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Fiber Cyclone Palm Oil Mill Capacity 45 Tons/Hour

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ABSTRACT

The processing of Fresh Fruit Bunches into crude palm oil and palm kernel can be done by starting to boil the Fresh Fruit Bunches until they are ripe, after the Fresh Fruit Bunches are ripe, then separate the bunches from the fiber by going through the slaughtering process, after which the fiber is then chopped and immediately pressed so that the oil comes out. After the oil and fiber are separated, the fiber will go to the fiber cyclone. Fiber cyclone is a device located at the solids station, the main function of the fiber cyclone is to separate the nut and fiber by sucking the fiber using air, through the ducting column and will exit through the air lock and then go to the boiler to be used as fuel. The fiber cyclone has a speed of 10.08 m/s for the velocity box, a vertical column of 6.86 m/s, and 8.57 m/s for the horizontal column. Fiber cyclone has 1 loss point for kernel, what is analyzed is the output of fiber cyclone which is fiber taken from air lock, the standard loss for fiber cyclone is 0.10%.

INTRODUCTION

The oil palm plant with the Latin name Elaeis guineensis Jacq. is currently still the largest commodity in Indonesia, this plant has grown a lot in Indonesia because the Indonesian soil is fertile so til palm plants can grow well. This plant is widely cultivated by the people of Indonesia because the maintenance is not difficult and the age of this plant can live up to 25 years, besides that this oil palm fruit harvest rotation time is arguably fast only takes taking 2 weeks once a month takes place 2 harvests. This plant is most widely grown on Sumatra, Kalimantan, Sulawesi, and Papua islands. The recorded area of oil palm plantations in Indonesia in 2019 was around 14,456,611 million hectares. (katadata.co.id, 2020).

The process of processing FFB into crude palm oil and palm kernel can be done by starting to boil the FFB until it is ripe, after the FFB is ripe, then separate the janjangan from the berondolan by going through the slaughtering process, after that the berondolan is then chopped and immediately pressed so that the oil comes out (thepalmscribe.id, 2021). The oil from the press will then be processed by the clarification station, the way the clarification station works is by filtering the oil after which precipitation is carried out so that fine sand, dust, and sludge can settle properly. The length of time for settling is ± 4 hours after settling is complete, then refining the oil is carried out by separating the oil with sludge, sand, and dust after which the oil is vacuumed to separate the water content. After the stage is complete, it is then sent to the stockpile tank for sale (Maulidna). Nut output from the press station will then be extracted at the nut and kernel station. Nuts that are still clumped together with fiber will be chopped after chopping the fiber will be discarded and the nut will be broken to take the kernel, after the shell separation process with the kernel is complete, the kernel will be heated for ± 6 hours to reduce the water content. After the water content is reduced, the kernels will be sent to the kernel stockpile tank for sale (Mariadi, 2019).

In the palm oil mill industry, the main products produced are CPO (Crude Palm Oil) and

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palm kernel. The CPO produced comes from the outer fruit flesh called mesocarp (Damanik, et al, 2017), while the palm kernel comes from the inner fruit flesh covered by the shell, the palm kernel is called the kernel (Selly, 2019). In addition to having the main product of the palm oil industry, it also has by-products such as empty stalks from loose fruit, fiber from presses, and shells from ripple mills.

The palm oil mill industry has 2 types of waste, namely liquids and solids. Liquid waste comes from CPO refining processing, this waste is called sludge. This liquid waste can be used as organic fertilizer for oil palm plants (ejurnal.bppt.go.id, 2020). After liquid waste there is solid waste such as empty palm kernel. This empty navel comes from the thresher, empty navel can be used as a land cover crop for oil palm plants. Furthermore, there are fibers and shells, fiber comes from fiber cyclone and is usually used as fuel for boilers. And finally, shells come from LTDS 1, LTDS 2 and claybath. Shells from LTDS 1 and 2 are dry shells commonly used as boiler fuel, while shells from claybath are wet shells usually used to fill roads in the palm oil mill area (Duaja, et al, 2020).

