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THE EFFECT OF DRUM SPEED ON TIME AND GRAIN SIZE RESULTS FROM THE MILLING PROCESS

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ABSTRACT

Grinding/crushing is a process of reducing the size in a crushing plant to get the desired size. The coal ball mill technique is where the ball collides with the feed on the tube wall, thus cracks will form in the feed which will result in a smaller size. Limitation of the problem in this study is the effect of speed on time and grain size resulting from the milling process, the mass of the sample used is 500 grams with grain sizes that do not pass a 10 mesh sieve, there are three types of pulley variations, namely, pulleys of 2 inch, 4 inch. , and 20 inches with a ball as a control using 10 uniform balls with a diameter of 4.58 cm

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1. INTRODUCTION

Coal is an alternative energy source that is being eyed by businessmen. Besides looking at the cost advantage, the availability of coal in various countries is also relatively large, especially in Indonesia which has high calorific value coal with production costs that are still low compared to other countries. (Suryadi, 2016)

Ball mill is a material used for grinding and mixing *clinker* and *gypsum* will be obtained *mill* with the desired fineness or what is called cementIn this process the *ball mill* used is a type of *ball mill* made of spherical steel material. (Suryadi, 2016)

A *ball mill* machine is a grinding machine whose function is to grind hard materials to reduce the size of the material until it becomes very fine. The shape of the *ball mill* is generally in the form of a tube with a horizontal shaft, this tube has several large grains of hard balls made of steel. These balls are called *ball mills*. (Marzuki, 2016)

Based on the description above, the writer conducted research related to the design of the tool entitled "The Effect *Drum* on Time and *Grain Size* Produced from the *Milling Process.*" (Marzuki, 2016)

The author limits the influence of:

1. Pulley size 2 inches vs 4 inches, 4 inches vs 4 inches, 20 inches vs 4 inches
2. Time 4 minutes, 8 minutes, 12 minutes, 16 minutes, 20 minutes, 24 minutes, 28 minutes.
3. Variations in sieve size ½ mesh, 4 mesh, 10 mesh, 30 mesh, 40 mesh, 50 mesh, 80 mesh, 100 mesh, 200 mesh, pan.

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4. The number of balls is 10 pieces. (Marzuki, 2018)

Research Objectives The

Objectives of the research conducted were:

1. To determine the effect of time variations using a ball mill.
2. Knowing the performance of coal ball mill tools in carrying out the grinding process with time variations with the speed of the ball mill tool.

The benefits of this paper are as follows:

1. Can find out the process of crushing coal with a ball mill in the laboratory.
2. Can be applied to Coal Utilization and Conversion Technology courses and Coal Piloting and Analysis Practicum.

LITERATURE REVIEW

Understanding *Revolution per Minute* (RPM)

According to Neno, (2012) RPM stands for Revolutions per minute or revolutions per minute with the sense of the number of revolutions or rotation of an axis in one minute. This term is known not only on motorbike or car engines but also on washing machine drums, CD spins, Hard Disks Drives, turbos and so on. Rpm has a direct effect on House Power (HP) due to factors the main components of HP are torque and rpm.

Definition of Torque

According to Mahendra. et al, (2021) Torque is a measure of an engine's ability to do work, so torque is energy. Torque is a derived quantity that can be used to calculate the energy resulting from the difference that rotates on its axis. As for the formulation of the torque is as follows. If an object rotates and has a centrifugal force of F, the object rotates on its axis with a radius of r, with these data the torque is:

$$P = (T x N):5252 \qquad (2.1)$$

Where:

T = Torque (Newton)
P = Power in units of HP (House Power)
N = Number of revolutions per minute (rpm)
5252 = is the fixed value (constant) for the motor power unit HP

$$T = F.r \qquad (2.2)$$

T = Torque
F = Newton units
R = Radius.

