Design of an organic waste biogas crushing blower with a capacity of 200 liters

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ABSTRACT

The development of machine technology has made things easier and faster for people, encouraging the public and the business community to use waste, especially organic waste, as a feedstock for biogas. When using waste as feedstock for biogas, a waste grinder is needed to speed up the decomposition process in the digester. When designing a biogas organic waste crusher, several planning methods should be adopted, namely: data research, data processing, design and production, machine planning, calculation of the machine, the manufacture of the machine, the production of trials and the writing of reports. So the required motor power is 0.342 kW, and is chosen according to what is on the market with a power of 0.373 kW or the equivalent of 0.5 HP. Determined in each chopper the machine is capable of chopping (m) 10 Kg (each chopping), and the number of blades in the shaft (z) 12 Blades, and (n2) Motor Rotation. The crushing drum is 420mm, the total height is 750mm, using a shaft with a diameter of 25 mm and a shaft length of 810 mm, it can cut up to 56 kg of mango skin per hour requires a motor power of 0.5 horsepower (0.373 kilowatts) at a speed of 2800 rpm.

I. INTRODUCTION

Waste that is considered obsolete and disposed of by previous owners/users, but can still be used if managed with the right procedures, whereas organic waste is a robust and relatively quick process. Organic waste itself comes from living things, including humans, animals, and plants. Disposal of organic waste should be of great public concern because, on average, organic waste is generated by households, cottage industries, etc. who do not pay attention to waste. So far, organic waste in Indonesia has only been used as raw material for compost. This is due to the lack of public knowledge on the use of organic waste and the lack of technology to manage organic waste in biogas.

All kinds of organic waste can be used to produce biogas, but the most economical are fruit scraps like mango peels. According to the information obtained, organic waste is very good as a raw material for the production of biogas because it is capable of producing methane gas which can be used for cooking needs, etc., but the gas which will be used by the waste organics used as raw material must be shredded. or mild to speed up the decomposition process.

In the above cases, observation and research are needed to deal with the use of organic waste to minimize the expense of daily cooking or other needs. In this way, a machete of a 200 liter organic waste production machine is made. It is hoped that this step can be carried out optimally and promote the recovery of organic waste.

II. LITERATURE REVIEW

A. *Definition of Biogas*

Biogas is a gaseous mixture produced by methanogenic bacteria in materials that decompose naturally under anaerobic conditions (Haryati, 2006). Biogas is an energy source that can be used as an alternative fuel to fossil fuels such as kerosene and natural gas (Houdkova et al., 2008). Biogas is the gas produced by the closed fermentation process of organic waste, animal manure and other organic matter. Biogas is an alternative energy source Compared to raw materials for organic fertilizers, the use of organic waste in biogas is not very popular at present.

Whereas with biogas technology, organic waste can be converted into energy that can be used to meet the energy needs of various needs such as cooking, lighting, transportation, and other energy-intensive needs. In general, the biogas production process is as follows:

The biogas production process is carried out by fermentation, i.e. the process of forming methane gas using anaerobic bacteria in a biogas digester under anaerobic conditions, thereby producing methane gas (CH4) and carbon dioxide (CO2), the content of which is relatively high and the volume greater than hydrogen (H2), nitrogen (N2) and sulfuric acid (H2S). The fermentation process takes 7-10 days to generate biogas, the optimum temperature is 35oC and the optimum pH is between 6.4 and 7.9. The biogas-producing bacteria used were anaerobes such as Methanobacterium, Methanobacterium, Methanococcus and Methanosarcina (Price and Cheremisinoff, 1981).

Component of Planned Biogas Generator

The figure below is the design and construction drawing of our planned 200 liter biogas generator for organic waste.