The station that separates the nut and fiber is the nut and kernel station. This station processes the nut until it becomes a kernel, the nut that is processed comes from the press results which are still clumped together with the fiber and chopped using the CBC and then enters the fiber cyclone. fiber cyclone is a tool that has a fan or blower that is used to suck fiber with the help of air, and drop the nut into the polishing drum (Mahfud, 2012).

Fiber cyclone in palm oil mills is a device located at the solids station, the main function of the fiber cyclone is to separate the nut and fiber by sucking the fiber using air, through the ducting column and will come out through the air lock and then go to the boiler to be used as fuel (Iswahyudi, et al, 2017). The fiber cyclone installed at PMKS Agribaras has a maximum standard loss of 0.10%. Of the samples analyzed, there were 3 samples that met the standard. Thus the author wants to know the actual process and results of the fiber cyclone.

Nut and Kernel Station

The nut and kernel station is a solids station that processes nuts into kernels. The nut that comes out of the press machine then enters the polishing drum to remove the fiber that is still attached to the nut then the nut will enter the nut hopper using a nut transfer fan after that the nut will be destroyed by using a ripple mill after the shell and kernel are separated then the kernel enters the kernel silo to be heated so that the water content is reduced. The duration of heating time is ± 6 hours After the moisture content is reduced, the kernels will be sent to the kernel stockpile tank for sale. (Dermawan, 2020).

Fiber Cyclone

Fiber cyclone is a tool used to separate the pulp from the seeds and separate the seeds from the remaining fibers that are still attached to the seeds with the help of a blower to push or blow the fibers up which will then enter the cyclone (Larasati, et al, 2016). Fiber cyclone is a tool in palm oil mills, located in the nut and kernel station. The function of the fiber cyclone is to separate the nut from the fiber, the fiber cyclone gets feed from the output of the press machine then the feed is chopped with a device called a cake breaker conveyor after the cake breaker conveyor then the new feed goes to the fiber cyclone where there will be a separation between the nut and the fiber caused by the air in the column and the air is only able to lift the fiber up and the fiber that is lifted will fall on the cone-shaped cyclone which is right before the fiber cyclone fan. Fiber that comes out through the air lock will then be taken to the boiler which will be used as fuel.

Fiber

Oil palm fiber is fiber that comes from oil palm fruit, this fiber is on the outer part of the oil palm fruit. Crude palm oil produced by palm oil mills comes from palm oil fibers that have undergone treatments such as boiling, flaking, chopping and pressing, so that the oil contained in the fiber can come out and separate from the fiber. Oil palm fiber waste, due to its very large amount, reaches 13% of the total weight of oil palm fresh fruit bunches (FFB) (Kurniawan, et al, 2020).

Sample Testing

Fiber cyclone output fiber that comes out through the fiber cyclone airlock will be sampled every two hours, starting from two hours after the process and the last sample is taken two hours before the factory stops the process. Each sample will be taken weighing ± 1,000 grams, the samples that have been taken are stored in a mini laboratory located next to the process office (PMKS Agribaras, 2021). Samples that have been taken every two hours will be analyzed in the morning. Sample analysis is carried out as follows:

a. samples that have been taken are collected so 1 place / container
b. Samples are homogenized until they become one
c. After homogeneous take a sample weighing ±

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1,000 grams to be analyzed

d. Separate all parts - parts as follows:
   1. Whole nut
   2. Nut broken
   3. Kernel intact
   4. Kernel broken

e. Break the intact nut

f. Separate the kernel that is still attached to the shell

g. Weigh each kernel and record losses

Losses fiber cyclone

In the analysis of fiber samples there is a formula that can determine the losses contained in these samples (PMKS Agribaras, 2019). The formula can be seen as below:

$$\frac{\text{Weight of kernel}}{\text{Weight of sample}} \; x \; 12{,}5\%$$

Description:

- 12.5% = material balance of kernels at PMKS Agribaras
- total weight of kernels contained in the sample
- sample weight (±1000 gram)

