A PROJECT REPORT

ON

"DESIGN AND FABRICATION OF FOOD COMPOSTER"

Submitted to

UNIVERSITY OF MUMBAI

In Partial Fulfilment of the Requirement for the Award of

BACHELOR'S DEGREE IN
MECHANICAL ENGINEERING

BY

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UNDER THE GUIDANCE OF
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Anjuman-I-Islam's Kalsekar Technical Campus
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Plot No. 2 3, Sector - 16, Near Thana Naka,
Khandagaon, New Panvel - 410206

2018-2019

AFFILIATED TO

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CERTIFICATE

This is certify that the project entitled

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is a record of bonafide work carried out by them, in the partial fulfilment of the requirement for the award of Degree of Bachelor of Engineering (Mechanical Engineering) at ***Anjuman-I-Islam's Kalsekar Technical Campus, Navi Mumbai*** under the University of MUMBAI. This work is done during year 2018-2019, under our guidance.

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Project I Approval for Bachelor of Engineering

This project entitled ***"DESIGN AND FABRICATION OF FOOD COMPOSTER¨*** by ***GROUP NO. .....*** is approved for the degree of ***Bachelor of Engineering in Department of Mechanical Engineering.***

Examiners

1. .....
2. .....

Supervisors

1. .....
2. .....

Chairman

.....

Declaration

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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ABSTRACT

Organic waste and especially Food waste is a worldwide problem, it cost to be disposed and nothing is gained from it, on the contrary, it causes the emission of harmful gases such as methane. In India 40 percent of the garbage is a food waste. One of the major problems that faces Saudi Arabia nowadays that there are no serious moves towards solving the food waste issue. In 2030 vision, one of their targets is to focus on the pollution and the causes of it.

Composting has proven to be a valid solution to this problem but not entirely explored. The objectives of this project are to design a composting machine with certain parameters for the design, Process time, Easy to use, odorless and power saving. The designed food waste decomposition system is designed for rapid composting performance. It can be used by households, restaurants, hotels, schools, apartment buildings, communities, offices and cafeterias depending on the capacity of the machine. The system employs high temperature, microorganisms to decompose food waste and organic matter. The machine was built with an DC geared motor with rated power input of 60W in addition to temperature sensor and humidity sensor and printed circuit board to control the process.

Keywords: Organic, Composting, decomposition

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Chapter 1

Introduction

1.1 Purpose

The designed machine is a semi automatic and highly compact composting machine, which uses special microorganisms to break down and decompose all kinds of organic waste into compost with a volume reduction of 80-90 percent. The entire process is natural and biological. The microorganisms we use thrives in high temperature and are effective even in high acidic or salty conditions. The machine has a U-shaped composting tank, with a humidity sensor, heater and mixing blades When organic waste is added to it, moisture is sensed by the humidity sensor, due to which the heater turns ON and the composting tank gets heated. Due to this, the water content in the organic waste is evaporated and it goes out to the atmosphere as water vapor through the exhaust system. As any organic waste contains 70-80 percent water content, we achieve 70-80 percent volume reduction at this stage itself.

At the same time, our special microorganisms then decompose the organic waste into compost, and this happens within 24 hours. That is how we achieve 80-90 percent volume reduction. The process is noiseless as there is no crushing or grinding involved. The blades are just for evenly mixing the waste.

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1.2 Project Scope

Helps soils hold or sequester carbon dioxide. In addition to emission reductions, compost replenishes and revitalizes exhausted farm soils by replacing trace minerals and organic material, reduces soil erosion and helps prevent storm water runoff. Recycling is an effective way to reduce greenhouse gases. The decomposition of organics in landfills produces methane, a greenhouse gas that, according to the EPA, is 70 times more effective at trapping radiant heat than carbon dioxide. Composting our organics protects air, water and soil quality.[2]

1.3 Project Goals and Objectives

1.3.1 Goals and Objectives

The project objectives are:

1. Study the different factors within the composting process
2. Learn how to make the machine as energy efficient as possible.
3. Increase public awareness on food waste and how to handle it.
4. Learn about sensors and control system.
5. Study the effects of bacteria on the composting process.

1.4 Applications

This machine provides food waste solutions for a variety of commercial uses, from restaurants to large-scale institutions.
Reduce garbage volume and disposal costs.
Houses, Hotels, Restaurants, Supermarkets, Municipalities, Canteen I Cafeterias, Shopping Centers, Food Processing Sites.