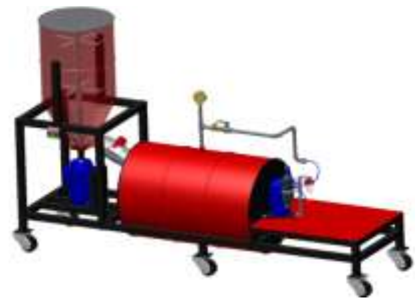


Fig 1. Organic Waste Biogas Generator

B. Chopper Container or Mixer Tube Planning

Chopper Container or Mixer Tube is used to receive organic waste that needs to be ground. There are two shapes in this mixer tube, namely tubular and conical. And how to do this, it is necessary to connect the two sides of the board by soldering. The

Mixing pipe is where the waste is shredded or crushed, and the diameter of the mixing pipe we provided is 42cm, and the height of the mixer is 75cm. The thickness of the mixing tube is 2mm, and there are two configurations in this mixing tube, namely, tubular and conical, where the top tube is 40cm in height, the conical is 35cm, and the angle is 60°, and it is connected to the bottom tube or the outlet of the digester. The length is 10cm and the diameter is 7.62cm.

There are two geometric shapes of cylinder and cone in the mixing cylinder. The planning formula for determining the cylinder and cone in the mixing cylinder is:

A tube or cylinder is a three-dimensional geometric shape formed by two identical parallel circles and a rectangle surrounding the two circles.

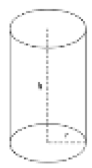


Fig 2. Chopper Tube

In order to plan and determine the calculations regarding the volume of the mixing tube, in particular the volume of the fume hood tube, the following formula is used:

$$V = \pi . r^2 . t$$

Design of hooded vessel cones, when designing the cone of a hooded vessel, calculations should be made as follows: The cone is a special type of circular base pyramid with 2 sides and 1 rib.

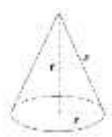


Fig 3. Cone

When planning the cone on the hood container, especially the volume of the cone, the formula used is:

$$V = \frac{1}{3} . \pi . r^2 . t$$

Planning the calculation of the crusher axis, in planning the organic waste crusher, the calculation to be planned is as follows:

1. Force acting on the shaft

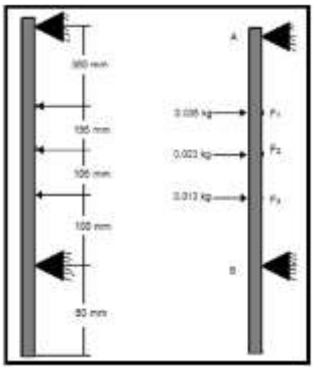


Fig 4. Forces on shaft

A = horizontal force on upper bearing

F1 = horizontal force on first blade

F2 = horizontal force on second blade

F3 = horizontal force on third

B = horizontal force on the lower landing

2. Shaft power

$$P_d = fc.P$$

P_d = rated power (kW)

fc = correction factor

P = rated output power of drive motor (kW)

3. Torque

$$T = 9{,}74.10^5 \frac{Pd}{n_1}$$

T = Torque (N.mm)

n_1 = Drive motor speed (rpm)

4. Shear stress

$$\tau_a = \sigma_B (Sf_1 + Sf2)$$

5. Shaft diameter

Determined for torsion and bending loads are:

$$d_s \geq \left\{ \frac{5{,}1}{\tau a} \sqrt{(k_m.M)^2 + (Kt.T)^2} \right\}^{1/3}$$

d_s = shaft diameter (mm)

τa = shear stress (kg/mm)

k_m = correlation coefficient

k_t = correction coefficient

and à à to determine the maximum shear stress as follows:

$$\tau_{\max} = (5{,}1/d_s^3)\sqrt{(k_m.M)+(K_t.T)}^2$$

6. Shaft check

$$ds \geq 4{,}1.\sqrt[4]{T}$$

C. Knife Chopper

Knife chopper has 12 different sized blades provided in each knife. In the shaft there are 3 machete holders with 4 blades in each holder. The function of the grinder is to smooth or chop the organic waste, soften it and speed up the closed fermentation process of the fermenter. A machete has a blade that acts as a garbage disposal. This scimitar is designed to be resharpened when it begins to dull.

