Design and Fabrication of Rotary Screen for Solid Waste Segregation of Ambad City

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Abstract— Segregating your waste allows your business to recycle more items, preventing them from ending up in landfills. This, in turn, reduces your overall impact on the environment. This study emphasizes on the importance of solid waste segregation for the proper solid waste management for processing on solid wastes and their disposal and reuse. For this firstly door to door segregated collection of solid dry waste and wet waste is necessary. But in this case we don't get 100% segregation results which can be observed at the actual dumping sites. So, secondly we need to have proper system and mechanism for the solid waste segregation and there comes the need for the segregation machine. In farmer's field and in minerals industries we come across various rotary screens for different purposes. Thus we will use the same technique hereby to develop a segregation machine. As we tried upon waste segregation solution forming different screen design but eventually with few failed attempts we came across the fact that it will not solve our total purpose of segregation of solid waste and compost material. Thus we decided to design a segregation machine named as Rotary Screen which is machine with its Rotating Screen which will help in segregation of solid waste. We will take the help of Trommel Screen for this purpose, which is explained below.

Keywords: Rotary Screen, Solid Waste Segregation

I. INTRODUCTION

We decided to design a Segregation machine named as Rotary SCREEN which is machine with its Rotating Screen which will help in segregation of solid waste. We will take the help of Trommel Screen for this purpose.

Vermicompost is separated from the worms using sieves. This process is manual and consumes a lot of time and labor. To elucidate this problem many researchers have introduced various schemes. A new machine for rapid separation of earthworms and substrate has been introduced in it uses a light source to drive away the worms into a separate compartment and then use a set of some motor driven sieves to separate the substrates. There has introduced use of rotary trammel screen separator and achieved up to 90% efficient separation at about 60% moisture content. A separator is designed to separate raw compost from vermicompost using rotating cylinder driven by electric motor. There has introduced a two stage separator the particles with size less than 6mm are separated using a rolling screen and the earthworms are separated from the vermicompost using special conical separator with a survival rate of 96 percent. This shows study on design and fabrication of sieve machine. New machine which is based on combing action is used to separate worms from the compost which had well moisture levels in it. Also the problem of blinding worms is addressed. This paper aims at creating a low cost separator for small scale applications, therefore design is based on improving design of rotary separator to cause less harms.

The rest of the paper is arranged as follows. Section 2 depicts component selection and design. Section 3 shows Working of the system. Section 4 shows Fabrication. Results & conclusions are discussed in section 5 & 6 respectively.

Fig. 1: Methodology

Fig. 2: Project development flow diagram

II. COMPONENT SELECTION AND DESIGN

A. List of Components

Sr.No.	Table Column Head		
	Component	Specifications	Quantity
1	Motor	Single phase 230V AC 1.5HP	1
2	Gearbox	36:1 Reduction ratio	1

3	Pulley	Diameter=200mm	4
4	Shaft	Diameter=30mm	1
5	Hopper	20kg weight capacity	1
6	Cylindrical Seive	Length = 2133mm Diameter=510mm	1
7	Collector	Weight capacity = 10kg	1
8	Belt	v groove type	2

Table I: List of components

B. Design Details

In this section design details of motor, shaft, frame, gearbox, sieve and bearings are discussed. The design discussed is aimed at creating a cost effective device for vermicompost separation to be used at cattle farms, agricultural purposes domestic purposes and medium scale industries.

1) Motor selection

The motor used for this application is a 230 V single phase AC motor.

The total weight acting on the motor is = 294.3 N

Required torque = 7.173Nm

Power required is given by,

P = (2∗π∗ N∗ T)/60

P = (2∗π∗1440∗7.173)/60

P = 1.5HP

Fig. 3: AC motor

2) Shaft design:

The shaft used in this application is used to support the weight of the cylindrical sieve and the compost in it which is to be separated along with accessories like belt and pulley. Assuming the total torque at the shaft to be 300 Nm Shear stress of shaft material (C40)=500mpa According to torque stress relationship,

$$T=\sigma \times \left(\frac{\pi}{16}\right) \times d^3$$

$$\therefore 300= 500 \times \left(\frac{\pi}{16}\right) \times d^3$$

∴ d = 14.51mm

as per standerd size d=30mm.