Chapter 2

Literature Survey

2.1 Paper Title 1

A Literature Review on Composting

2.1.1 Advantages of Paper

a. Composting is a natural process that turns organic material into a dark rich substance, this substance called compost is a wonderful conditioner for soil, during composting microorganisms such as bacteria and fungi break down complex organic.

b. Compounds into simpler substances and produce carbon dioxide, water, minerals and stabilized organic matter (compost).

c. The process produces heat, which can destroy pathogens (disease causing microorganisms) and weed seeds.

2.1.2 Disadvantages of Paper

a. To develop long term markets, the products must be of consistently high quality.

b. Other essential marketing factors include planning, knowledge about end users, following basic marketing principles and overcoming possible regulatory barriers and product stigma.

2.1.3 How to overcome the problems mentioned in Paper

a. Compost characteristics desired by end users vary with intended uses, but most compost users look for the following elements (in order of importance): • Quality (moisture, odor, feel, particle size, stability, nutrient concentration, product consistency, and a lack of weed seeds, phototoxic compounds and other contaminants). • Price (should be competitive with other composts, although high

quality and performance can justify a higher price). • Appearance (uniform texture, relatively dry, earthy color). • Information (product s benefits, nutrient and pH analysis, and application rates and procedures).

2.2 Paper Title 2

Composting of Food and Agriculture Wastes.

2.2.1 Advantages of Paper

a. Environmental point of view, because during this process the biomasses are transformed to material rich in nutritional substances that can improve the structural characteristics of the soil.

b. Hygienic point of view, because during the process the organic matter is disinfected by the inuence of the high temperatures.

c. Energy management point of view, because during the process energy is released through the degradation of large organic molecules.

2.2.2 Disadvantages of Paper

a. Substantial space is required for composting.

b. Excavation of contaminated soils is required and may cause the uncontrolled release of volatile organic compounds (VOC). High levels of fugitive emissions also are observed during windrow composting. If VOC contaminants are present in soils, off-gas control may be required.

c. Composting results in a volumetric increase in material because of theaddition of amendment material.

2.2.3 How to overcome the problems mentioned in Paper

a. Traditional remediation can cost several times more than bioremediation by composting technology, as addition of compost to contaminated soils accelerates plant and microbial degradation of organic contaminants and improves plant growth in toxic soils as well.

b. Using the composting process or adding compost to a biopile-type remediation process may decrease remediation time, and compost bioremediation could be completed in weeks instead of months. The extended time period increases cost, since the site must be monitored and operated for along-term period.

c. Compost has a high microbial diversity with microbial populations much higher than fertile soils and many times higher than in highly disturbed or contaminated soils. Therefore, compost bioremediation takes far less time than land farming.

2.3 Paper Title 3

Evaluation of Kitchen Waste Composting and its Comparison with Compost Prepared from Municipal Solid Waste.

2.3.1 Advantages of Paper

a. The quality of compost becomes better with the use of sewage and animal manure.

b. The time for the completion of composting process including curing period can be reduced from four months to two months by the use of animal manure and sewage

2.3.2 Disadvantages of Paper

a. Waste is being dumped without proper treatment at these sites. This causes critical impacts to ground and underground water system and soil. The remaining 24 percent uncollected waste remains on streets, roads and open spaces.

b. It is widely accepted that uncontrolled dumping either in landfills or in open spaces may cause serious threats to soil and underground water and threaten human health directly or indirectly.

2.3.3 How to overcome the problems mentioned in Paper

a. There should be certain arrangement from the City District Local Government to separate the organic waste (food waste) from the municipal waste during the collection phase.

b. Composting plants can be setup at all the landfill sites. These plants can help reduce the load on the landfill sites and thus reduce their impacts on the environment.

c. An awareness raising campaign regarding the use of compost and its benefits can be initiated so that the amount of waste composted in the backyards increases.

2.4 Paper Title 4

A Review Study on Municipal Organic Waste Composting

2.4.1 Advantages of Paper

a. Composting, as a treatment of organic waste, had been proven to significantly reduce the volume of wastes in the country.

b. In addition, composting can also provide nutrients that are suitable for agriculture and can be used as fertilizer to replace chemical fertilizer.

c. Furthermore,compost can also be used as soil amendments as well as being eco-friendly, hygienic economical and toxic free.