Sketch of Fiber cyclone

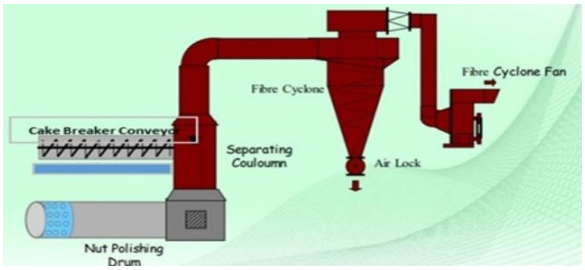

Figure 1. Sketch of Fiber cyclone

In the sketch of the fiber cyclone above, it can be seen that the feed enters the fiber cyclone through the cake breaker conveyor after which the nut falls down to the polishing drum and the fiber rises upwards to the cyclone and exits through the air lock then carried by the conveyor to the boiler as fuel.

Fiber cyclone calculation

1. Velocity

Speed is a derivative quantity of the main quantity. The speed formula is distance divided by time (Fahrizal, 2013)

$$Velocity\ (V) = \frac{s}{t}$$

Description:
V = Velocity (m/s)
s = distance (m)
t = time (s)

2. Cross-Sectional Area

Cross-sectional area is a field or area of an object. (Zinergi.id, 2015)

Cross-Sectional Area of a Circle

$$A = \pi r^2$$

Square Cross-Sectional Area

$$A = p \; x \; l$$

Description:
π = 3.14 or 22/7
r = radius of the circle
p = length
l = width

3. Continuity Equation

The continuity equation says the relationship between the speed of the fluid entering a pipe and the speed of the fluid leaving it (Bagus, 2019).

$$Q = V \times A$$

Description:
Q = Capacity
V = speed
A = column cross-sectional area

4. Reynold's number

To find out the type of fluid flow in a pipe, you can use Reynold's number. (Jalaluddin, et al, 2019)

$$Rey = \frac{\rho \times v \; x \; d}{\mu}$$

Description:
ρ = density, fluid
v = velocity
d = pipe diameter
μ = viscosity
rey = reynold number
In determining the type of flow that must be considered are as follows:

- laminar < 2300
- transition > 2300 < 4000
- turbulent > 4000

Head Losses

Liquid substances in this universe have viscosity properties, thus they can be calculated using fluid mechanics calculations. Flow loss is a loss that occurs in piping. (Rahardja, 2019: 81)

1. Major Losses

Major losses are pipes that experience head losses, the cause is friction between the fluid and the wall. (Muliawan, et al, 2018)

$$hf = \mathrm{f}\frac{\mathrm{L} \times \mathrm{v2}}{\mathrm{d} \times 2\mathrm{g}}$$

Description:
hf = head loss due to friction (m)
f = friction factor (see moody diagram)
d = inner diameter of the pipe (m)
L = pipe length (m)
V = fluid flow velocity (m/s)
g = gravity (m/s2)

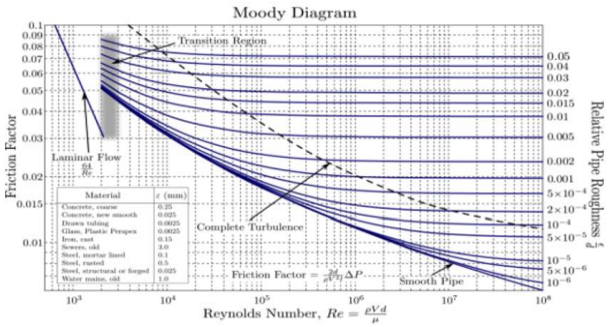

Figure 2. Moody diagram

2. Minor Losses

Minor flow losses are caused by turns, joints, and others. (Putra, et al, 2017).

$$hm = k \times v^2/g$$

Description:
hm = minor loss
k = flow loss coefficient
v = flow velocity (m/s)
g = gravity (9.81 m/s^2)

Framework

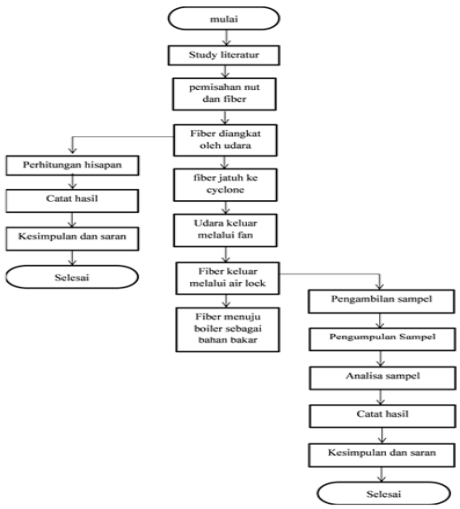

Figure 3. Framework of this research

Fiber cyclone is a tool that serves to separate the nut and fiber using air assistance.

