintenance system are as follows: (1) So that the machine or equipment used is in an optimal state of readiness to ensure the smooth working process of the machine. (2) To extend the life of the machine. (3) To ensure the safety of the operator in using the machine or equipment. (4) To find out engine damage as early as possible so as to prevent more fatal damage. Maintenance carried out on this peeler machine can be done in several ways as follows: (1) Routine maintenance. Maintenance is carried out continuously, for example every day or after using the machine. In this machine routine maintenance activities carried out are cleaning and lubrication of rotating parts. (2) Periodic maintenance. Periodic maintenance is an activity carried out within a certain period of time. For example once a week, once a month, and once a year. In this machine, periodic maintenance activities are belt tension, peeling shaft. So that this peeler machine can work optimally.

3.7. Maintenance of Main Machine Parts

The main maintenance carried out on the main parts of the machine are as follows: (1) Pulleys and belts. The part that requires maintenance on the pulley is checking the tightness of the pulley fastening bolts, visually checking the alignment between the pulleys. Check the belt tension and the damage that occurs to the belt, if the belt is damaged it should be replaced and if the belt tension is loose it must be tightened again. (2) Shaft. On the shaft maintenance activities carried out are checking the balance of the bearings and checking the condition of the nails. (3) Bearings.

Check the bearings, if the bearings are worn, they must be replaced even though they have not reached the age of working hours. The very important thing about bearing maintenance is regarding lubrication, because the lubrication of the bearing to reduce friction and wear rate between the rolling element and the bearing housing, reduce heat caused by friction, and prevent corrosion. The method of lubrication used here is grease/grease lubrication. On these bearings are recommended with grease lubrication as their construction is simpler and all good quality greases can extend bearing life. Greasing is done by filling the inside of the bearing sufficiently by using a grease pan through the bearing nipple.

4. CONCLUSION

From several tests that have been carried out, the following conclusions can be drawn: (1) The tool production speed is 60 minutes with 93% tool efficiency. (2) The rotational speed used is 478 rpm (3) The planned load capacity is 40 kg (4) The driving motor power Hp. (5) The transmission system used is belt and pulley. There are several factors that cause coffee cherries not to be peeled by a peeler, including: (1) Young coffee cherries (green) - Irregular shape - Sleeping paring teeth. (2) The distance between the teeth of the peeler and the bruising plate is far apart. Suggestions in this study are: (1) It is better to prioritize the maintenance of the components of this tool because it is easy to corrode. (2) Check the tool before operation.

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