2.4.2 Disadvantages of Paper

a. During the composting of agricultural wastes the addition of animal manure can enhance the degradation process, whilst in the composting of municipal solid waste and kitchen waste it is important to measure the heavy metal content because of its toxicity and different method of composting influenced the nutrient status of compost.

b. Nevertheless, the compost provided must comply with the standard limit to ensure the quality of the compost.

2.4.3 How to overcome the problems mentioned in Paper

a. Segregation of waste should be carried out at initial level.

b. Metal detectors can be incorporated in the machine to detect metals if any.

2.5 Paper Title 5

A Literature Review on Municipal Solid Waste.

2.5.1 Advantages of Paper

a. Composting of municipal solid waste has potential as a beneficial recycling tool. Its safe use in agriculture, however, depends on the production of good quality compost, specifically, compost that is mature and sufficiently low in metals and salt content.

b. The compost has a lot of benefits like:, reduce surface and water leachates, minimise landfill space, methane emissions, air pollution from burning waste, transportation costs etc. Compost can be used as organic fertilizer in agriculture field in place of chemical fertilizer.

2.5.2 Disadvantages of Paper

a. As the population increases rapidly in India which causes high rate generation of Municipal Solid Waste. Municipal Solid Waste contains both domestic and commercial waste. The large amount of waste creates lots of problems in day to day life of living creatures and also in Environment.

b. It has been realized throughout the world that the use of chemical fertilizers and other chemicals is harmful to soil productivity and also a cause of water and air pollution.

2.5.3 How to overcome the problems mentioned in Paper

a. Composting is one of the methods to manage the waste at source. Since a place like India has higher composition of organic wastes, composting has become a convenient and effective method to treat the municipal solid waste.

b. On the other hand, compost causes no harm to environment and provides suitable nutrients to soil. Adding additives can also help to speed up the biodegradation of waste sand enhance the quality of the finished compost as well.

c. In addition, composting can also provide nutrients that are suitable for agriculture and can be used as fertilizer to replace chemical fertilizer. Furthermore, compost can also be used as soil amendments as well as being eco-friendly, hygienic economical and toxic free.

Chapter 3

Project Planning

3.1 Members and Capabilities

Table 3.1: Table of Capabilities

SR. No	Name of Member	Capabilities
1	DANISH KHAN	Ansys, Inventor
2	DANISH BHATKAR	Data Analyst
3	ZIYAD DINWARE	AutoCad, Inventor
4	SAJJAD DALVI	Machine Shop

3.2 Roles and Responsibilities

Table 3.2: Table of Responsibilities

SR. No	Name of Member	Role	Responsibilities
1	DANISH KHAN	Team Leader	Fabrication
2	DANISH BHATKAR	Project Documentation	Research papers, Project Report
3	ZIYAD DINWARE	Planning and Design	Project Design
4	SAJJAD DALVI	Accounts	Procurement

3.3 Assumptions and Constraints

As we know that food waste is a global issue that need to be deal with. As government and communities try to manage and solve food waste, composting machines is one of the best option in this case, which leads to a reduction in the amount of food waste that happens at home, school, restaurants and any food service sector. Composting machine is the best way to avoid creating pollution, while at the same time creating a high-quality soil amendment which is inexpensive and effective. Economically, compost machine can be useful in many ways such as, eliminating the cost of dumping the organic waste, also getting benefit of the soil amendment by resell it in markets. Composting is considered as eco-friendly because it is giving back to nature and it reduces the amount of methane emissions

in landfill that caused by dumping food waste. There are a lot of development in composting machines in the whole world that fits a wide variety of applications with many different features.

3.4 Project Management Approach

We have divided our project in 4 main phases which includes number of multiple tasks.

Phase One: Composting development.

Tasks: composting processes and systems, researching composting development.

Phase Two: Machine Design and requirements.

Tasks: Finding an optimum machine design, parts, and workshop.

Phase Three : Machine construction

Tasks: Building the machine, configuring the control system.

Phase Four: Testing and analysis.

Tasks: Operating the machine, checking the performance, results.

