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Design and Development of Pan Granulator Capacity 250 Kg/Hour

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Abstract: This granular organic fertilizer making machine is a machine used for make fertilizer in the form of granules to make it easier to store fertilizer and later it will be more efficient in use. The process of making organic fertilizer the granules start with manure as an organic fertilizer material dried then mashed. Manure that has been mashed then formed into granules using a pan granulator. Manure that has been done into granules and then dried. This pan granulator machine is made with using motor power calculations, shaft calculations, belt calculations, settings angle, and rotational speed of the granulator pan. This machine has dimensions of 200 cm x 170 cm x 200 cm which is suitable for farmer groups who are farmer partners. This machine is capable of granulating 250 kg/hour of organic fertilizer with a daily production capacity of 2000 kg for 8 working hours per day and a granulating size of 5 – 7 mm.

Keywords: organic fertilizer and pan granulator

1. Introduction

Continuous excessive use of chemical fertilizers is consideredfarmers have actually been able to increase soil fertility so farcauses a decline in soil quality. As the ground becomes hard andthe balance of nutrients contained in the soil is also disturbed. As in several areas in Indonesia, agricultural land is experiencing phosphate saturationand potassium due to excessive and unbalanced use of NPK fertilizer.The most effective way to fix this is to restore the materialorganic in the form of organic fertilizer to agricultural land. To provide conveniencefor farmers when fertilizing, organic fertilizer is given toagricultural land is made in the form of granular organic fertilizer. Farming groups are starting to understand the effects of chemical fertilizers which cause the soil to become saturated and experience shallowing. So farmers are switching to using organic fertilizer, but currently farmers are still using bulk organic fertilizer whose storage and use methods are still less efficient. 1 hectare requires ± 2000 kg of bulk fertilizer.

Granule machines on the market have large dimensions withoverall height 5 m, length 4 m, width 3 m, using energyelectricity, the resulting capacity is 600 kg/hour, the granule yield obtained withsize 3 mm,4 mm,6 mm. Because the size of the granule machines on the market is largeand takes up a lot of space. Researchers make a tool for making granulated organic fertilizer. The machine has dimensions of overall height 200 cm, length 200 cm, width 175 cm,capacity 250 kg/hour, granule yield 5-7 mm. In the future, this tool will help farmers make organic fertilizer in granule form. This granular organic fertilizer maker can be an inspiration for other farmers to increase their agricultural yields.

2. Methode

Granular organic fertilizer is fertilizer made from the remains of living creatures which are processed through a decomposition process in the form of spheres with a size of 5 - 7 [mm]. Granular organic fertilizer generally has a certain density so that it is not easily blown away by the wind and carried away by water. Materialcontained in granular organic fertilizer in the form of manure. Manure is an organic fertilizer derived from livestock manure. Manure is the main raw material for making granular organic fertilizer. The quality of organic fertilizer affects the quality of the fertilizer used. Manure is the decomposition of organic matter, such as food waste, livestock manure, fish waste. This decomposition process into simpler forms is carried out biologically with the help of microorganisms such as bacteria, fungi and actinomycetes. The decomposition process requires conditionsoptimal conditions such as the availability of adequate nutrition, sufficient air and proper humidity. The more appropriate the environmental conditions, the faster the decomposition process and the higher the quality of the cage.

Therefore, the design team used manure as granule material. In the world of manure, there are terms known as hot fertilizer and cold fertilizer. Hot fertilizer is manure whose decomposition process takes place quickly so that heat is formed. Cold fertilizer happens the opposite, the decomposition process takes longer and does not generate heat. The characteristics of good manure can be seen physically or chemically. Its physical characteristics are blackish brown in color, quite dry, not lumpy, and does not have a strong odor. The chemical characteristic is that the constituent materials are invisible and the temperature is relatively stable. When comparing granular organic fertilizer with bulk manure, the absorption capacity of granular organic fertilizer takes longer to run out than bulk manure.