The blade can be easily removed from the disc holder and sharpened with a grinder or hand sharpening stone. Find the mass (Wp) of the helicopter as follows:

1. Dimensions of chopper (V_0)

$$V_0 = \{(p.l.t) - (\pi(7.5^2) - 2\{(\frac{1}{2}.\alpha.t).\frac{1}{2}.l\}$$

2. Chopper weight (Wp)

$$w_p = (\rho.V_0)$$

3. Split area

$$L_a = (L_{luar} - L_{dalam})$$

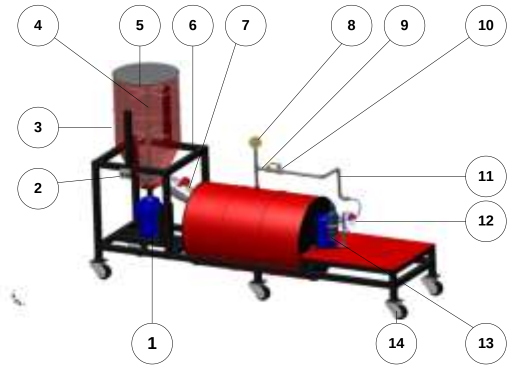
4. Chopper speed (V).

$$V = \frac{\pi.d.n}{60.100}$$

III. METHODOLOGY

Design Drawing Plan

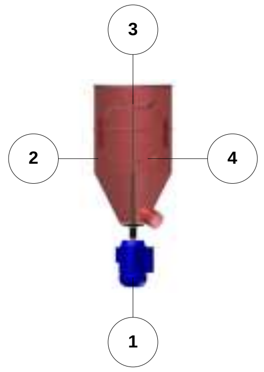
The design drawing plan for the organic waste disposer is completed after the design drawing plan planning stage is completed. Here is the design drawing of a 200 liter biogas generator for organic waste.



1. Motor	8. Manometer bourdon
2. *Power push button*	9. ½ inci ball valve
3. Chopper Tube	10. *Check valve*
4. Shaft	11. Gaspipe
5. Knife Chopper	12. Gas filter
6. Frame	13. Compressor
7. 3 inci valve	14. Wheel

Fig 5. Biogas generator

The parts to be designed are:



1. Motor	3. Shaft
2. Cover tube	4. Cover clip

Fig 6. Design of Organic Waste Chopper Machine Parts

IV. RESULTS AND DISCUSSION

A. Calculation of the capacity

Calculating the capacity of the grinding section, a machine capacity of 10 kg was determined for each mill. The capacity of the mixer tube itself is as follows:

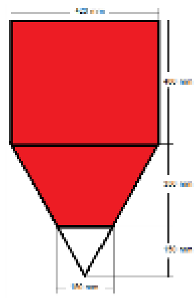


Fig 7. Mixer Tube

The calculation of the volume of the hood tube is :

V = volume of the tube + volume of the cone

$$V = \pi.r_1^2.t + ((\frac{1}{3}.\pi.r_1^2.(t_1 - t_2)) - (\pi.r^2)$$

$$V = 3{,}14.210^2.t + (\frac{1}{3}.3{,}14.210^2(420))$$

$$-(\frac{1}{3}.3{,}14.75^2.150)$$

$$V = 55389600 + 19386360 - 883125$$

$$V = 55389600 + 18503235$$

$$V = 73892835\,\text{mm}^3$$

$$V = 73{,}892835\,\text{dm}^3$$

$$V = 74\,\text{Liter}$$

This equals 1.21 liters based on the measurement of 1 kg of mango skin. And the specified capacity is 10 kg per hood, 10 kg of hood equals 12.1 liters. Therefore, the chopper tube has a volume of 74 liters > 12.1 liters, so the tube can hold the capacity of the chopper.

B. Calculation of the chopper blade shaft

The chopper blade shaft is used to transmit the rotation of the engine to the helicopter, the force acting on the shaft is the horizontal force of the chopper blade and no vertical force because the shaft is in an upright or upright position. This is the force acting on the helicopter blade shaft.