3.5 Project Budget

Name of the part	Specifications	Quantity	Price
1. DC geared motors	60W	2	Rs.1900
2. Footstep Bearings	ID=20mm	2	Rs.700
3. Heating coils	1000W	2	Rs.90
4. Coupling		2	Rs. 160
5. MS sheet	22gauge	1	Rs.1100
6. Shaft	MS Rod	1	Rs.650
7. Power Supply	12v/5A	2	Rs.735
8. Digital Thermometer		1	Rs.560
9. Control unit	MCB	1	Rs.450
10. Bolts,Seals,Cutter			Rs.800
11. Fabrication Expenses			Rs.3000

Table 3.3: Bill of Materials

3.6 Project Timeline

Week	Main task	Description
1-2	Study composting and its system	Study the various types of composting system and processes.
3	Machine design	Choosing and modelling an optimum design.
4	Market survey	Searching for parts with minimum cost and optimum quality.
5	First draft presentation and report	Gathering information to make first draft of literature review and the first presentation.
6-8	Purchase and collecting part	Ordering parts from local stores.
10	Locating a workshop	Searching for a workshop for welding and mounting of other components.
11-12	Building the machine	Building the machine and configuring the control system.
13	Testing the machine and data analysis	Testing the performance of machine and collecting the data.
14	Data analysis	Collecting data.
14	Finalizing the final paper	Finalizing the thesis.

Table 3.4: Project Timeline

Chapter 4

Machine Design and Assembly

4.1 Composting Drum/Mixing chamber

Our desired composting drum has U shape. Therefore, in order to measure it we will divide the shape into rectangular and sphere and we will measure the total volume by adding their volumes together.

The composting drum's volume = Volume of rectangle + Volume of hemisphere

Therefore, Volume = **84.693kg**

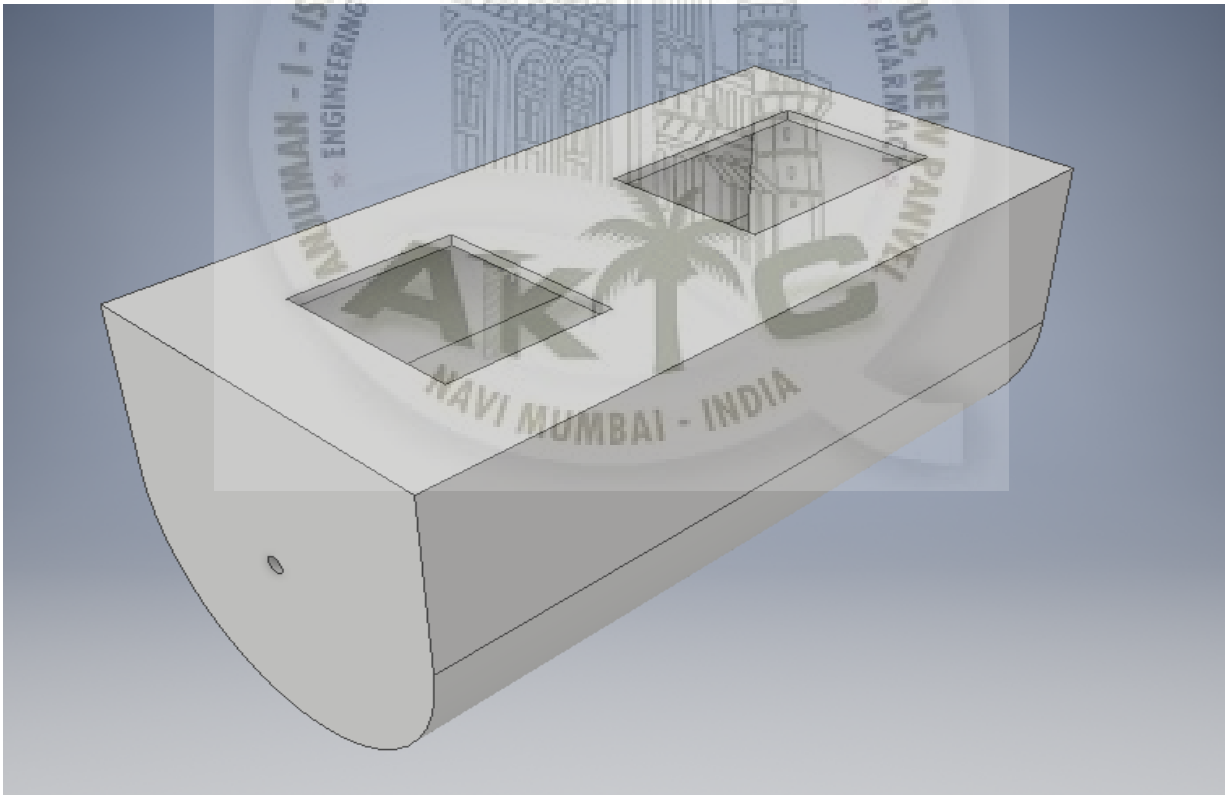

Figure 4.1: Composting drum

4.2 Mixing Blades

The mixing blades are attached to the auxiliary shaft which is fixed to the main shaft of 20mm in diameter with a length of . The material used for the main shaft and the blades is mild steel rod. The shaft is 965mm in length.

