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Design and Development of Fertilizer Manufacturing Machine from Kitchen Waste

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***Abstract*: The principal objectives of organic agriculture include to produce food of high nutritional quality in sufficient quantities; to interact in a constructive and life-enhancing way with natural systems and cycles; to encourage and enhance biological cycles within the farming system, involving microorganisms, soil flora and fauna and plants and animals; to maintain and increase long term fertility of soils, to help in the conservation of soil; to work, as far as possible, within a closed system with regard to organic matter and nutrient elements; to work, as far as possible, with materials and substances which can be reused or recycled, either on the farm or elsewhere; to give all livestock conditions of life which allow them to perform the basic aspects of their innate behavior; to minimize all forms of pollution that may result from agricultural practice; to maintain the genetic diversity of the agricultural system and its surroundings, including the protection of plant . Organic fertilizer is capable of restoring lost fertility to the soil and boosting crop production. This organic machinery plant consists of the shredder and a mixer system that will link the shredder to the mixer, in such a way that, the shredding and mixing operation can be done simultaneously The machine can widely use in agricultural and waste recycling process. The cost of the setup is around 500 USD (approx.). The outcomes of low cost pressure chamber instrument revise the cost of the instrument up to 35000 INR and providing stable use.**

***Keywords*: Organic fertilizer, shredder, mixer.**

1. Introduction

Organic fertilizer machinery which can be producing organic fertilizer for small to large scale farming to restore lost fertility to the soil and boosting crop production. Organic fertilizer is the end product obtained by converting various organic wastes such as crop residue, urban wastes, poultry droppings, animal dung, etc., into a usable fertilizer by a modified aerobic anaerobic process of composting. Organic fertilizer has advantages which include high nutrient content suitability to a range of crops fast biodegradability and safety. Organic fertilizers are used as supplements to chemical fertilizers, thereby reducing the import of the chemicals. Characterization of the organic manure was carried out indicated a carbon to nitrogen ratio of approximately 30 and a pH value of 7. This is an indication that the organic manure is rich in nutrient composition and healthy for soil rejuvenation.

A. Need for organic fertilizers

Agriculture is an economic driven activity which aims to produce and increase production of crops and food supply to feed the human population. However, the continued exploitation of our natural resources such as land and other resources lead to poor productivity level and future shortage of food supply while the use of modern agricultural practices had damaged our environment Also, the increasing prices of farm inputs in the market is a common problem farmer in the word today because not everyone could afford to buy farm inputs just to increase productivity and that affects food security. Organic fertilizers are used as supplements to chemical fertilizers, thereby reducing the important of the chemicals. Farmers are cleaning new land resulting in deforestation, tilling of pasture and soil degradation. For the agricultural sector, the need to shift into sustainable farming practices is necessary for food security and to mitigate of stop soil erosion and convert carbon losses into gains particularly due to the use of green and manure, soil fertility.

B. Properties of organic fertilizer

Organic fertilizer is the end producer obtained by converting organic wastes such as crop residue, urban waste, poultry dropping and animal dung etc. into a useable fertilizer by a modified aerobic-cum-anaerobic process of composting. Organic fertilizer has advantages which include high nutrient content suitability to a range of crops fast biodegradability and safety. Fresh composted manure generally has high nitrogen content than composted manure. This process depends upon the activity of microorganism. These microorganisms require a carbon to nitrogen ration (C: N) between 25 and 30 moisture content of 40–60%, pH between 5 and 12 and particle size greater than 30% free air space when manure is composted, its volume decreases and nutrient density increases.

C. Objectives of fertilizer manufacturing machine

The aim is to design and develop a fertilizer manufacturing machine from kitchen waste by using a shredder and mixer.

D. Scope of Fertilizer manufacturing machine

Organic fertilizer manufacturing machine, and found out that chemical fertilizers are expensive for formers to combat with in rejuvenating the lost nutrients of the soil. They identified four major problems which propel their design and they are:

- The machines available for preparing organic

fertilizers are costly which farmers cannot afford to buy.
- Available machines are fuel consuming and operate at high power consumption which indirectly increases the cost.
- Available machines are very bulky.

2. Methodology

The fertilizer manufacturing machine consists of the following components.
- Dumping hopper
- Shredder blades
- Shredder machine
- Hopper
- Mixing chamber

A. Working of a dumping hopper

The dumping hopper which is used to dump the kitchen wastes. A container for a loose bulk material such as grain, rock, or rubbish, typically one that tapers downward and is able to discharge its contents at the bottom. The shredding process produces new raw materials to be re-introduced into manufacturing machine.