Spin Speed

According to Mahendra. et al, (2021) the performance of an induction motor is greatly influenced by the load that is carried, when a load on the motor goes up or down it has an impact on voltage and frequency (unstable). For this reason, a frequency converter is needed to control the output voltage (380 V, 50 Hz) on the electric motor, so that it rotates at a constant set speed. The influence of speed and capacity as a combination of parameters for SEIG to produce voltage regulation, frequency regulation and load values to provide optimal performance. According to the Heyland diagram, a change in load results in a change in rotation and also causes a change in

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the blind current generated by the engine. The rotational speed of an electric motor can be calculated by the following equation:

Ns=(120×f)/p.......................... ....(2.3)

Where:

Ns = speed of rotating field (rpm)
F = mains frequency (Hz)
P = number of frequency poles

With the following equation:

Basically induction motors are greatly affected by several things, namely rotational speed, load, and power requirements.

Ratio and Rotation Calculations

According to Laksono and Handi (2018), the magnitude of an electric motor's rotation is commonly referred to as rpm (Revolution per minute), or the number of revolutions per minute. Electric motors generally have a large number of rpm rotations, including:

a. 3000 rpm electric motor,
b. 1500 rpm electric motor,
c. 1000 rpm electric motor, and
d. 500 rpm electric motor.

Some machines used in industry or factories require the same rotation speed (rpm) as the electric motor's rpm, so that the electric motor can be directly connected to drive the machine. However, some machines in the factory require a different rotation (rpm) than the rotation (rpm) of the electric motor.

Machines that are generally used in factories and require smaller rotation than electric motor rotation include:

a. Belt conveyor,
b. Bucket elevator,
c. Mixer
d. Stirrer,
e. Capstand, and others

To be able to adjust the rotation produced by the electric motor with what is needed by the machine, a speed reducer system is needed or a decrease in speed, if the speed (rpm) required by the engine is lower than the rotation of the electric motor as follows:

a. If a machine requires a drive with speed (rpm) of 3000 rpm, then an electric motor can be used with a rotation of 3000 rpm,
b. If a machine requires a drive with a speed (rpm) of 1500 rpm, then an electric motor can be used with a rotation of 1500 rpm,
c. If a machine requires a drive with a speed (rpm) of 1000 rpm, then an electric motor with a rotation of 1000 rpm can be used,
d. If a machine requires a drive with a speed (rpm) of 500 rpm, then an electric motor with a rotation of 500 rpm can be used.

Usually if the difference in rotation between the engine and the electric motor is not too large, there is no need to use a gearbox, simply by adjusting the pulley or sprocket ratio. 1. Pulley is used for machines with high rotation, low torque, 2. Sprocket is used for machines with low rotation, high torque.

We can usually find this in industrial machines such as pumps, blowers, and fans. 2.

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Gearbox Ratio Gearbox is a piece of equipment that contains gears which function to transfer the mechanical energy from a driving machine (input) to the machine to be driven (output shaft). A gearbox usually has a name plate that contains information about several things, such as:

a. N1 is the number of initial rotations (input shaft) originating from a drive (electric motor),
b. N2 is the number of rotations generated (output shaft) for rotating the engine,
c. Ratio (i) the ratio of the input shaft to the output shaft,
d. Torque or torque.

Engine speed (N2) using an electric motor of 1,500 rpm and a gearbox ratio of 50, is obtained at 30 rpm, while the desired engine speed is 15 rpm?

There are two ways to reduce the conveyor belt machine, namely:

1. Reducing the rotation of the electric motor N1 with the pulley ratio
2. Reducing the N2 gearbox rotation with the sprocket ratio on the gearbox engine. Pulley ratio on electric motors (N1)

Desired engine speed (N2) = 15 rpm
Gearbox ratio = 50
N1 = N2 x Ratio
N1 = 15 x 30
N1 = 750 rpm.

This means that the electric motor rotates at 1,500 rpm, we have to reduce it using the pulley ratio to get it to 750 rpm.

Crushing Coal

Crushing Grinding/crushing, which is the process of reducing the size in a crushing plant to get the size according to market demand. Ball mill as it is known by its name, ball is a ball, this machine works with balls rolling in a tube which continues to rotate with a time that is set and predetermined by the operator. Ball mill machine is a machine used to smooth, pulverize or crush a material into smaller particles and even powder.

