Design and Fabrication of Vacuum Shredder Machine

Mr. S. Krishna Raj [#1], M. Mansoor Basha [*2], R. Sudarshan [#3], S. Sanjay[#4]

Department of Mechanical Engineering, Sri Sai Ram Engineering College, West Tambaram, Chennai 600044

Abstract

In this particular project, our aim is to develop and construct a vacuum machine that possesses enhanced suction power efficiency. This machine is specifically designed for the purpose of extracting bio waste through suction. The extracted waste is then transformed into a powered form, which is stored after undergoing an initial moisturized process. This powered waste serves as a natural manure, and to further facilitate its usage, we have incorporated a shredder machine that effectively chops the leaves into smaller fragments. This process greatly aids in the fertilization process, making it more convenient and efficient. It was little complicated to design this vacuum shredder machine since the shredder gears are integrated with the vacuum machine. Analysis is also done for the efficiency of blades and the suction power of the servo motor. Promises a solution, that bio waste can be segregated and used as natural manure.

Keywords: Vacuum, shredder, suction mechanism.

Introduction

The Vacuum and Shredder Integration project is a testament to innovation in home appliance design. By combining the capabilities of a high-performance vacuum cleaner with an efficient shredder, we aim to simplify and elevate the way households manage both cleanliness and waste disposal. This integration is poised to redefine the standards of convenience, offering users a versatile and time-saving solution for maintaining a pristine living environment. This project addresses the common inconveniences faced in homes today: the need for separate devices to clean and dispose of waste. Our integrated solution not only minimizes the need for multiple appliances but also promotes sustainability by reducing the volume of waste through effective shredding. As we embark on this technological journey, we envision a future where households can effortlessly maintain cleanliness while contributing to a more eco-friendly lifestyle.

Methodology

Our project is designed in way that at the top of the machine a switch is placed for the power source and inside the frame an AC motor of 3500 rpm and for the shredding purpose we have integrated with the shredder gears which of the material of carbon steel, a four gear is meshed at a constant speed to chop the leaves into fine powder then a collector end is set in the bottom for segregation purpose and a mist sprinkler is used for the moisturizing purpose. We had designed our project in solid works software CAD and had done analysis on the basis of thermal analysis and stress and strain analysis. And for the mobility we have fixed revolving wheels with the number of four and diameter of 40mm. A long suction tube is fitted on the suction valve for the suction of the bio wastes around the surroundings. The moisturized material in the collector end is then dumped to the plants and saplings for the better growth and this method also prevents the contamination of bio wastes.

The Various Types Vacuum Suction Machine and Shredders are:

Vacuum Suction Machine

A vacuum suction machine, also known as a suction pump or vacuum pump, is a device used to remove

air, gases, or fluids from a sealed or confined space. These machines work by creating a partial vacuum within a chamber, causing air or other substances to be drawn into the chamber and expelled through an outlet while not exactly the same as industrial or medical suction machines, household vacuum cleaners also use suction to remove dirt, dust, and debris from floors and surfaces.

Fig 1. Vacuum cleaner

Frame:

The material used in the frame of the machine is Polyethylene terephthalate (PETE) which is the highest grade of plastic, the main reason for the selection of this material is due to its feasibility and availability. This material also withstands the toughness and the temperature that prevail in internal parts of the machine.

Fig 2. Frame

Overall Design

Parts used in the machine

Gears:

Gears are used in the material of carbon steel since generally gears are made up of the materials like carbon steels, cast iron and in aluminium (EN 24). This material is used due to the availability in the market and easy in machining. They are used as shredder part in this machine.

Physical property of steel are:

- High tensile strength.
- High impact strength.
- Good ductility

Suitable for various heat treatment options to improve properties.

Fig 3. Shredder gear

Roller Wheels:

The wheels are made of tube less tires to have free movement and reduced weight of the overall machine. These have bigger surface to move on rough surfaces and smooth surfaces. The wheels would have a lock which will help to keep the machine in one place. The wheels of the vacuum shredder machine is of the material polypropylene which the wheels are the wheels are revolving mechanism. The

diameter of the wheel is 40 mm and number of wheels used is 4 and they can withstand up to a weight of 100 kg.

Fig 4. Rollers used in existing design

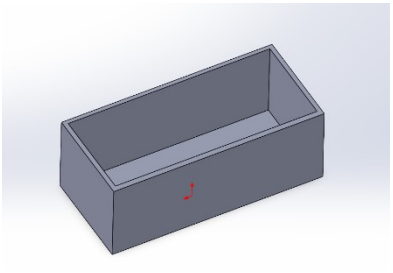
AC Motor:

The motor that are fixed in the machine are used for the rotation of the rollers in the egg shell remover and used in the rotation of the glide way in the egg shell remover in which the egg travels.

Fig 5. Motor used for suction

Collector End:

The Storage area is used to collect the dry leaves which are chopped into tiny pieces after completing the stage of shredder



Shredder Setup:

A shredder gear of 2 pair used at the mid portion of the vacuum machine which runs at the 150rpm and diameter of 130mm, as soon as the gear meshes together the bio wastes (ie) the leaves or twigs are chopped into fine powder.

