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ROTARY ELECTRICAL CONTROLLED DRUM DRYER FOR ORGANIC FERTILIZER PRODUCTION

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Abstract. *This research is aim to provide design and prototype of rotary electrical controled drumdrier machine for drying organic fertilizer to increased production capacity and quality by using a source of heat energy from electricity. This machine consists of five main components i.e. drying cylinder, heating unit, support frame, engine and transmission system. Engine specifications are high 130 cm, 720 cm long, and 120 cm wide, cylinder diameter 60 cm, power engine 14 hp, and heating temperature 142 °C. Engine performance test are: capasity 805,03 kg/hours, drying rate 27,40 %/hours, noise level 81,54 db. cost analysis result are operational cost 155,06 Rp/kg and break event point 159.219,73 kg/years*
Keywords : *dryer, fertylizer,, energy, electricity*

1. Introduction

There is one of many unresolved issues in agriculture production and it is the fertilization issue. The long-term non-organic fertilizer availability with reasonable price will determine the national agriculture production sustainability, which it will also guarantee the national food resilience. Since the fertilizer is an essential need for agricultural growth, in the 60s the goverment gave the subsidized fertilizer. While in fact, the stocks continue to decline over time. (Hasman et al., 2013).

The use of organic fertilizer is increasing along with the rise of organic farming phenomenon. Consequently, there are no other alternative ways to fertilize for the farmers unless they have to use organic fertilizer as well. Meanwhile, the manual production of organic fertilizer is indeed a rough work and takes time to produce until it is ready to be used (Suryanto & Teguh, 2002).

The preliminary research result that it is identified that its production process is time-consuming, particularly the drying stage. This problem is very pronounced when relying the process on conventional drying using sun heat and air circulation on its drying place. Furthermore, using the standard drying machine is still required a large amount of heat, difficult to control the temperature and needs plentiful human resources to process reversing raw materials. Therefore, it does not overcome the current problem on the production process

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(Hasman et al., 2012). The next phase of the study is to engineer the rotary electrical controlled drum dryer for supporting organic fertilizer drying process. On this step, the labour needs and fatigue problems are not yet resolved. However, to control the efficiency of heat source and its precise temperature is still can be solved as well as the high cost of production.

This program is expected to be able to produce a package of organic fertilizer production technology with a high standard, high capacity and efficiency. Nonetheless, it is simple to run by the farmers. This package of technology that is engineered, is so-called a rotary electrical controlled drum dryer machine. Here in after, it is also inferred to be able to improve the agricultural production capacity and upgrade the quality of the agricultural products. Moreover, it will be able to solve the deficiency of the fertilizer stocks.

The roadmap of product development and enrichment the organic fertilizer nutrition consist of the materials, research and development, the technology that is used for machine-making process, products and its development, and target its market (Hasman et al., 2013).

Regarding the program, the first year term provides the rotary electrical controlled drum dryer machine for drying process to achieve an advance organic fertilizer product. This technology is an effective machine that is needed by the farmers to solve the chemical fertilizer deficiency. This roadmap is depicted in Table 1.

Table 1. The roadmap for rotary electrical controlled drum dryer research

Year	First	Second	Third
Material	The assorted size of steel for machine making process.	Rotary electrical drum dryer, organic fertilizer, assorted size of steel	An efficient and economic fertilizer machine maker and organic fertilizer.
Research and Development	Development and machine improvement.	Control system development.	Monitorized control system development.
Technology	Structural and functional approach, performance test.	Temperature and humidity control technology.	Monitorized temperature and humidity control.
Product	Rotary electrical controlled drum dryer machine and organic fertilizer.	Rotary dryer machine for controlling temperature and humidity.	Monitorized rotary dryer machine for controlling temperature and humidity.
Market	Farmers, farmers' association, small enterprises.	Farmers, plantations, small workshop enterprises.	Farmers, plantations, small workshop enterprises.

The development of this machine will support the evolution of agricultural machinery workshops that will produce agricultural machines, which are needed by the community. It is expected to be able to solve the labor issues, heating temperature that can be easily controlled and utilizing its own electrical power as the heat source for drying process. This machine will ease the work and cost and improve the production capacity and product quality. Furthermore, it will also decrease the dependency on labour in agricultural works. Hence, it is expected to fulfil the needs for fertilizer. Therefore, it will escalate the agricultural production so that Indonesia will genuinely have its own self-sufficiency on many agricultural commodities.