The grinding process with the ball is the collision between the ball and the feed on the tube wall, thus, cracks will form in the feed which will result in a smaller size. Grinding with a ball mill produces a smaller feed size, this is influenced by the physical properties of the grinding media, which is then influenced by the process that occurs during grinding where the ball can follow the movement of the tube to the maximum height and when the ball falls it will produce a relatively smaller particle size.

When operating, the mill will rotate and the grinding media and ore will also be carried up by the mill wall in a higher direction until it reaches a point or dynamic equilibrium position. Dynamic equilibrium is reached when the weight equals the centrifugal force. After the equilibrium point is reached, the load will move downward according to the rotational speed of the mill. (Ramadan, 2019) The grinding mechanism in a ball mill can be seen in Figure 2.1.

Based on the rotational speed of the mill, there are two grinding mechanisms, cascading and cataracting. Both of these mechanisms will produce a different product size distribution. (Wills, 1988)

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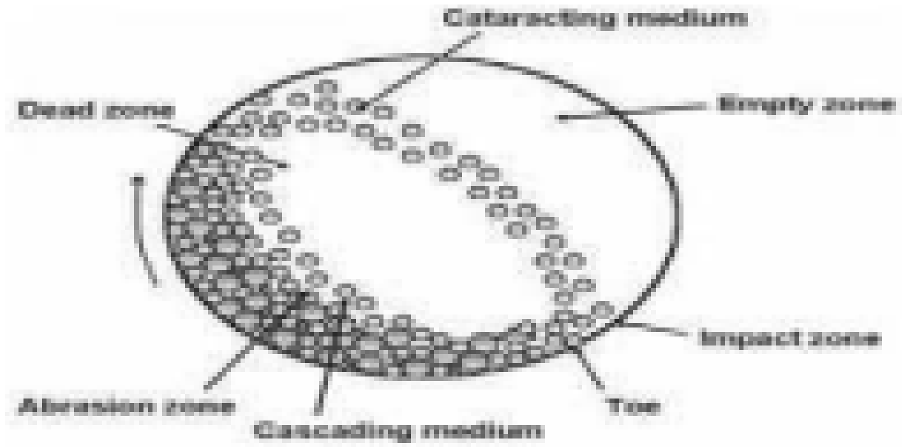


Source: Subba, 2011

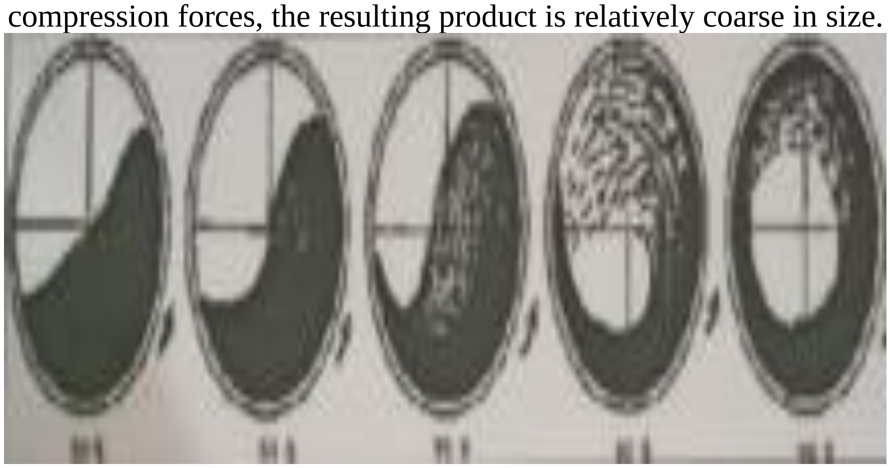
Figure 2.1 Rotating Movement in *Ball Mill*

a. Cascading mechanism

At a relatively low mill rotation, the load will move up not so high and after reaching the load balance point it will immediately slide back or roll over another load that is moving up. In this mechanism, size reduction occurs due to abrasion or attrition forces and the product shear produced by this mechanism is very fine.

b. Cataracting mechanism

When the mill rotates high enough, the charge also rotates and moves up relatively high with a high equilibrium point. Once equilibrium is reached, the charge will fall freely to the bottom of the mill. In this mechanism, size reduction occurs due to the influence of impact and compression forces, the resulting product is relatively coarse in size.