3) Cylindrical seive design:

The cylindrical seive used is of DOT 4 rating to extract only useful compost and segregate the useful waste.

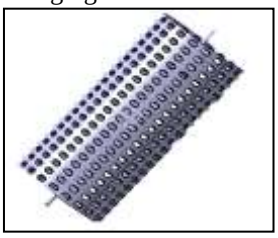

Fig. 4: Cylindrical sieve and shaft.

4) Frame design:

The total weight acting on the frame is assumed to be around 400N

∴Converting UDL in Point load we have,

∴400×2135=854000N

Stress on Frame=F/A=854000/2836.34=301.09 N/mm2

For Safe Design,

Required stress =Estimated stress × FOS

∴301.09×1.2=361.308 N/mm2

Therefore, the material selected is C40 which has characteristics required by the design.

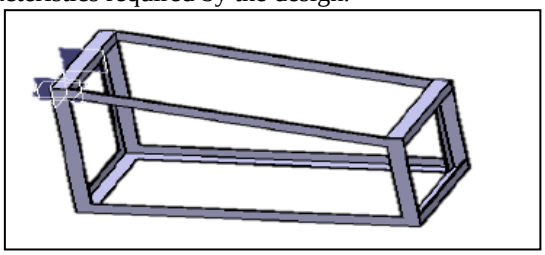

Fig. 5: Frame structure.

5) Bearing selection

For this application we select pedestal bearing,

Radial force on pulley=1480N

Diameter of shaft =30mm

Equivalent dynamic load

Pe=$Fr \times Ka$

∴69.64×1.25=87.05

Rating life of bearing in million revolutions

L10=720MR

Dynamic load carrying capacity

L10=(C/Pe)3

C=780N

From manufacturing catalogue we select bearing no- 61806

Fig. 6: Pedestal bearing.

6) Gearbox, Pulley, Belts and Hopper selection

The gearbox is used to provide a reduction from AC motor to shaft. The shaft is required to be rotated at 40 RPM so as not to harm the worms. Therefore the required reduction calculated comes out to be 36:1. Such high reduction ratio can be obtained using worm type gear box only.

To keep the ratios constant V Pulleys of the same size are used along with belts. The hoppers are selected on basis of its weight capacity to accommodate around 10kg of compost at once.

Fig. 7: Worm gearbox, pulleys, and hopper.

III. WORKING OF THE SYSTEM

Vermicompost cleaning machine is very easy to construct and can be operated easily. It is very economic among this kind of machines and is targeted for users which work on small scale or cattle farm level. This machine is both simple in

construction and working and can be perated easily by virtually anybody. The figure 9 below shows the developed CAD model of the proposed system.

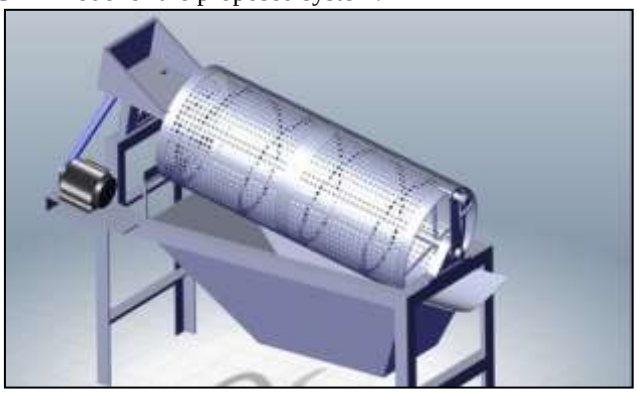

Fig. 8: CAD model of the proposed system.