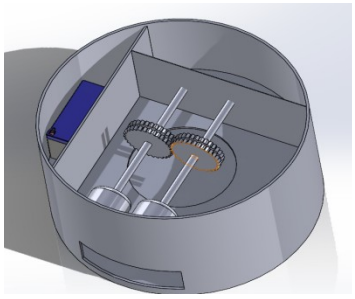


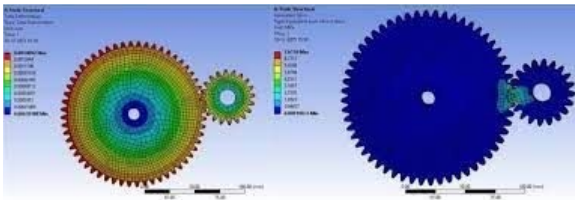
Fig 6. Shredder setup

Suction tube:

This suction tube is the length of 2 meters with the diameter of 50mm used for the suction purpose which sucks the wastes from the ground and lets into the shredder setup. This process takes a less time period and makes time efficient. This tube is not a rigid type and they are flexible to reach all the corners if it requires.

Fig 7. Suction tube

Analysis for gear



Gear Design Specifications

Number of Teeth: 30

Module: 3

Pressure Angle: 20 degrees

Gear Type: External

Outputs

OD Reference:	96.0000	mm
Pitch Diameter:	90.0000	mm
Root Diameter:	82.5000	mm
Addendum:	3.0000	mm
Dedendum:	3.7500	mm
Working Depth:	6.0000	mm
Whole Depth:	6.7500	mm
Circular Pitch:	9.4248	mm
Tooth Thickness:	4.7124	mm
Base Circle:	84.5723	mm

Calculation

PITCH DIAMTER(PD):

PD = T/Module = 30/3 = 10mm

DIAMTERAL PITCH(DP):

Since you provided the module instead of diametral pitch, we'll first convert the module to diametral pitch:

DP = 25.4/Module = 25.4/3 =8.47 teeth/inch

CIRCULAR PITCH(CP):

CP = 3.14*D/T =3.14*10/30 = 3.14mm

ADDENDUM(A) AND DEDENDUM(Dd):

A = 1/DP = 1/8.47 = 0.118 Inch = 2.99mm
Dd = 1.157/DP = 1.157/8.47 = 0.136 Inches = 3.4544mm

Conclusion

In conclusion, careful evaluation of a number of elements, including design, functionality, safety, is necessary for the development of an efficient machine for industries. We have worked hard to develop a solution that tackles these issues and satisfies the requirements of all places from household to industries through extensive study, prototyping, testing, and refinement. Efficiency and accuracy are given first priority in our design, which ensures effective design. We hope to improve our machine's accessibility and usage while protecting the safety of users and the surrounding ecosystems by including features that are easy to use and safe. Our commitment to responsible stewardship of resources is further demonstrated by our adherence to best practices in industrial application and regulatory compliance. When compared to manual type of cutting and peeling, time taken for egg shell removing and vegetable cutting for this machine is reduced. Through collaboration with relevant parties and the utilization of technological and scientific developments, we can endeavor to realize a time when egg shell management is not only efficient but also ecologically sustainable.

Reference

[1] Mirjam Visser 1,* , Ab Stevels 2 and Jan Schoormans
https://doi.org/10.3390/su132312988

[2]Pedraza Cristian et.al 2018 Analysis by Means of the Finite Element Method of the Blades of a PET Shredder Machine with Variation of Material and Geometry Contemporary Engineering Sciences 11 4113-4120
https://iopscience.iop.org/article/10.1088/1757-899X/993/1/012013

[3] Sakthivel M. et.al 2017 Design And Analysis Of Twin Shaft Shreader Using Pro-E And Hyperworks Software International Journal of Advanced Research in Basic Engineering Sciences and Technology **3** 836-855
https://iopscience.iop.org/article/10.1088/1757-899X/993/1/012013

[4] Tran Thanh Tung
Faculty of Engineering Mechanics and Automation, University of Engineering and Technology, Vietnam National
University Hanoi, 144 Xuan Thuy, Cau Giay District, Hanoi, VietNam
https://www.researchgate.net/publication/355294045_DESIGN_AND_ANALYSIS_OF_A_PAPER_SHREDDER_MACHINE

[5] A Critical Review on Design and Development of Shredder Machine for Waste Recycling Prof. M. S. Motghare1 , Tejendra Mule2 , Mayur Chafle3 , Shubham Tandulkar4 , Shubham Damahe5 , Sumed Tembhurkar6
http://www.ijsred.com/

[6] Sudhakara Reddy, Thunga Raju. (2018) "Design and Development of mini plastic shredder machine". IOP Conf. Series: Materials Science and Engineering 455 (2018) 012119, IOP Publishing. doi:10.1088/1757- 899X/455/1/012119. 1-6
http://www.ijsred.com/

[7] Tung Tran Vietnam National University, Hanoi, https://www.researchgate.net/publication/355294045_DESIGN_AND_ANALYSIS_OF_A_PAPER_SHREDDER_MACHINE