B. Working of a shredding machine

Shredding machine chops the raw material into minute pieces, thus making the material easily digestible. The multiple blades in the machines help in shredding the material and from the shredder machine it goes into the mixing chamber through the hopper. It consists of two shafts in which the blades are attached to these shafts when the shafts rotate one blades shaft in clockwise direction and another blade rotates in clockwise direction. The blades are attached alternatively so it can cut the wastes easily. A motor is directly coupled to the shredding machine. It is made up of EN8 mild steel. The shredding chamber is powered by a 2HP motor with 1440rpm which was coupled directly to the shredding shaft.

C. Working of a hopper.

The shredded kitchen waste from the shredder machine is goes to the tapered hopper which is used to release the kitchen waste slower into the mixing chamber. It is made up of EN8 mild steel.

D. Working of the mixer

The kitchen wastes from the tap hopper is comes to the mixing chamber. It consists of shaft in each the ribbon type mixer blade is attached to that shaft. The mixer is directly coupled with the motor with gearbox. In this mixer chamber we add the enzymes which is used to breakdown the bio molecules. The mixer chamber mixes the waste into a finite solid particle and below to the mixer a chamber a opener is attached through that only we can able to take the final products. Ribbon type mixer blades are used in the mixing chamber; their spiral structure is efficient enough to mix the materials is the well needed proportion. Mixer is powered by a 1.5 HP gear motor with bevel gears coupled directly to its blade's shaft.

3. Design

A. Parameters considered for design.

The materials used selected after careful study of its physical, mechanical, chemical and aesthetic characteristics. For the purpose of this work, due to economic consideration and material availability, high and medium carbon steel were mostly used for body parts while EN8 was chosen for shredder and mixer blades.

B. Dimensions of shredding chamber

The shredding chamber consist of rotatory blades attached to a shaft with four branches, each branch consists of ten number of blades assembled opposite two each other. Chamber Length - 250mm Diameter – 60mm Wall thickness – 8mm Blades thickness- 6mm Blades length – 25mm Shaft breadth – 116mm.
- Capacity characteristics of shredding chamber Maximum load capacity of the shredding chamber: 3.5Kg. The most suitable form of load is by batch type loading for more efficient shredded output.

C. Dimensions of mixer chamber

The mixer chamber consists of a ribbon type mixer blade, In mixing chamber the shredded waste material and the absorbent gets mixed in a proper ratio.
Chamber Length - 360mm Diameter – 120mm, Wall thickness – 5mm Blades thickness- 3mm Blades length – 250mm Shaft breadth – 100mm

D. Dimensions of the hoppers

Length -240mm Breath -200mm Thickness -1.6mm
Materials and manufacturing methods

1) List of components used.
- 1.6mm Mild steel sheet
- Hexagonal bolts and nuts.
- Base frame
- Variable motors
- Shafts
- Shredder blades
- Mixer blades

E. Process used in manufacturing

1) Cutting

The process of cutting is necessary in any industry and no component can be manufactured without a cutting process. Cutting is defined as the separation or opening of a physical object, into two or more portions, through the application of an acutely directed force. The first process carried out after the purchase of raw material is cutting process. The raw material is cut as per the specifications stated in the part drawing. At first all the pieces of the required dimensions is cut with the help of a cutting machine. The cutting process was carried out with the

help of a computerized numerical control (CNC) machine.

2) Welding

Welding is a fabrication or sculptural process that is used to join the two dissimilar materials, usually metals or thermoplastics, by using high temperatures to melt the parts and applying pressure in order to form a joint know as fusion. The welding operation is mainly done on the mild steel cubic rod. At first the rod is cut as per the dimensions in the design. Then the parts which are to be joint are welded. At the end of the welding process the whole frame or the structure of the machine was completed. The dimensions of the structure are stated in the part drawings.

3) Drilling

Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill bit is usually a rotary cutting tool, often multi-point. The bit is pressed against the work piece to form a hole of the required dimensions. In this project 16 drilling operations were carried out. Out of which 10 drilling operations were carried out in a 11.8mm drill bit, 2 drilling operations were carried out in a 13.8mm drill bit and 4 drilling operations were carried out on a 17.8mm drill bit. The drilling operations were carried out in a computer numerical control (CNC) machine. The drilling operations were carried out in different places as per the design and drilling was carried out in places were fasteners were used and the bigger diameter drills were performed on the fixture for tightening the work piece to the same.