IV. ANSYS RESULT

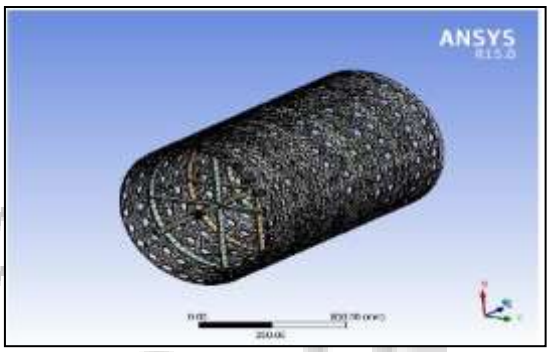

Fig. 9: Meshing

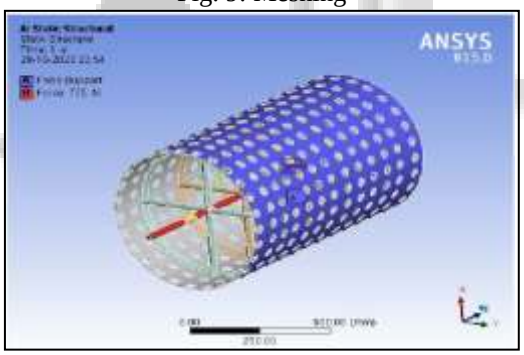

Fig. 10: Static Structural

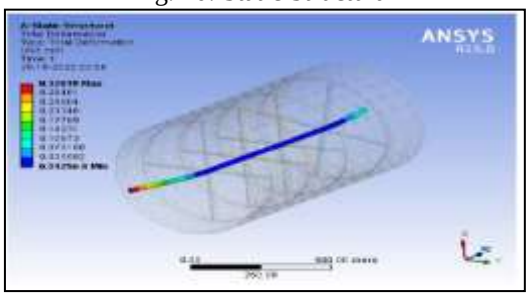

Fig. 11: Total deformation (at rod)

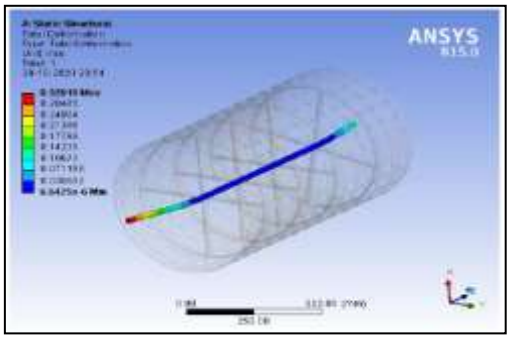

Fig. 12: Total deformation

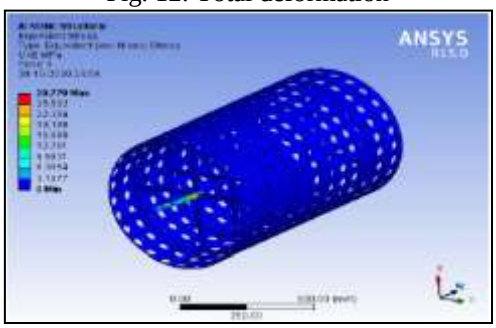

Fig. 13: Equivalent stress

Object Name	Static Structural (AS)
State	Solved
Definition	
Physics Type	Structural
Analysis Type	Static Structural
Solved Target	Mechanical APDL
Options	
Environment Temperature	22 °C
Generate Input Only	No

Table II: Static Structure

Density	7.85e-006 kg mm^-3
Coefficient of thermal expansion	1.2e-005 C^-1
Specific Heat	4.34 e+005 mJ kg^-1 C^-1
Thermal Conductivity	6.05 e-002 W mm^-1 C^-1
Resistivity	1.7 e-004 ohm mm