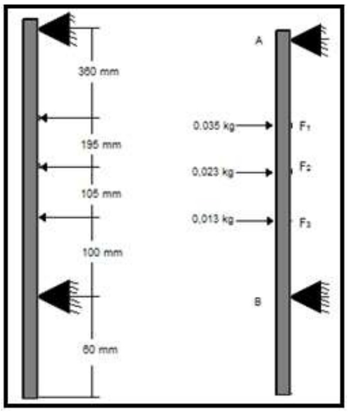


Fig 8. Forces on shaft

1. Forceacting on shaft
   a. Horizontal reaction force

$$\sum_{MB} = F_1 + F_2 + F_3 - R_A$$

$$= (0.035 . 400) + (0.023 . 205) + (0.013 . 100) - (R_A . 760)$$

$$= 14 + 4{,}715 + 1{,}3 - 0{,}760 . R_A = 0$$

$$= 20{,}01 - 760\, R_A = 0$$

$$R_A = \frac{20{,}01}{760} = 0{,}0263 \text{Kg}$$

$$\sum_{MA} = F_1 + F_2 + F_3 - R_B$$

$$= (0.035 . 360) + (0.023 . 555) + (0.013 . 660) - (R_B . 760)$$

$$= 12{,}6 + 12{,}765 + 8{,}58 - 760\, R_B = 0$$

$$= 33{,}945 - 760\, R_B = 0$$

$$R_B = \frac{33{,}945}{760} = 0{,}0446 \text{Kg}$$

b. Shaft check

$$M_A + M_B = F_1 + F_2 + F_3$$

$$0{,}0263 + 0{,}0446 = 0{,}035 + 0{,}023 + 0{,}013$$

$$0{,}071 = 0{,}071$$

$$0 = 0$$

c. The bending moment

$$M_{RA} = F_1 + F_2 + F_3 - R_B$$

$$= (0.035 . 360) + (0.023 . 555) + (0.013 . 660) - (0{,}0446 . 760)$$

$$= 12{,}6 + 12{,}765 + 8{,}58 - 33{,}896$$

$$= 0{,}04 \text{ Kg}$$

$$M_{F1} = F_2 + F_3 - R_B$$

$$= (0{,}035 . 195) + (0{,}023 . 300) - (0{,}0446 . 400)$$

$$= 6{,}82 + 6{,}9 - 17{,}84$$

$$= -4{,}12 \text{ Kg}$$

$$M_{F2} = F_3 - R_B$$

$$= (0{,}023 . 105) - (0{,}0446 . 205)$$

$$= 2{,}41 - 9{,}14$$

$$= -6{,}73 \text{ Kg}$$

$$= (0{,}0446 . 100)$$

$$= 4{,}46 \text{ Kg}$$

$$M_{RB} = 0$$

d. Combined bending moment

$$M_{RA} = \sqrt{(M_{RA} V)^2 + (M_{RA} H)^2}$$

$$= \sqrt{(0)^2 + (0{,}04)^2}$$

$$= \sqrt{0 + 0{,}0016} = 0{,}04 \text{ Kg.mm}$$

$$M_{RA} = \sqrt{(M_{RB} V)^2 + (M_{RB} H)^2}$$

$$= \sqrt{(0)^2 + (0)^2}$$

$$= \sqrt{0} = 0$$

After knowing the force generated on the shaft, the next step is to determine the diameter of the chopper shaft, i.e. by calculating the correction factor.

This correction factor is necessary to take into account the possibility of occurrences of loads that have not been precalculated. The correction factor for normal drift is 1.0 to 1.5, then use the following formula to determine the shaft diameter:

e. Shaft diameter

P = 0.5 HP = 0,373 kw = 373 w,

n1 = 2800 rpm

fc = 1.0

$$P_d = f_c \times P = 1.0 \times 0.373 \text{ kW} = 0.373 \text{ kW}$$

$$T = 9{,}74 \times 10^5 . \frac{P_d}{n^2}$$

$$T = 9{,}74 \times 10^5 . \frac{0{,}373}{2800}$$

$$T = 1297 \, kg.mm$$

$$S30C, \sigma_B = 48 \, (kg.mm2), \, sf_1 = 6{,}0, \, sf_2 = 2{,}0$$

$$\tau_a = 48 / (6{,}0 \times 2{,}0) = 4 \, (kg.mm2)$$

$$C_b = 2{,}0, K_t = 2{,}0$$

$$ds \geq \left[\frac{5{,}1}{4} . \sqrt{(C_b . M_{RA})^2 + (K_t . T)^2} \right]^{1/3}$$

$$ds \geq \left[\frac{5{,}1}{4} . \sqrt{(2{,}0.0{,}04)^2 + (2{,}0.1297)^2} \right]^{1/3}$$