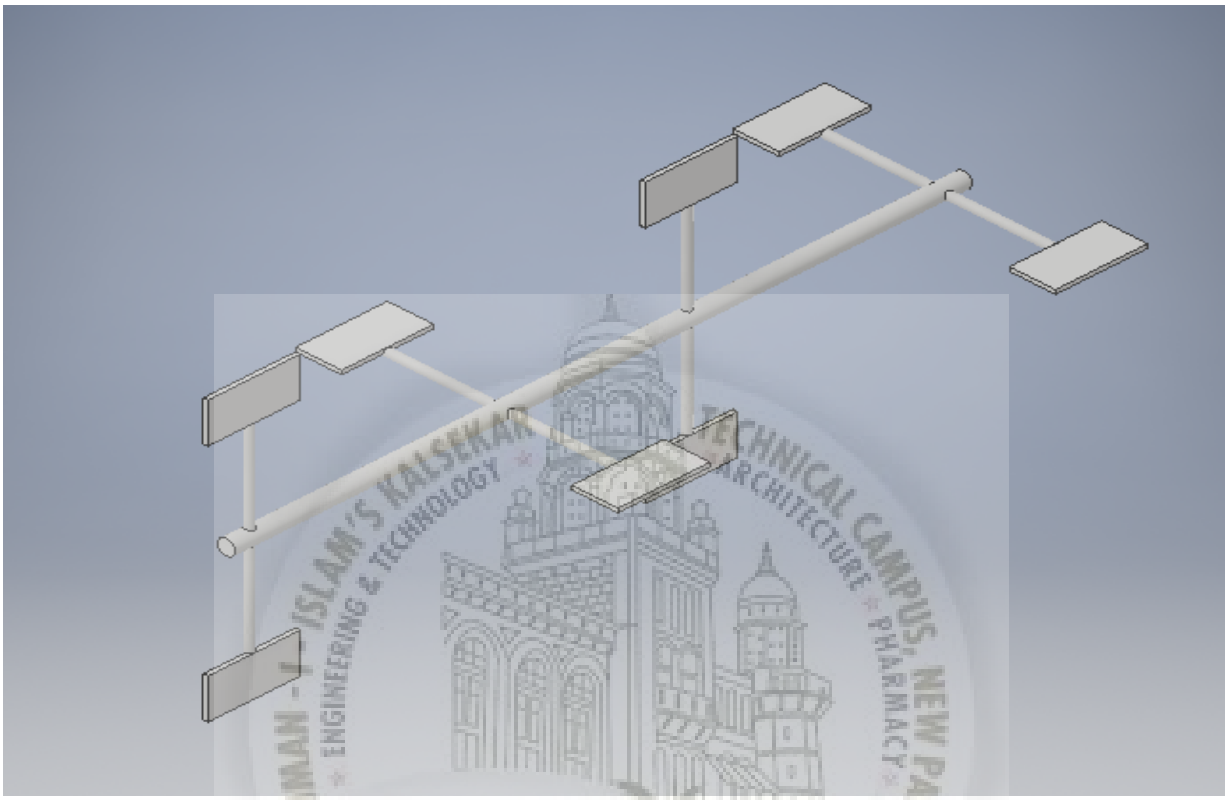

Figure 4.2: Mixing blades

4.3 Digital thermometer

The digital thermometer is used to sense the temperature inside the mixing chamber and display it for reference. It is an important control tool and is fixed in the control switch board.

Figure 4.3: Digital thermometer

4.4 Coupling and Motor alignment

The Coupling having hole equal to motor shaft at one end and next hole equal to the diameter of mixing blades shaft at another end is fixed with the help of bolts. It serves the purpose of transferring the rotation of motor shaft to get the desired rotation of mixing blades.

Figure 4.4: Coupling and motor alignment

4.5 Footstep Bearing

The bearing used in our project is footstep bearing which serves the purpose very efficiently. The ID of the bearing is 20mm.

Figure 4.5: Footstep bearing

4.6 Shredder

The Shredder used is the different from the standard shredders available in the market. The body of the shredder is made of wood and the blades used are MS plate with a shaft of 10mm in diameter. The material used for shaft is MS rod. The shredder basically serves the purpose of chopping the waste particles in size useful for proper composting.