4) Tapping

Tapping is also known as taps and dies. Taps and dies are tools used to create screw threads, which is called threading. A tap is used to cut or form the female portion of the mating pair say nut and a die is used to cut or form the male portion of the mating pair say bolt. The process of cutting or forming threads using a tap is called tapping. As the definition already states that tapping is done in order to fix the fasteners in the correct direction in the place as required in the design. In this project as already stated in the process of drilling there are 16 drilling operations carried out and all these drills are performed in order to make way for the fastener. After the drilling process is carried out tapping was performed in each of the drills.

5) Thread cutting

Internal thread cutting Internal thread cutting operation is carried out on the on the inner surface of the fixture. The internal thread cutting operation is done in order to hold and fix the lead screw which is used for moving the fixture front and back carried out the cutting operation. 3.6.2 External thread cutting. The external thread cutting operation is carried out on the lead screw. This operation is carried throughout the lead screw as per the design requirements.

F. Components and quantity

Table 1
Components and quantity

Parts	Components	Quantity and NO's
1	MS sheet	4'x3' feet
2	Hex bolts and nuts	50
3	Base frame	1
4	Variable motors	2
5	shafts	2
6	Shredder blades	20
7	Mixer blades	1

G. Fabrication of components

Table 2
Fabrication of components

S. no.	Component name	Method fabrication	function
1	frames	Welding cutting and surface grinding	It is used to provide a mounting area for the stand
2	Shredder blades	Machining Cutting Grinding	It is used to cut the food wastages into minute particles
3	mixer	Machining Grinding	It is used for mixing the particle
4	sieve	Arc welding	Filter the shredded particles

H. Cost estimation of components

Table 3
Cost estimation of components

S. No.	Components	Cost (Rs.)
1	wheel	400
2	Ac motor (2HP)	4000
3	Ac motor with gear	7000
4	frame	1500
5	Shaft	1600
6	Shredder blades	1900
7	Mixer blades	2500
8	Stand	500
9	Enzymes (per/kg)	300
10	bearings	400
11	Bolts	100
12	Nuts	75
13	Washer	25
	Total cost	23,550

4. Result

The charges for the analysis process is Rs.2250/-. The time period taken for analysis process ranges from 3-4 days. The analysis process is done by Green Link Analytical and Research Laboratory. Total cost was estimated to be Rs. 26,000 which has procurement, manufacturing and miscellaneous cost.

A. Testing result of compost.

Table 4
Testing result of compost.

S.no	Parameters	Unit	Test Result
1	Bulk density	Kg/m^3	0.892
2	moisture	%	56
3	Ash content	%	10.3
4	Loss on ignition	%	89.7
5	PH at 25C	-	6.70
6	Total organic carbon	%	37
7	Total nitrogen as N	%	1.43
8	C:N ratio	-	30.65
9	Calcium	mg/kg	1628
10	Magnesium	mg/kg	587
11	Sodium	mg/kg	3658
12	Potassium	mg/kg	726

Fig. 1. Fully assembled fertilizer manufacturing machine from kitchen waste

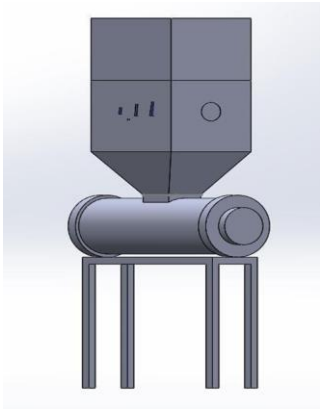

Fig. 2. Conceptual design of fertilizer manufacturing machine using Solid works

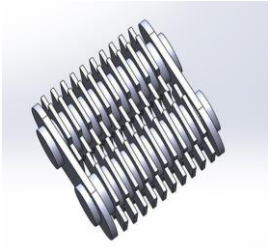

Fig. 3. Design of shredder blades

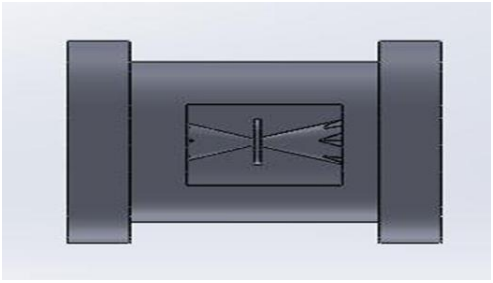

Fig. 4. Design of mixing chamber

5. Conclusion

The project carried out by us will make an impressive mark in the field of agriculture. The project has also reduced the time period of fertilizer manufacturing. The project has been designed to perform the required task at minimum time at minimal risk involved at fertilizer manufacturing.

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