$$ds \geq \left[1{,}275 . \sqrt{(0.0064) + (6728836)} \right]^{1/3}$$

$$ds \geq \left[1{,}275.2594 \right]^{1/3}$$

$$ds \geq 14.8 \, mm$$

And the diameter of the chopping knife shaft used is 25.4mm to ensure the safety of the chopping knife shaft. Also, to know the shear stress that occurs, use the following calculation:

f. The shear stress (τ) that occurs is:

$$\tau = \frac{5{,}1}{d_s^{\,3}} . T$$

$$\tau = \frac{5{,}1}{25{,}4^3} . 1297 \, Kg.mm^2 = 0{,}40 = 0{,}4 \, Kg.mm^2$$

So get, such an axis is safe to use. After getting the shear stress, check the shaft with the following calculation.

g. Inspection of the axle

$$d_s \geq 4{,}1 . \sqrt[4]{T}$$

$$25{,}4 \geq 24{,}60$$

From the inspection of the axle above, it appears that the axle used can safely transmit the rotation of the motor to the cutter.

C. Blade Computing

The blade is the main component of the system running on the design of the 200 liter organic waste disposer. Here are the calculations for machete supporters.

Table 1. Calculation Supporting Data

Supporting data	Description
Chopper blade material	S 30 C
The density of the chopper blade material	$7{,}2.10^{-6}$ $Kg.mm^3$
The volume of the chopper blade	48 cm^3
Length x Width x Height	256 x 20 x 1
The angle formed by the chopper blade	∝ 60°

To perform calculations in finding the dimensions of the chopper blades are as follows:

1. Chopper Blade Dimensions

   Dimensions of the first chopper blade (V_1)

$$V_1 = (p.l.t) - (\pi (7{,}5^2) - 2\{(\frac{1}{2}.\alpha.t).\frac{1}{2}.l\}$$

$$V_1 = (256 . 20 . 1) - (3{,}14 (7{,}5^2)$$

$$- 2\{(\frac{1}{2}.1{,}15.1).\frac{1}{2}.20\}$$

$$V_1 = (5120) - (176{,}63) - 5{,}75$$

$$V_1 = 4937{,}62 \, mm^3$$

   Dimensions of the second chopper blade (V_2)

$$V_1 = (p.l.t) - (\pi (7{,}5^2) - 2\{(\frac{1}{2}.\alpha.t).\frac{1}{2}.l\}$$

$$V_1 = (151. 20 . 1) - (3{,}14 (7{,}5^2)$$

$$- 2\{(\frac{1}{2}.1{,}15.1).\frac{1}{2}.20\}$$

$$V_1 = (3020) - (176{,}63) - 5{,}75$$

$$V_1 = 2837{,}62 \, mm^3$$

   Dimensions of the third chopper blade (V_3)

$$V_1 = (p.l.t) - (\pi (7{,}5^2) - 2\{(\frac{1}{2}.\alpha.t).\frac{1}{2}.l\}$$

$$V_1 = (101. 20 . 1) - (3{,}14 (7{,}5^2)$$

$$- 2\{(\frac{1}{2}.1{,}15.1).\frac{1}{2}.20\}$$

$$V_1 = (2020) - (176{,}63) - 5{,}75$$

$$V_1 = 1837{,}62 \, mm^3$$

2. Chopper Blade Weight

   First chopper blade weight (Wp)

$$W_p = (\rho . V_1)$$

$$W_p = 7{,}2.10^{-6} . 4937{,}62$$

$$W_p = 0{,}035 \, Kg$$

   Second chopper blade weight (Wp)

$$W_p = (\rho . V_2)$$

$$W_p = 7{,}2.10^{-6} . 2837{,}62$$

$$W_p = 0{,}023 \, Kg$$

   Third chopper blade weight (Wp)

$$W_p = (\rho . V_3)$$

$$W_p = 7{,}2.10^{-6} . 1837{,}62$$

$$W_p = 0{,}013 \, Kg$$

   The compressive strength of the mango peel is worth 322.88 grams. The shear stress of the mango peel is = $0{,}6 x f c$