Figure 4.6: Shredder

4.7 Coupling

The coupling was manufactured in the machine shop itself as the standard size wasn't available in the market. The operations were performed on the lathe machine followed by radial drilling and the surface finishing.

Figure 4.7: Coupling

4.8 Motor

The motor used in the machine is DC geared motor with rated power of 60W. The motor gives a torque of 55 with a speed of 31rpm. The same motor is used to rotate the shredder.

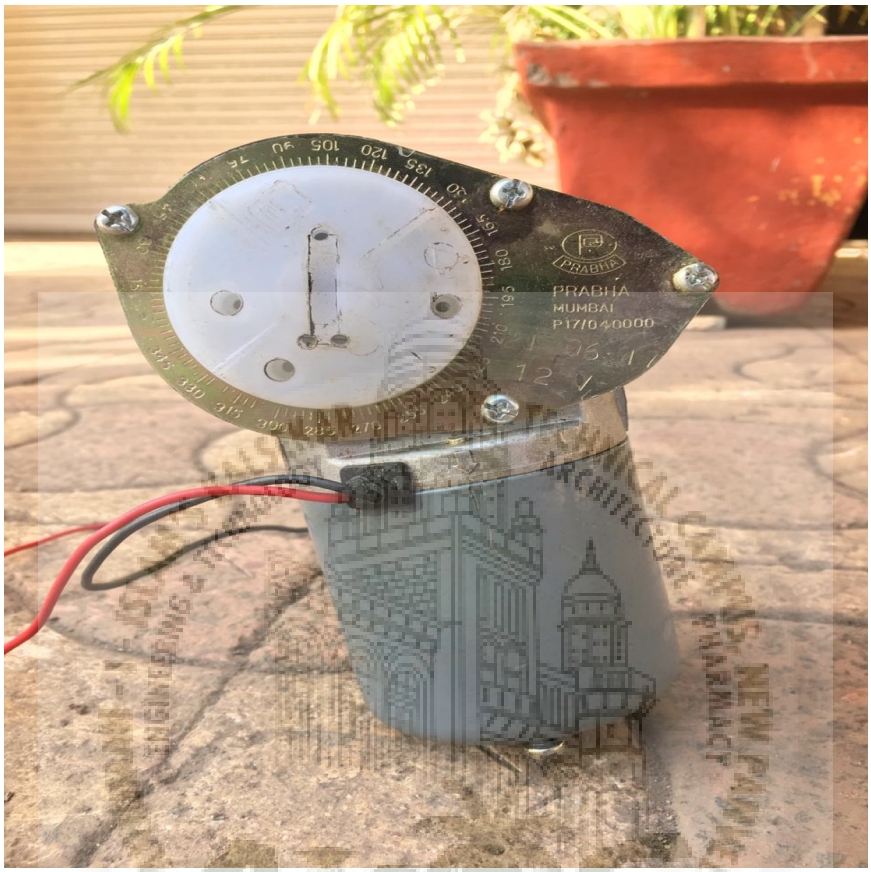

Figure 4.8: DC geared motor

Figure 4.9: Mixing chamber

Figure 4.9 shows the mixing chamber after complete fabrication along with the bearing mounted on the shaft of the blades. The frame acts as a support for the mixing chamber as well as the entire machine.

Figure 4.10 shows the mounting of motor to the shaft of the mixing blades with the help of coupling. A stand is also fabricated in order to provide resting support for the motor and bearing.

Figure 4.10: Motor Fixing

Figure 4.11 shows the mounting of shredder unit on the machine. It is mounted on the metal frame which is welded on the left top surface of the machine.

Figure 4.11: Shredder Mounting

Figure 4.12 shows the second bearing mounted at the end of the shaft i.e. the other side of the machine.

Figure 4.12: Bearing no.2

Figure 4.13 **4.14** shows the arrangement of both the motors to provide rotation for shredder as well as mixing blades. A 12V/5A eliminator is used to supply power for both the motors.