Source: Wills, 1988

Figure 2.2 Mechanism of Load Behavior When the *Mill* Rotates

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Source: Wills, 1988

Figure 2.3 Mechanism *Breakages*: (1) *Impact*, (2) *Chipping*, (3) *Abbrasion*

METHODE RESEARCH

Type of Research

Research this research was conducted with a design tool and experimental, there are various stages of activity. The first thing to do is a literature study, a literature study is done by reading books or reports related to coal crushing, then looking for data that supports the problems taken in the final project.

Time and Place of Research

The place that will be used as the location for this research is the coal laboratory, Akamigas Palembang Polytechnic which is located in the Plaju Education and Training Area, Jl. Kebon Jahe, Komperta, Kec. Plaju, Palembang City, South Sumatra and this final assignment was carried out on March 5 to. May 6, 2022 with a description of activities consisting of tool design, tool manufacture, data collection, data processing, and report generation.

Research Tools and Materials

A. Research Tools

To support the implementation of the manufacture, measurement, observation, and testing of coal ball mill tools, several tools are used, namely:

1. Analytical balance,
2. Sieve shaker,
3. Stopwatch,
4. Electric welding,
5. Grinder,
6. Drill,
7. Sprygun, and
8. Welding wire.

B. Research Materials

Materials needed in the manufacture of coal ball mill design and construction with specifications:

1. 1-phase induction motor dynamo, 220 volts,
2. Steel frame,

3. 1 inch Axle iron,
4. Drum,
5. Pully in hole 1 inch,
6. Rubber v belt
7. Pillow block bearing,
8. Steel balls,
9. Coal,
10. Armature mounting plate,
11. Bolt,
12. Nut,
13. Paint,
14. Brush,
15. Box Wood,
16. Indicator light,
17. Pause button,
18. Reset button, and
19. On – off switch.

C. Research Methods

The research method in this final project is as follows:

a. Literature

Study Literature study was conducted by seeking information and theories related to coal ball mills based on references from books, journals and previous final project reports. b. Data collection

In this final project research using primary data where the data is data obtained from direct observations in the field in carrying out the process of using coal in the laboratory including:

1. mass passing through the sieve,
2. cumulative mass per sieve
3. Percent passing through each sieve.

b. Data processing

The data that has been obtained is then classified based on the type of data and then analyzed and calculated according to the needs and objectives of this final project research. Stages of data processing:

1. Calculation of retained mass
   Mt = Mas-Ma.. (3.1)
2. Calculation of the cumulative passing mass
   Mkpa = Mcal+Mtpal....................................... (3.2)
3. Mass calculation via
   PI = (Mts.Mkta)/Mts×100 %...................(3.3)

c. Research Results

From the results of ball mill analysis data, several time variations were obtained.

RESULTS AND DISCUSSION

Level of Effectiveness of Ball Mill

Results of this study are a coal grinding machine or coal crusher which has been tested for grinding the coal that has been characterized for size and for the resulting grains. This grinding

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tool is made like the initial design using a motor but there is a little extra stopwatch on the tool. The characteristic results include the grain size of the milling results from the sieving process. The test results for the ball mill tool can be seen in graph 1