   So, $\sigma k \alpha = 0{,}6 x 0{,}32 = 0{,}18 \; Kg/mm^2$

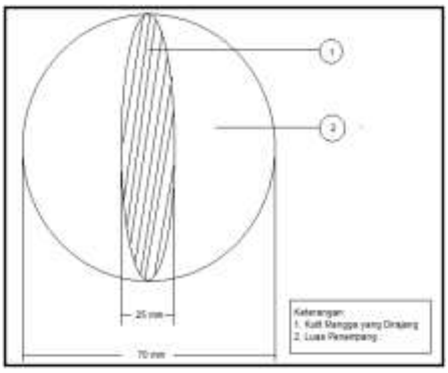


Fig 9. Mango Skin Shading Area

3. Exposed Skin Area

$L_a = (L_{luar} - L_{dalam})$

$= 70\,mm - 25\,mm$

$= 45\,mm = 4.5\,cm$

4. Chopper blade speed (V)

$$V = \frac{\pi.d.n}{60.100}$$

$$V = \frac{3{,}14.25{,}4.2800}{60.100}$$

$$V = 37{,}2\,m/s$$

D. *Motor Calculations*

Motor is the power source used to spin the blade. And to determine the power of the electric motor, it is first necessary to know the forces appearing on the shaft and the blades of the helicopter. such as cutting force, moment of inertia of shaft and blade, moment of inertia of shaft and blade, force of inertia of shaft and blade and resultant force. The total power (Ptot) itself is the sum of the powers of the cutting power (PPOT), the shaft inertia (Ppo) and the blade inertia (Ppi). So the total horsepower is what the motor needs to power the chopper on the mixer tube.

1. Cutting Force (Fp)

$F_P = A\,.\,fs$

$= 1{,}77\,in\,.\,0{,}18\,.\,10\,Kg = 8{,}1\,Kg/cm$

2. Cutting Speed (Vp)

$$V_P = \frac{\pi.d.n}{60.100}$$

$$V_P = \frac{3{,}14.25{,}4.2800}{60.100} = 37{,}2\,m/s$$

3. Cutting Power (Ppot)

$P_{Pot} = F_p.V_p$

$P_{Pot} = 8{,}1.37{,}2$

$P_{Pot} = 301\,Watt = 0{,}301kW$

4. Moment of inertia of blade and shaft

First blade:

$$I_{pi} = \frac{1}{3}.m_{pi}.L_{pi}$$

$$= \frac{1}{3}.0{,}0035.0{,}256^2$$

$$= 0{,}11.\,0{,}065 = 0{,}007\,Kg.m^2$$

Second blade:

$$I_{pi} = \frac{1}{3}.m_{pi}.L_{pi}$$

$$= \frac{1}{3}.0{,}023.0{,}151^2$$

$$= 0{,}007\,.\,0{,}022 = 0{,}0001Kg.m^2$$

Third blade:

$$I_{pi} = \frac{1}{3}.m_{pi}.L_{pi}$$

$$= \frac{1}{3}.0{,}013.0{,}101^2$$

$$= 0{,}004\,.\,0{,}010 = 0{,}00004\,Kg.m^2$$

So the total moment of inertia of the three knives is 0.00714 $Kg.m^2$. Next is to determine the moment of inertia of the shaft by using the following calculation:

5. Shaft Moment of Inertia

Shaft weight

$W_P = \rho\,.\,V$

$V = \pi\,.\,r^2\,.\,t$

$= 3{,}14\,.\,12{,}7^2\,.\,0{,}82$

$= 415{,}28$

$W_P = \rho\,.\,V$

$= 7{,}2\,.\,10^{-6}\,.\,415{,}28$

$= 2990{,}016\,gram = 2.99\,Kg$

Shaft moment of inertia

$$I_{po} = \frac{1}{3}.m_{po}.r_{po}$$

$$= \frac{1}{3}.2{,}9.12{,}7^2$$

$$= 1{,}49\,.\,1{,}61 = 2.40\,Kg.mm^2$$

$$= 0{,}002\,Kg.m$$

6. The angular velocity

$$\omega_2 = \frac{\pi.n^2}{30}$$

$$\omega_2 = \frac{3{,}14.2800}{30} = 293{,}06\,rad/s$$

7. Angular acceleration

$$\alpha = \frac{2.\pi}{\omega}$$

8. $$\alpha = \frac{2.3{,}14}{293{,}06} = 0{,}02\,s$$

$$\omega_1 = \frac{2.\pi}{t}$$

$$\omega_1 = \frac{2.3{,}14}{0{,}02} = 3{,}14\,rad/s$$

$$\alpha = \frac{\omega_1 - \omega_2}{t}$$

$$\alpha = \frac{314 - 0}{0{,}02} = 15700\,rad/s$$

8. Torque of Inertia in Blades and Shafts

$$T_{pi} = \frac{I_{pi}.\alpha}{g}$$

$$T_{pi} = \frac{0{,}0071.15700}{9{,}8} = 11{,}37\,Kgf.mm$$

$$T_{po} = \frac{I_{po}.\alpha}{g}$$

$$T_{pi} = \frac{0{,}002.15700}{9{,}8} = 3{,}20\,Kgf.mm$$

9. Blade and shaft inertia

$$P_{pi} = \frac{T_{pi}.n^2}{9{,}74.10^5}$$

$$P_{pi} = \frac{11{,}37.2800}{9{,}74.10^5} = 3268.5 \text{ watt}$$

$$= 0.032 \text{ kW}$$

$$P_{po} = \frac{T_{po}.n^2}{9{,}74.10^5}$$

$$P_{po} = \frac{3{,}20.2800}{9{,}74.10^5} = 919{,}9 \text{ watt}$$

$$= 0.009 \text{ kW}$$

10. The total power required to perform the slicing is:

$$P_{tot} = P_{lpi} + P_{lpo} + P_{Pot}$$

$$P_{tot} = 0{,}032 + 0{,}009 + 0{,}301$$

$$P_{tot} = 0{,}342 \text{ kW}$$

So the required motor power is 0.342 kW, and is chosen according to what is on the market with a power of 0.373 kW or the equivalent of 0.5 HP. Furthermore, to determine the rpm rotation of the electric motor using the following calculations:

Determined in each chopper the machine is capable of chopping (m) 10 Kg (each chopping), and the number of blades in the shaft (z) 12 Blades, and (n2) Motor Rotation.

So:

$$Q = m.n^2.z$$

$$56 \text{ Kg/jam} = 10 \text{ Kg}.\ n^2\ .12$$

$$56 \text{ Kg x } 60 \text{ menit} = 10 \text{ Kg x } n^2 \text{ x } 12$$

$$3360 \text{ Kg/Menit} = 10 \text{ Kg x } n^2 \text{ x } 12$$

$$n^2 = \frac{3360.10}{12}$$

$$n^2 = 2800 \text{ rpm}$$

So the speed of the motor needed to chop waste with a capacity of 10 kg in each chopper is 2800 rpm, and in 1 hour this machine is capable of chopping mango skin as much as 56 kg/hour.

CONCLUSION

The design made by results in a biogas generator with a capacity of 200 liters, which has a shroud engine with a shroud tube size of 420 mm and an overall height of 750 mm, then the shaft in This design waste disposer uses a shaft with a diameter of 25mm and a shaft length of 810mm. Capable of shredding up to 56 kg/h of mango skin, the grinder requires a motor power of 0.5 HP (0.373 kW) and a speed of 2800 rpm. So, when assembling a helicopter, the first thing to do is to install the motor, then the chopper tube, then the shaft after the next chopper tube. There is a knife on the shaft, which is used for chopping.

REFERENCES

Anonim. Jurnal Biogas. www.scribd.com. Accessed date 28 March 2023.

Anonim. Kerucut www.id.wikipedia.org. Accessed date 28 March 2023.

Anonim. Pemanfaatan Sampah. www.indonetwork.co.id. Accessed date 28 March 2023.

Anonim. Sampah Organik. www.id.wikipedia.org. Accessed date 28 March 2023.

Aryazones. (2014) Jurnal Cara Membuat Biogas. www.aryazones.blogspot.com. Accessed date 28 March 2023.

Nnugroho. (2010). Cara Membuat Biogas. www.nnnugroho1.blogspot.com. Accessed date 28 March 2023.

Sujoko, Ahmad. Cara Membuat Biogas www.blog.ub.ac.id Accessed date 28 March 2023.

Sularso, Kiyokatsu Suga, K. (1997). Dasar Perencanaan dan Pemilihan Elemen Mesin. Cetakan ke sepuluh Jakarta: PT Pradnya Paramita.