Figure 4.13: Motor arrangement LHSV

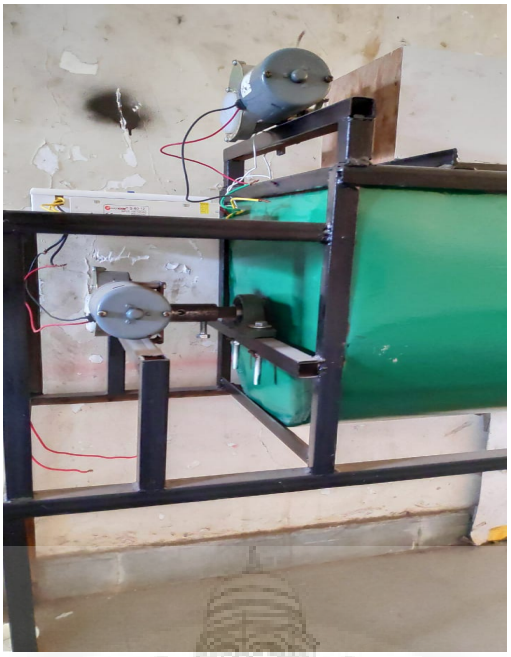

Figure 4.14: Motor arrangement FV

Figure 4.15 displays the control unit of the machine. It consists of MCB, Switches, Digital thermometer and an eliminator. MCB is used to switch ON/OFF the machine. Three switches are used to turn on both the motors and heater. A digital thermometer is fixed onto the switch board to display the inside temperature of the mixing chamber. It works on the button cells. As the motor requires 12V/5A to operate an eliminator of same specification is used to which the motor terminals are connected. Further, the terminals of eliminator are connected to the switch board which steps down the received voltage from the main supply to the desired voltage of the motors.

Figure 4.15: Control unit

Figure 4.16 shows the final assembly of the machine with all the components mounted in order to function the machine properly and get the desired output.

Figure 4.16: Final assembly

Chapter 5

System Testing and Analysis

5.1 Experiment 1

As we started experimenting the machine, we searched for what parameters to be focusing on because this process has lots of parameters to be considered. In order to test and measure for some of the parameters special equipments and knowledge were needed which considered hard to do because it will cost time and money,we decided to stick to certain parameters to test for which were temperature and humidity as they are considered essential to composting process.

It is worth mentioning that testing didn't start at the desired time due to certain problems which limited the number of experiments.

Two experiments were conducted with the sample weight of 1.5kg of food waste, the first testing sample was mixed food not following the 30:1 C:N ratio and large pieces of food waste, the second experiment sample was an equal mixing volume of green plant materials with naturally dry plant to balance the ratio of carbon to nitrogen and the sample was cut into small pieces.

Time/Hour	Temperature/celsius	Humidity
0	23	76
2	26	65
4	29	62
8	31	57
13	33	54
18	34	51
24	36	49
29	39	45
34	42	39
39	44	37
44	46	26
48	50	20
50	52	16

Table 5.1: Experiment 1

Time/Hour	Temperature/celsius	Humidity
0	22	80
1	24	78
3	27	73
5	29	69
8	33	59
11	37	51
14	39	49
16	39	47
20	42	43
24	45	39
25	50	29
33	53	21
38	55	15

Table 5.2: Experiment 2

Table 5.1 shows the variation of temperature and humidity with respect to time, the experiment went for almost 50 hours without adding any additional waste, the food waste was about 1.5kg of mixed food waste that has not followed a 30:1 C:N ratio which has could be observed affected the temperature gain and slowed down the process even more with noticing that the heater isn't supplying enough heat. The food waste pieces were of different sizes which could also affect the process time.

5.2 Experiment 2

This experiment was conducted under more cautious condition, the C:N ratio of food waste was more balanced between green and brown food, also every piece of food was cut into small pieces. The total food mass was also 1.5kg.
Table 5.2 shows the variation of temperature and humidity with respect to time for the second which was conducted under more careful conditions for the organic waste, it shows a significant improvement in the process time which went from more than 2 days down to a little above a day and a half.

Chapter 6

Overall Results, Analysis and Discussion

Upon testing the machine upon different conditions such as the size of the sample, its temperature, different types of foods - green and brown - and other conditions and observations we came to notice some factors that affects the decomposition process and its efficiency.

The organic waste will compost best if the pieces were small in the range of 5cm in size. Soft tissue wastes such as orange don't need to be very small because it will decompose fast. Any woody materials should be grinded into small pieces before its put in the machine.

To have the composting process as effective as possible, the input waste should have approximate carbon to nitrogen ratio of 30:1. Its not measured easily but experts say mixing equal volume of green plant materials with equal volume of naturally dry plant materials will equate to the same ratio of 30:1. If the C:N ratio is more than 30:1, heat production drops and decomposition slows. Table provides estimates C:N ratio for selected composting materials.