Before doing calculations on the fiber cyclone, you must initially start by looking for literature studies on fiber cyclone. Looking for literature studies can be journals or books in the library or can also be accessed via the internet. After looking for the desired literature study, then look for the diameter of the parts of the fiber cyclone to calculate the suction that occurs in it. After the calculation results are obtained, the next thing to do is to record the results of the suction calculation. Then conclusions and suggestions can be drawn.

The fiber cyclone has 1 sample point as one part of the losses in the production kernel, therefore sampling is carried out after the sample is taken not directly analyzed but must wait until the process stops at the factory. Thus the samples taken earlier will be collected in one container and stored in the laboratory. Before analyzing the sample is homogenized first after homogeneous then take a few grams of sample to be analyzed. After the sample is analyzed, the results will be recorded to be entered into the logshet kernel losses from the results there will be conclusions and suggestions obtained and then finished.

EXPERIMENTAL METHOD

Time and Place

The making of the final project specifically about the fiber cyclone found at PMKS Agribaras and its implementation was carried out on May 2, 2021 to May 10, 2021. The location of PMKS Agribaras is located in Motu Village, Baras District, Pasangkayu Regency, West Sulawesi Province.

Tools and Materials

In working on the final project, there are tools and materials used as research support. Tools and materials can be seen in table 1 Tools and their functions and table 2 Materials and their functions.

Table 1. Tools and their Functions

No	Tool Function
1	Stationery is Used to write the data obtained
2	Laptop Used for writing data in the form of soft files
3	The printer Used to print the results of the report
4	Hammer Used to break samples such as nut
5	Analytical Scales Used as weighing the sample

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Table 2. Materials and their Functions

No.	Material Function
1.	Fiber As a sample of fiber cyclone output
2.	Nut, Kernel As sample analysis result

Quantitative Methods

The quantitative method is a type of method used for research that analyzes a number that can be explained. In this study there is data in the form of numbers such as kernel losses data obtained from the laboratory logsheet of the solids section, the next data is to calculate the suction power which can be found using the formulas listed and from these numbers, the meaning of the data can be explained.

RESULTS AND DISCUSSION

Result

Description of Fiber Cyclone Sample Analysis Results Fiber cyclone output fiber samples can be seen in the table as a result.

Table 3. Analysis Results

no	Tanggal	Berat sampel (gr)	Kernel dari nut utuh (gr)	Kernel dari nut pecah (gr)	Kernel utuh (gr)	Kernel pecah (gr)	Total seluruh kernel (gr)	Losses kernel	Standar losses (0.10%)
1	19 Mei 2021	1,000.80	2.7	2.0	0.3	6.2	11.2	0.14%	0.10%
2	20 Mei 2021	1,000.40	2.3	0.9	0.2	9.0	12.4	0.15%	0.10%
3	21 Mei 2021	1,000.10	1.3	2.4	0.3	6.7	10.7	0.13%	0.10%
4	22 Mei 2021	1,001.20	1.8	1.2	0.3	4.4	7.7	0.10%	0.10%
5	23 Mei 2021	1,004.80	2.1	1.4	0.2	4.1	7.8	0.10%	0.10%
6	24 Mei 2021	1,003.20	2.3	1.0	0.6	4.4	8.3	0.10%	0.10%
7	25 Mei 2021	1,003.70	2.2	1.0	0.3	6.2	9.7	0.12%	0.10%
8	26 Mei 2021	1,003.50	2.5	1.0	0.4	5.3	9.2	0.11%	0.10%
9	27 Mei 2021	1,004.80	2.1	1.2	0.2	5.7	9.2	0.11%	0.10%