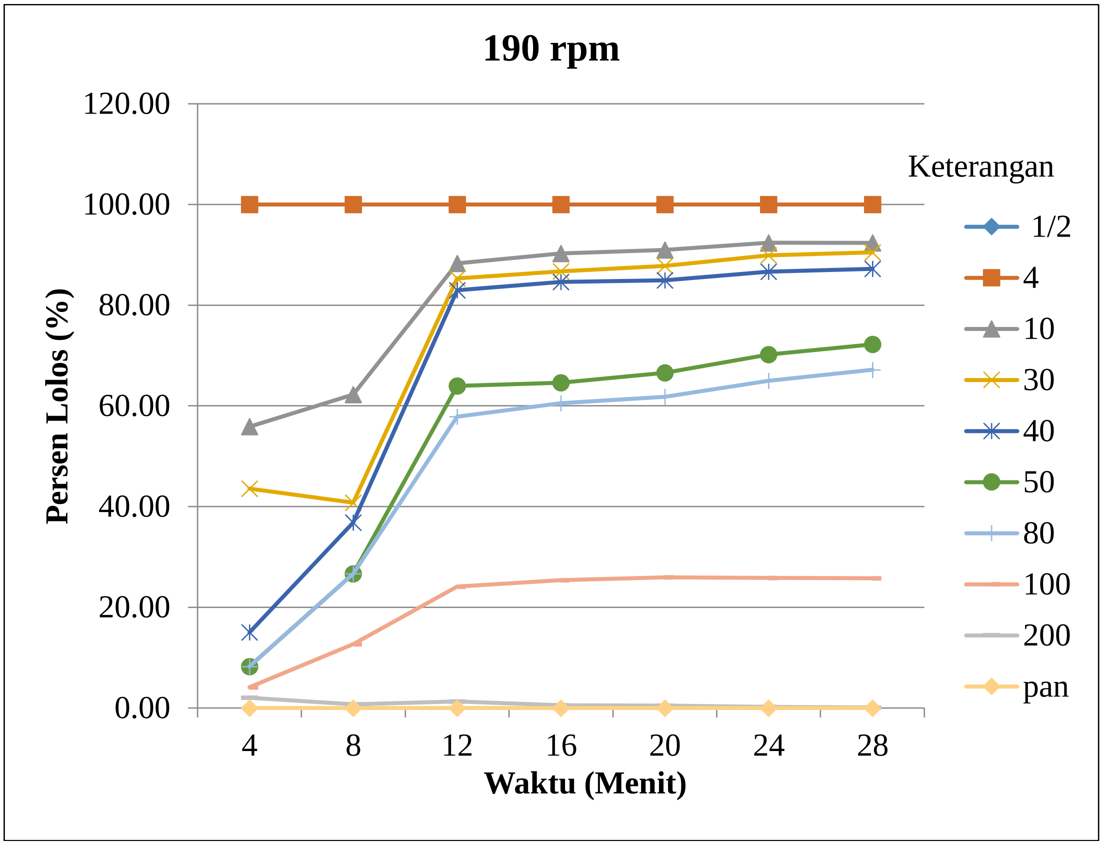

Figure 4.1 Relation of Time to Percent of Passing for 190 rpm rotation.

From the graph in Figure 4.1, it can be seen that the longer the time, the percentage through each sieve will increase for milling results with a rotational speed of 190 rpm by using 10 balls as a controller. This is illustrated by the percent passing conditions under optimum conditions. This graph can also be used to predict the percentage of passing each sieve for velocity carried out in research, namely by using the manual method in the form of line plots or using statistical analysis for further analysis.

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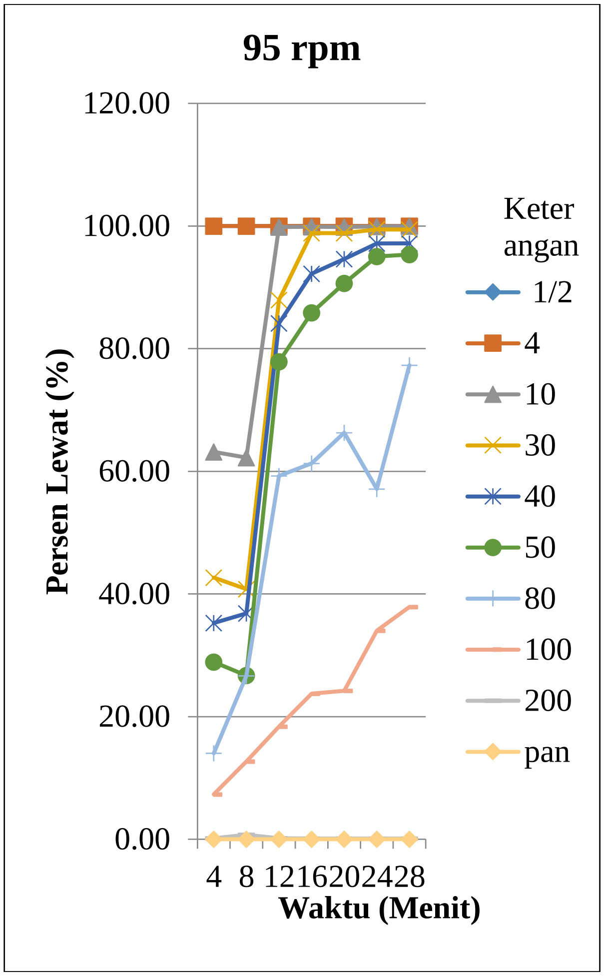