Table III: Parameter for Ansys

V. ROTARY SCREEN FABRICATION

This system is fabricated with the help of parts like cylindrical sieve, shaft, hopper, frame, bearings, motor, and pulleys. This vermicompost separation system works on the basis of simple rotary mechanism. An electric motor is mounted on the frame and connected to the shaft of cylindrical sieve through gearbox and pulley system. After turning on the AC motor the sieve starts rotating at 40 RPM. The prepared compost is then fed into the hopper mounted at some height above the frame. The compost fed into the hopper keeps falling into the rotating sieve due to gravity at a constant rate. As the sieve is rotating the sieving action will take place. Due to the inclination of the sieve with respect to horizontal and gravitational force acting on the compost particles, the useful compost is sieved out and gets settled in the collector while the un compost matter along with live

worms are collected in a separate collector. The worms then can be transferred back to the pit for vermicomposting and the final product which is often called as "Black Gold" can be packed.

In the fabrication of Screen products, components, or equipment, manufacturers employ welding as the principal joining method. Iron is a weld-able material, and a welded joint can provide optimum corrosion resistance, strength, and fabrication economy.

Rotary screen Components are all Iron materials hence can be fabricated with Gas welding Techniques.
Also Bolting of some of the Parts will be necessary.

- The proposed system can be easily fabricated at low cost for small scale industries and cattle farms.
- The manual effort earlier required now reduced drastically.
- The operating time is also reduced increasing efficiency.
- Since, the system is quite small in size it occupies very less floor area rendering more space for creating vermicompost pit.
- Also the net weight of the system is quite less and can be transported easily.
- The limited number of parts and very less stressed members present in the system reduce the chances of breakdown making the system almost maintenance free.
- With reduction of process time and labor individual owner can also save capital.
- The cost estimation of the system is given in table 13 below.

Sr.No.	Table Column Head		
	Component	Quantity	Cost
1	Motor	1	4500
2	Worm Gearbox	1	3000
3	Pulley	4	1000
4	Bearing	2	700
5	Hopper	1	800
6	Cylindrical Seive	1	1065
7	Frame	1	400
8	Belt	2	400
9	Shaft/Center Rod	1	300
	Total Cost		18465

Table IV: Cost Estimation.

Images below shows the system in its initial stages of development operated manually to find out best outcome by iterating various speeds and inclination of cylindrical sieve so as to not cause discomfort and trauma to the worms

VI. RESULTS

1) The machine is faster and portable; hence, it reduces labor compare to manual screening.
2) The adjustable of the machine was really effective and well satisfactory.
3) By observation for screening 5kg required 1min (60 sec).
4) By using these machines material handlings reduce.

VII. CONCLUSION

As per proper design, fabrication and specifications ROTARY - SCREEN for solid segregation worked fine and smoothly.
It is playing a multipurpose role for:-

- Segregation of dry and wet waste as well as large and small particles.
- Direct compost in raw nature at final screening is obtained.

It is possible to conceptualize, design and execute a locally Rotary screening machine at casting industries for increasing production.

Finally, these projects should be place regularly on service so as to enhance its workability and durability.

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REFERENCES

[1] Khurmi R. S., Gupta J. k., A textbook of Machine design, first edition, S. chand publication, 1979.
[2] Bhandari V. B., Design of machine elements, eighteenth edition, MC graw-hill Companies, 2003.
[3] Inroduction to standards and specifications for design in mechanics or strength of material , Georginna Lucas and Lisa Hatcher
[4] Design standards - Mechanical engineering and Installations ,M. Mottier
[5] Workshop Technology, Volume-1, 2, Hajara Chaudhari.
[6] Joseph E. Shigley, Mechanical engineering design, sixth edition, Tata Megraw hill, 2005.
[7] Glaub, J.C., Jones, D.B. & Savage, G.M. (1982). "The Design and Use of Trommel Screens for Processing Municipal Solid Waste", *Cal Recovery Systems, Inc*