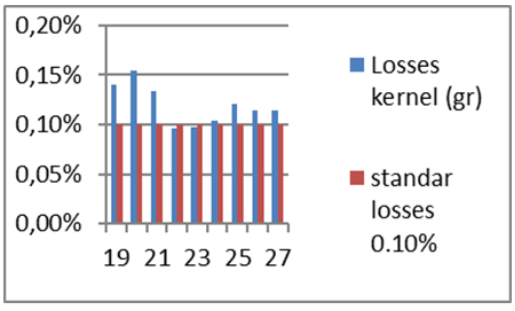

Figure 4. Graph of kernel losses

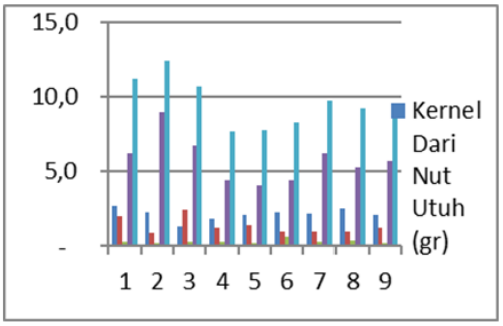

Figure 5. Graph of kernel losses

Description of Fiber Cyclone Calculation Results

Velocity box

Figure 6. Velocity box

The velocity box is known to measure length = 1,500 mm (1.5 m), and width 235 mm (0.235 m) Then the results can be seen below:

Flow Rate (Flow capacity)

Q = 12.380,14 m^3/hour

$$Q = \frac{12.380{,}14\ m^3}{3.600\ s}$$

$$Q = 3{,}43\ {}^{m^3}/_{s}$$

$$\text{Velocity (v)} = \frac{Q}{A}$$

$$= \frac{3{,}43\ {}^{m^3}/_{s}}{0{,}34\ m^2}$$

$$= 10{,}08\ {}^{m}/_{s}$$

In the velocity box, the flow velocity that occurs in it reaches 10.08 m/s. The greatest speed is in the velocity box, this is due to the small cross-sectional area.

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Ducting vertical

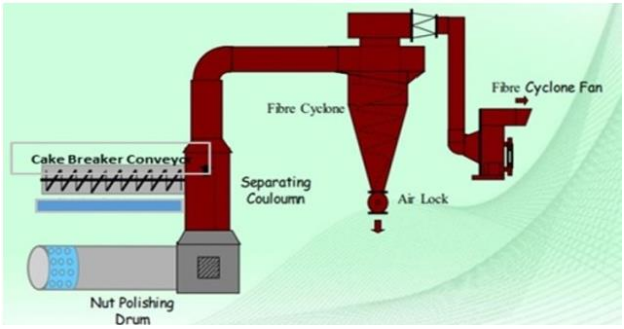

Figure 7. Fiber Cyclone

Vertical ducting is known to be ducting length = of 7,000 mm (7 m), a ducting diameter of 800 mm (0.8 m), and a radius of 400 mm (0.4 m). Then the results can be seen below:
Flow Rate (Flow capacity)

Q = 12.380,14 m^3/hour

$$Q = \frac{12.380{,}14\ m^3}{3.600\ s}$$

$$Q = 3{,}43\ {}^{m^3}/_{s}$$

Cross-Sectional Area

$= \pi \times r^2$

$= 3{,}14 \times 0{,}4\ m \times 0{,}4\ m$

$= 3{,}14 \times 0{,}16\ m^2$

$= 0{,}50\ m^2$

$$\text{Velocity (v)} = \frac{Q}{A}$$

$$= \frac{3{,}43\ {}^{m^3}/_{s}}{0{,}50\ m^2}$$

= 6,86 m/s

Rey's number

$$Rey = \frac{\rho \times v \times d}{\mu}$$

$$Rey = \frac{80 \times 6{,}86 \times 0{,}8}{0{,}018 \times 10{-}3}$$

$$Rey = \frac{439{,}04}{1{,}8{-}5}$$

$$Rey = 24.391.111$$

Major Losses

$$hf = f\frac{L \times v2}{d \times 2g}$$

$$hf = 0{,}009\ \frac{7 \times 6{,}86 \times 6{,}86}{0{,}8 \times 19{,}6}$$

$$hf = 0{,}009 \times \frac{329{,}4172}{15{,}68}$$

$$hf = 0{,}19\ \text{m}$$

The vertical column has a velocity of 6.86 m/s. The type of air flow contained in the vertical column is 24,391,111, namely the turbulent flow type. The flow loss that occurs in the vertical column is 0.19 m.