Figure 4.2 Relation of Time to Percent of Passing for 95 rpm rotation

From the graph in Figure 4.2 it can be seen that the longer the time, the percentage passing through each sieve will increase for milling results with a rotation speed of 95 rpm using 10 balls as a controller. This is illustrated by the percent passing conditions under optimum conditions. This graph can also be used to predict the percentage of passing each sieve for velocity carried out in research, namely by using the manual method in the form of line plots or using statistical analysis for further analysis.

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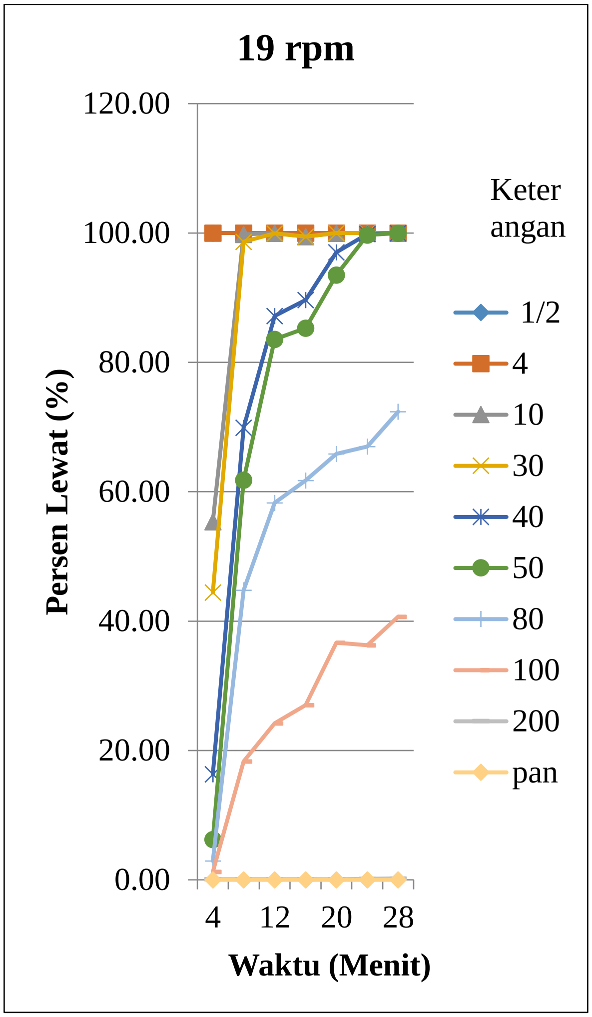

Figure 4.3Relation of Time toPercent of Passing for 19 rpm rotation

From the graph in Figure 4.3 shows that the longer the time, the percentage through each sieve will be obtained will increase for milling results with a rotation speed of 19 rpm using 10 balls as a controller. This is illustrated by the percent passing conditions under optimum conditions. This graph can also be used to predict the percentage of passing each sieve for velocity carried out in research, namely by using the manual method in the form of line plots or using statistical analysis for further analysis.

CONCLUSION

Based on the description and explanation in the previous chapter, several conclusions can be drawn, including:

1. The performance success rate of the ball mill tool in the coal grinding or grinding process shows good results with variations in pulley sizes of 2 inches vs 4 inches, 4 inches vs 4 inches, and 20 inches vs 4 inches with 10 balls as a controller showed significant results on the 10-30 mesh sieve while it decreased on the 30-pan mesh sieve.
2. The level of effectiveness of the ball mill tool is at a speed of 190 rpm with a total of 10 balls due to a decrease in the percent yield through each sieve.

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Suggestion

To get good results from the ball mill tool, it is better to use a 20 inch vs 4 inch pulley with a speed of 19 rpm in order to get maximum results.

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