Furthermore, the other advantages are partners will be able to intensify the production capacity and product quality, and the value of the product could be competitive. Hence, those are raising incomes and welfare amongst the labors. For the local government, this program will be able to increase the community welfare and regional income, create job opportunities and reduce the unemployment (Hasman et al., 2012). For Politani, this achievement will be able to strengthen the function of its agricultural workshops, as the leading in agricultural machinery expertise and the machines that is built is potential to achieve intellectual property rights and international publications.

2. Methods

The implementation of this research uses several methods, functional and structural method that depends on each stage of work. In the first year, it was focused on design and manufacture of the machine, so that it creates a truly efficient and effective machine. Next, the functional and structural method was used for the selection of the right components and materials. It would produce an efficient machine for producing the organic fertilizer. Afterwards, performance test and economic analysis were done. Then, dissemination and socialization were carried out on farmers and local community nearby Politani Negeri Payakumbuh. Finally, the mass production of organic fertilizer will be started.

The prototype would be designed for possessing the main component that consists: cylindrical compartment (i.e. as the channel for drying the raw material and it will be rotating while drying process until the mixture exiting the outlet shaft at the end of the channel.). Outside of the outlet will be provided with heating element, completes with the temperature control system and electric fan, as the energy resources and hot air blower to the dried mixture. The machine is moved by the 14HP motor engine to rotate the drum dryer, transmission system and controlled heating system. The design is depicted in Figure 1 (autoshape version).

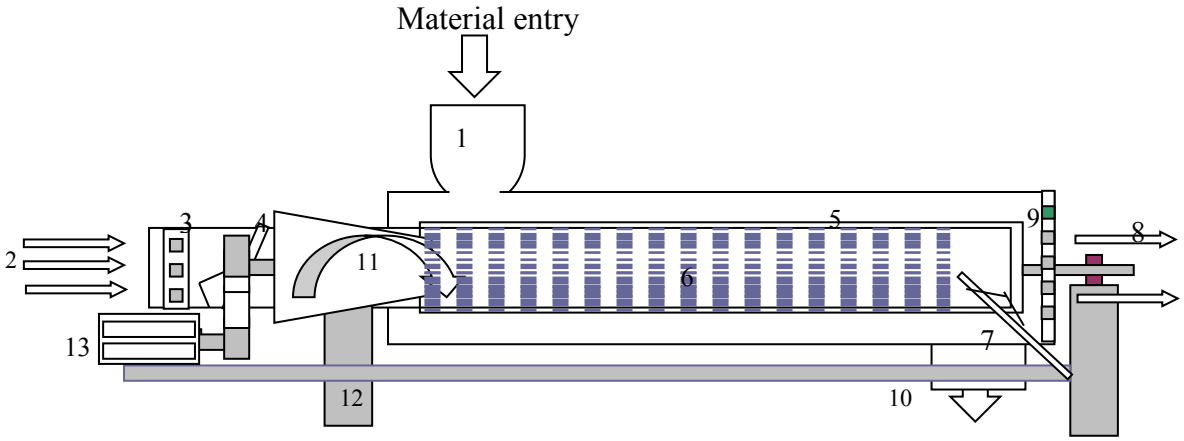

Figure 1. Design of rotary electrical controled drum dryer

Figure annotation:

1. Hopper input
2. Air flow
3. Heating element
4. Inlet Fan
5. Drum dryer
6. Dried material
7. Scrapper
8. Hot air flow
9. Temperature control system
10. Outlet
11. Drum rotation direction
12. Frame
13. Engine and electric motor

The technical evaluation that will be held is intended for:

- Identifying the physical characteristics (segregation) from organic fertilizer before it enters the machine and product at the outlet of the machine.
- Determining the capacity and drying efficiency. The time needed for drying until the mixture is dried with the determined water content.
- Knowing the number of labours, types of work, operational convenience and technical problem that appear while operation.
- Determining the engine power for production process to determine the optimal engine power for the procedure.
- Calculating the noise level while production process and give the recommendation for the operator while operating the machine.
- Economical analysing on basic cost, BC ratio, IRR and current bank rate interest.