Ducting Horizontal

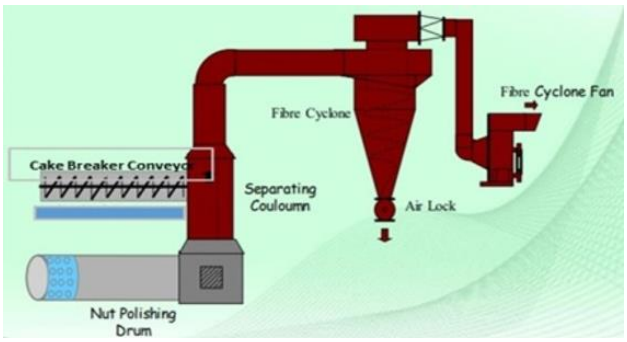

Figure 8. Fiber Cyclone

Horizontal ducting is known to be 11,700 mm (11.70 m) long, 720 mm (0.72 m) in diameter and 360 mm (0.36 m) in radius. Then the results can be seen as below:
Flow Rate (Flow capacity)

Q = 12.380,14 m^3/hour

$$Q = \frac{12.380{,}14\ m^3}{3.600\ s}$$

Q = 3,43 m^3/s

Cross-Sectional Area

$= \pi \times r^2$

$= 3{,}14 \times 0{,}36\ m \times 0{,}36\ m$

$= 3{,}14 \times 0{,}13\ m^2$

$= 0{,}40\ m^2$

$$\text{Velocity (v)} = \frac{Q}{A}$$

$$= \frac{3{,}43\ {}^{m^3}/_{s}}{0{,}40\ m^2}$$

= 8,57 m/s

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Rey's number

$$Rey = \frac{\rho \times v \times d}{\mu}$$

$$Rey = \frac{80 \times 8{,}57 \times 0{,}72}{0{,}018 \times 10{-}3}$$

$$Rey = \frac{493{,}632}{1{,}8{-}5}$$

$$Rey = 27.424.000$$

Major Losses

$$hf = f\frac{L \times v2}{d \times 2g}$$

$$hf = 0{,}0085\frac{11{,}70 \times 8{,}57 \times 8{,}57}{0{,}72 \times 19{,}6}$$

$$hf = 0{,}0085 \times \frac{859{,}3053}{14{,}11}$$

$$hf = 0{,}51 \text{ m}$$

The velocity for the horizontal column is 8.57 m/s. The type of flow that occurs in the horizontal column is turbulent because the number is 27,424,000. The flow loss that occurs in the horizontal column is 0.51 m.

Minor Losses

$$hm = k\frac{v2}{2g}$$

$$hm = 0{,}7 \times \frac{6{,}86 \times 6{,}86}{2 \times 9{,}8}$$

$$hm = 0{,}7 \times \frac{47{,}0596}{19{,}6}$$

$$hm = 1{,}68 \text{ m}(elbow\ ducting)$$

$$hm = 0{,}7\frac{0{,}51 \times 0{,}51}{2 \times 9{,}8}$$

$$hm = 0{,}7\frac{0{,}2601}{19{,}6}$$

$$hm = 0{,}009\ (elbow\ fan)$$

The minor flow loss at the ducting elbow is 1.68 m and the flow loss at the fan elbow is 0.009 m.