Materials	C:N Ratio
Corn Stalk	50-100:1
Fruit waste	35:1
Grass clippings	12-25:1
Hay, Green	25:1
Leaves, ash	21-28:1
Leaves, pine	60-100:1
Leaves, other	30-80:1
Manure, horse and cow	20-25:1
Paper	170-200:1
Sawdust	200-500:1
Seaweed	19:1
Vegetable waste	12-25:1

Table 6.1: C:N Ratio

The process will work best if the moisture level of the input waste is about 50 percent. It is not easily measured. Too much moisture in the waste will make a soggy pile and decomposition process will slow down and it will smell. If the input is too dry then the decomposition process will be very slow or might not even occur at all.

The turning blades are playing a big role in the composting process because it prevents the waste from overheating at some point inside the tank and it will be aerated also.

After the process is completed all the weeds and weed seeds are killed, even insects, that is done by the help of rising temperature.

Chapter 7

Project Analysis

7.1 Lifelong Learning

This project helped us in several ways, it gave us good experiences in teamwork and gained the ability to work as a team to accomplish something. As engineers our work environment need teamwork skills to do projects and work at field, so we gained the needed skills for the work place. We were also able to improve the communication skills by sharing the ideas and thoughts which will play good role in our future jobs. To build the project we needed several skills, but as a team we lacked some of the skills, so we had tough time to gain these skills during the semester. One of the skill was time management which was very needed to finish our project in desired time.

By dividing tasks between the team members, each one of us gained the ability to take the responsibility to complete the task in proper time. At first we faced some delays in some tasks but eventually we could avoid it at the end of the project. Doing marketing survey helped us to increase the knowledge in the costs of common mechanical parts, welding, cutting and control systems parts. We gained the most skills by doing research on the internet, reading other people experiences in doing projects and also by asking our graduated friends about their experiences in their senior projects.

7.2 Impact of Engineering Solutions

As aforementioned, the project is meant to be eco-friendly and it has significant benefits for the environment. By using the composting machine we can reduce the amount of organic waste that is eventually disposed in the landfills. Also by returning the nutrients back to the soil that will make the life cycle of the waste continuous. By decreasing the amount of food waste in the landfills which will also decrease the amount of greenhouse gases that cause the pollution. Spreading composting machine across the country will make the country eco-friendly and green.

The project also has impact on the society, it will educate people about the food waste issue and they will cooperate with the government to solve this issue. Also they may have their own composting machines in their houses which meet the project future goal. It also have impact on the economy, the government will be able to decrease the amount of workers, disposal cost and landfills. That will lead to decrease the expenses that the government pays for the food waste.

7.3 Contemporary Issues Addressed

Food waste is one of the most prominent waste stream across the whole world and in India 40 percent of garbage waste is food waste. One of the major problems that faces India nowadays that there are no serious moves towards solving the food waste issue. In 2030 vision, one of their targets is to focus on the pollution and the causes of it. Since food waste is one of the pollution causes, it has direct relation to health and needs to be solved. Also, by composting the food waste the government will be able to save more money instead of spending it in the disposal. Moreover, the government could sell or use the compost. Therefore, this project will help the country to manage and sustain the excess food waste that related to 2030 goals.

Chapter 8

Conclusion and Future Scope

8.1 Conclusion

At the start of the project we set our objectives to find a solution for waste disposal problem, those objectives were that the solution should be eco-friendly and it should help decrease the garbage volume and the disposal cost, it also should be sustainable and socially responsible. Those objectives were all met choosing composting to deal with the food waste disposal problem. When trying to design the composting machine, objectives were that machine should reduce the processing time as much as possible. Being easy to was also one of the design objectives which was met as this machine only require a push of button to function properly. Power saving was also an objective of the design that it has not been properly since blades are running for long time which in a long run consumes lot of power. Also we installed a digital thermometer on the outer vessel which was used to display the inside temperature of the vessel.

8.2 Future Scope

- Using plastic on outer vessel instead of metal to decrease the weight of the machine.
- Enabling the mechanism of gears and motors to withstand larger amount of waste.
- Using wheels at the bottom of the machine to make the machine easier to move.
- Adding a safety feature as a switch door sensor that stops the blades when machine door is open to prevent any accident.
- Implementing the use of solar panels to reduce the power consumption to some extent.
- Using Arduino UNO for complete automation of the machine.

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