3. Results and Discussion

Technical Description for Rotary Dryer

The rotary electrical controlled drum dryer machine is a type of dryer that works continuously. This machine consists of five main components, namely:

- Drying cylinder

- Heater
- Driver motor
- Transmission system

Machine Specification on Thorough Dimension

By the process of making the machine that has been carried out, it is obtained a rotary electrical controlled drum dryer machine, which has the following specifications:

Model	: Rotary electrical controlled drum dryer
Capacity	: 805.03 kg/hour
Height	: 30cm
Length	: 720 cm
Width	: 120 cm
Diameter	: 60 cm
Driver motor	: Diesel Yanmar 14Hp
Heater	: Electric heater - 700 W
Temperature control system	: Thermostat AC 240 V - output 9 V
Heating temperature	: 142^{o}C

Drying unit

The unit is shaped like elongated cylinder that is rotating during the drying process. The specification as follows:

Length	: 600 cm
Width	: 120 Cm
Height	: 130 Cm
Diameter	: 60 Cm
Driver motor	: Diesel Yanmar 14 Hp
RPM cylinder	: 7 RPM

The drying unit can be seen in Figure 2.

Heater

While the drying process, the machine uses two elements of heaters with power source comes from electricity. It has power of 700 W, includes with thermostat for maintaining the temperature. Heat that comes from the sources will be transported by the blower to enter drying unit. Moreover, the powerful fire comes from the heater is transported by the power of the blower and be moved by the ½ Hp dynamo. With its powerful blast, it can reach the end of the drying unit inlet. Therefore, the drying process

can be done perfectly. The heater unit is depicted in Figure 3.

Figure 2. Cylinder drying unit

Figure 3. Heater drying unit

Drying Process of Organic Fertilizer

The drying process of organic fertilizer was started with loading the material and rotating the acylinder at 7.0 RPM and air temperature entering the drying unit is 142.20 ^{o}C. The time needed for drying process in 15.43 minutes to lessen the water content to 13%.

Rotary Electrical Controlled Drum Dryer Machine Performance

After having the functional test on the machine, henceforth the machine performance test. Economic analysis of rotary electrical controlled drum dryer machine was to calculate the operational cost of the machine by using economic analysis. Similar method has been used in: Paisal, Mahatta, and Mayu (2018); Yusuf, Aprilla, Mardotillah,

and Saputra (2018); Putera, Intan, Mustaqim, and Ramadhan (2019). The results is shown on Table 2.

Table 2. Result of machine performance test

Parameter	Test results	Unit
Rotation of driver motor without average load	960.80	RPM
Rotation of driver motor with average load	935.60	RPM
Rotation of drying cylinder without average load	8.0	RPM
Rotation of drying cylinder with average load	7.0	RPM
Air temperature enters drying cylinder	142.20	^{o}C
Air temperature exits drying cylinder	101.73	^{o}C
Drying time	15.43	Minute
Average capacity based on initial weight (input)	805.03	kg/hour
Initial water content	20.37	%
Final water content	13.32	%
Drying rate	27.40	%/hour
Noise level without load	80.86	dB
Noise level with load	81.54	dB
Machine price	95.993.700	Rp
Fixed cost	25.150.349	Rp/year
Variable cost	114.349,81	Rp/year
Basic cost	155,06	Rp/kg
Break even point (BEP)	159.219,73	kg/year

4. Conclusion

Rotary electrical controlled drum dryer consists of five main components i.e. drying cylinder, heating unit, support frame, engine and transmission system. Engine specifications are high 130 cm, 720 cm long, and 120 cm wide, cylinder diameter 60 cm, power engine 14 hp, and heating temperature 142 ºC. From the result of technical and performance tests can be seen that; machine's performance is proper, where; drying capacity is 805.03kg/hour with initial water content from 20.37 % to 13.32 %; noise level while operating is 81.54 dB. It means that it is still in a safe range for the operator. While on the economic analysis, the basic cost is Rp 155,06 /kg and BEP is 159.219,73 kg/year.

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