Granulation Process

Manure is put into the granulator disk. Filling fertilizer into the granulator disk is done in stages using a shovel or pouring it from a sack. It is best if this process is carried out while the disk is rotating so that the fertilizer can move directly following the rotation of the disk. During the granulation process, spray 5% molasses solution.It is best to spray evenly and little by little so that the fertilizer does not clump. The fertilizer that sticks together will rotate following the movement of the disk. This rotational movement will cause the formation of increasingly larger granules. Therefore, it is necessary to stir itprevents the formation of grains larger than 5 [mm] accumulating at the bottom of the disc. Stirring also functions to prevent crust from forming on the walls of the dish.

The design of the granular organic fertilizer making machine is also undergoing an analysis stage. Before it becomes a definite machine, a design is made first. Steps in designing a machine:

1. The first step in designing a machine for making granulated organic fertilizer is to review the problems with existing machines in the factory that are not suitable for farmers. This step is carried out to find information about problems that arise, from problemswill later be used as a basis for planning a machine for making granular organic fertilizer.
2. The second step is making and assembling the tool. This method includes making machine components and assembling them into a machine of the desired design.
3. The third step is, machine testing. This step was carried out to determine the level of functional and operational success in designing and manufacturing a granular organic fertilizer making machine. If there are still deficiencies, the machine can be repaired and refined again so that the goal of making this machine can be achieved.
4. The fourth step is evaluation and revision. After the tool has been tested, its deficiencies must be corrected so that it becomes a more perfect tool.

Design Alternatives

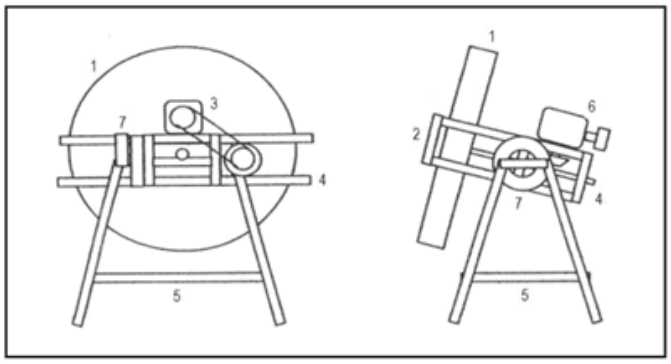
Based on the existing problems, several alternative machine designs are needed which will later be taken into consideration in determining the machine to be made. Design selection is based on existing design values or criteria.

These criteria are grouped into two, namely:

1. Criteria that must be met include:
    a. The machine created can save space.
    b. Safe machine for operators.
    c. Has a production capacity of 15 kg/hour.
    d. Operation does not require a special operator.
2. Expected criteria include:
    a. Granule results are as expected (3mm, 4mm, 5mm)
    b. Easy to maintain the machine.
    c. Machine prices are cheaper.

Design Selection

The desired criteria have been determined, then proceed with the preparation of design alternatives which aim to determine the advantages and disadvantages of existing machine design alternatives. Some of the selected design alternatives are:



Information Figure1.
1. Pan granulator
2. Leveling backing and adhesive spray.
3. Gear box (reducer)
4. Granulator pan retaining frame.
5. Machine frame.
6. 8.5 HP drive motor.
7. Gear to hold the Pan granulator tilt position

Figure 1 Pan granulator design.

3. Results and Discussion

A granulation machine (pan granulator) that can granulate organic fertilizer is planned to have a capacity of 250 kg/hour. This granulation machine (pan granulator) has the advantages: it uses simple technology, can be operated by just 2 people, is economical and easy to maintain.

This waste shredder has the following specifications:

1. Length x width x height = 2 x 1.75 x 2 meters.
2. Organic fertilizer granulation capacity = 250 kg/working hour.
3. Using a gasoline engine with 8.5 hp to drive the pan shaft.
4. Pan elevation angle with a slope of 45^{o}.

Capacity Planning

After knowing that the cross-sectional area of the knife (A) is 0.0016 mm^2, n = 1200 rpm then calculate the waste volume from the experimental results (V) which is 0.01413 m^3. From this volume, it can be seen that the density of the waste chopper (ρ) is 70 kg/m3, the cutting knife speed (V) is 282.6 m/minute. So the capacity of the granulation machine (pan granulator) (Q) is 70 kg/minute.