Cyclone

Figure 9. *cyclone*

Flow Rate (Flow capacity)

Q = 12.380,14 m3/jam

$$Q = \frac{12.380{,}14\ m^3}{3.600\ s}$$

Q = 3,43 m^3/s

Cross-Sectional Area

$= \pi \times r^2$

$= 3{,}14 \times 1{,}45\ m \times 1{,}45\ m$

$= 3{,}14 \times 2{,}1025\ m^2$

$= 6{,}60\ m^2$

$$\text{Velocity (v)} = \frac{Q}{A}$$

$$= \frac{3{,}43\ m^3/s}{0{,}40\ m^2}$$

$= 0{,}51$ m/s

Specifications of fan and electro motor

Figure 10. Fan and Electro Motor

- Fan

  Type : Axial centrifugal fan
  Size : SQA 36 . 12
  Round : 1.850 rpm
  Ø Pulley : 8 inch
  V- Belt : C 139
  Bearing : FYH F 212

- Electro Motor

Power : 55 Kw
Round : 1480 rpm
Ø Pulley : 10 inch
Voltage : 380
Bearing : 6316

Discussion

Depericarper Station Operational Standards

1. Function:
   - Separating fiber from nut from press cake by keeping the loss of kernel to fiber cyclone and fiber to nut to a minimum.
   - Reducing the remaining fiber still attached to the nut to prepare the nut for breaking.
2. Operating Procedure

   A. Fiber Cyclone
   - Run the "air lock" inclined wet nut conveyor before operating the depericarper drum.
   - When the CBC is operated, check for possible fiber accumulation in the polishing drum and CBC.
   - Small debris/lengths at the end of the polishing drum should be removed regularly.
   - Separating column should be in tight/closed condition to avoid air leakage.
   - Shell/kernel debris and broken cores collected from the screen polishing drum should be cleaned regularly.
   - Perform regular inspection of the gearbox and tightening of loose bolts to avoid breakdown of the unit.

   B. Fiber Cyclone Fan
   - Before operation, check the V-belt, V-belt safety, and bearing housing, and clean the dirt attached to the impeller blades.
   - During operation, check the noise/vibration and bearing temperature.
   - Press the off-fan button after the CBC stops and make sure that no more fiber comes out of the fiber cyclone.

   C. Cyclone, Air Lock, and Ducting
   - Before the operation, check for possible ducting leaks and clean all fibers that remain on the platform, and ladder.
   - Check the possibility of a clogged cyclone by looking at the regularity of fiber/shell coming out and no fiber/shell coming out through the fan.
   - Stop the airlock cyclone if the fan has stopped.

Fiber Sample

Based on the fiber analysis data conducted for 9 days, there are some data that exceed the standard losses that have been set for the fiber cyclone. As on May 20 the table recorded losses up to 0.15%, this is due to too many broken kernels that losses increase on that day, the cause of too many broken kernels is one of the press machines whose pressure is too high causing many broken nuts, the way to overcome it is to set the pressure back to normal.

Flow Speed of Fiber Cyclone ducting

From the calculation results obtained, it can be seen that the speed is greater in the horizontal column than the vertical, this is because the horizontal column is smaller in diameter and the column is longer. The horizontal column is designed like that because of the needs of the factory, the speed is made greater because the horizontal column needs this speed to lift the material that is on the vertical to be maximized.

Major Losses and Minor Losses

Major losses are flow losses that occur in straight columns. From the calculation results obtained, it can be seen that the major losses are greater in the horizontal flow, this is because the horizontal column is longer.

Minor losses are a type of flow loss that occurs at the elbow or turn. In the fiber cyclone, there are 2 elbows, namely the elbow connecting the vertical column and the horizontal column, and the elbow that is before the fan after the cyclone. Larger flow losses occur at the elbow in the ducting because the column is longer.

CONCLUSION

The conclusion of this research is:

1. Fiber cyclone is a tool to separate fiber with nut and this separation process requires the help of air suction. The way the fiber cyclone works is to lift the material whose density is lighter, namely fiber. Fiber is lifted up and the nut falls down to the polishing drum.
2. Sampling is done every 2 hours. Starting from 2 hours after the start of the process and ending 2 before stopping the process. Fiber sample analysis is carried out every 1 day. Fiber sample analysis is carried out every 1 day The standard kernel losses on fiber cyclone is 0.10%. From the tests carried out for 9 days,

only 3 days were in accordance with the standard.

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