Power Planning Results

The cutting force of the waste chopper (F) is 0.4 kg. With a pan radius of 277.5mm. So the torque that occurs (T) is 320 kg.mm. The power required to cut waste (P) is 390 W, the correction factor (fc) is 0.8, then the planned power (Pd) is 1540 W.

Figure 1 Designed organic fertilizer granulation machine (pan granulator).

Pulley and V-Belt Design Results

The motor used is 8.5 HP and the motor rotation speed is 2200 rpm. The diameter of the driving pulley = 95 mm and the diameter of the driven pulley = 180 mm, the length of the belt used is L = 1044 mm. axle distance (C) = 1226 mm. Required reduction ratio (i) = 1.83. From this data, the belt used is type B with the following specifications $\alpha = 36°$; W= 16.07; L0= 12.5; K= 5.5; Ko = 9.5; e = 19.0; f= 12.5.

Shaft and Stake Planning.

The shaft material that will be used is S30C. With tensile strength specifications (σB) = 48 kg/mm^2, the knife weight is 16.4 kg, the pulley weight is 1 kg, the pulley pulling force is 7.17 kg. Force on RA = 0.97 kg and RB = 17.37 kg.The largest moment that occurred was 2336 kg with a torque (T2) = 319.7 kg.mm. The safety factors (Sf1) and (Sf2) used are 6 (because S-C material is used) and 2.0 (because the shaft is given a keyway) while the bending factor (Km) is taken as 1.5 because the impact load that occurs is large, the twist factor (Kt) is taken as 2.0 because a large shock/impact occurs, the allowable bending stress (τa) = 4 kg/mm^2.
To design a peg, you must know the tangential force (F), the magnitude of the tangential force is F = 16.82 kg. The shaft diameter is 38 mm with S30C post material with tensile strength (σB) = 48 kg.mm with safety factors (Sf1) = 6 and (Sf2) = 2.0. Peg length (lk) = 65 mm, peg width (b) = 10 mm, and peg height (h) = 5 mm.

Bearing Planning Results

The bearing to be used is an installed angular ball rolling bearing with open type bearing number UCP 211, which has the following specifications: d = 38; D = 80; B = 20; r = 1.The radial load on the bearing (Fr) = 17.37 kg and the axial load on the bearing (Fa) = 0. So the X factor = 0.56, V = 1 and the Y factor = 0, because the bearing used is a radial bearing, the bearing equivalent load is 9 .72 kg. The bearing speed factor is (fn) = 0.01, and the bearing life factor is (fh) = 6.59. Nominal bearing life (Lh) = 143095.59 hours with bearing life reliability factor (Ln) = 143095.59 hours.

Pan Shaft Calculation

Calculation of the pan shaft with the material used for the shaft in the pan is St 40 with a tensile strength ST 40 of 40 kg/mm^2 = 392 N/mm^2, pan mass (m-pan) = 30 kg, spur gearmass (m-gear) = 11.1 kg, pan shaft diameter (D - pan shaft) = 48 mm, gravitational acceleration (g) = 9.81m/s^2.

5. Conclusion

Based on the results of designing and testing organic fertilizer granulation machines (pan granulators), it can be concluded that:

1. The power required to rotate the organic fertilizer granulator pan is 1540 W, The diameter of the driving pulley (pinion) is 10 mm and the diameter of the driven pulley (gear) is 500 mm.
2. The shaft material used is S30C with a tensile strength (σB) = 48 kg/mm^2. The diameter of the shaft used is 50 mm and the shaft length is 1000 mm;
3. Based on test results, the granulation size is 5 – 7 mm with a success percentage of 85%.The capacity of the organic fertilizer granulation machine (pan granulator) is 250 kg/hour at a low speed of 40 rpm and uses a reducer box with a ratio of 1:50.

Suggestion

1. In implementing the design and manufacture of the organic fertilizer granulation machine (pan granulator), there are still things that need to be recommended.
2. It is recommended to give the petrol engine a higher speed (above 1400 rpm) so that the pan rotation is stable.It is recommended that the support plate be made using thicker flat plate material (above 12 mm) so that the construction is strong.

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