

DESIGN OF ORGANIC COMPOST MACHINE

Mansi Pare¹, Mohd. Aman²

¹Student, Dept. of Mechanical Engineering, IES, IPS Academy, Indore, India

²Student, Dept. of Mechanical Engineering, IES, IPS Academy, Indore, India

Abstract - The designed machine is a fully automatic and highly compact composting machine, which uses special microorganisms to break down and decompose all kinds of organic waste into compost within 24 hrs with a volume reduction of 85-90%. The entire process is natural and biological. The microorganisms we use thrive 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, mixing blades and an exhaust system. When organic waste is added to it, moisture is sensed by the humidity sensor, heater, mixing blades and an exhaust system.

When the organic waste is added to it moisture is sensed by humidity sensor, due to which the heater turns on and the composting tank gets heated due to this the water contain 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% water content, we achieve 70-80% 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 85-90% volume reduction. The process is noiseless as there is no crushing or grinding involved. The blades are just for evenly mixing the waste

Key Words: aerobic composting, decomposition,

1. INTRODUCTION

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 effect of bacteria on the composting process.

1.1 Project background and Process

Composting is known as a natural process, it occurs by using microorganism under specific condition, which leads to the decomposition of organic waste. As we know, food waste one of the biggest global issues that faces the world nowadays, it could be at home, school, restaurants and food services

sector. One of the recent statistics said that 1.4 billion tons of food is wasted every year [1]. We all know that the waste of food unavoidable, so the best way to makes this food waste useful is by composting the organic waste and returning the nutrients back into the soil to make the cycle of life to continuo which will help protecting of environment.

There are two common types of composting process that can be used, one of the types called "aerobic composting" that uses air in composting. In this process the bacteria is growing by high nitrogen waste, which also will make the bacteria create high temperature that makes organic waste breaks down quickly. We can say that aerobic composting is usually happens in nature. The microbes responsible for composting are naturally occurring and live in the moisture surrounding organic matter. Oxygen from the air diffused in to the moisture and is taken up by the microbes. As aerobic digestion takes place due by-products are heat, water and carbon dioxide (CO₂). While CO₂ can be classified as a greenhouse gas it's evolution from the composting process is not counted in emissions. Additionally, CO₂ is only 1/20th as harmful to the environment as methane (the main by-product of anaerobic degradation) the heat produced in aerobic composting is sufficient to kill harmful bacteria and pathogens as these organisms are not adapted to these environmental conditions. It also helps support the growth of beneficial bacteria species including psychrophilic, mesophilic, and thermophilic bacteria which thrives at the higher temperature levels (3). This composting process takes 8-10 days

The second type called "Anaerobic" and this composting process use no oxygen. The composting occurs by making the organic waste piled up and starts breaking down by its self. This process is very slowly and takes many years in order to compost the organic waste .The process is characterized by very strong odors and only a small amount of heat is generated meaning decomposition takes much longer and does not reach sufficient temperatures to safely kill plant pathogens, weed and seeds. To overcome these limitations external (artificial) heat is normally added.

As the material is broken down by anaerobic digestion, it creates a sludge-like material that is even more difficult to break down. This material digestion, typically requires aerobic composting to complete the stabilization process.

It can also assist in enhancing the disease resistance of some plants, like tomatoes and vegetables. This can reduce the amount of crops you lose to disease, there are several types of bacteria that are used in decomposition, in this project we

are using special bacteria called "Acidulo". This bacteria has the very high temperature (above 100C), also can live in a very salty and acidic environment. So these special bacteria can live in a tough environment without losing efficiency. In order to speed up due composting process we need a specific high temperature that will cause the bacteria to break down the organic waste quickly. By using "Acidulo" our large is to minimize the duration of composting to make it happens in 24 hours

Compost is a valuable soil amendment as the compost feeds soil. The use of the compost is an effective way to improve plant growth compost can be used for bioremediation of soil and pollution prevention, reduce erosion and nutrient runoff, and alleviate soil compaction. Composting also helps the soil retain much needed moisture, and research has also shown that composting which often leads to wasted expenses.

1.2 The Need

Food waste is one of the most prominent waste streams across the whole world and in India 35 percent of garbage is a food waste. One of the major problems that face India nowadays that there are no serious moves in solving the food 42 waste. In 2030 vision, one of their targets is to focus on the pollution and the causes of it. Since food waste is one of die pollution cause, it has a direct relation to the health and it need 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 the compost or use it .Therefore, This project will help the country to manage and sustain the excess food waste that related to 2030 goals, which will show the world that Saudi Arabia is a leading country in recycling.

2 Literature Survey

2.1 Previous Work

In this section we tried to look for different composting methods and machines in order to find their capability and how they work, these subsections below are examples of different composting process that we will discuss in details in order to be able to compare them to our designed machine.

WEMI-4000:

Ohio University became the university with the largest in-vessel compost facility in the United States with The Wright Environmental Management, Inc. WEMI-4000 that was installed in 2009. A 2 ton in-vessel composting system, The tunnel inside the system is controlled for air supply and temperature, a supply and exhaust fan and an air circulation shows that Composting material moves through a set of spinners that act to invert, homogenize, agitate and stack the

material into the next zone. water will be added to the mix during material cross-mixing if needed to raise moisture levels to the desired levels Material remains in the second tone for an additional r of days equivalent to the retention time in zone (7 days in Zone 1 and 7 days in Zone 2 equals 14 retention days) while significant stabilization happens through control of air supply. Water and temperature the best temperature range for composting organic waste in this system is 50 degrees Celsius to 65 degrees Celsius. Any moisture that drains out of the composting material flows into the pl that run along the base of the tunnel and from the plenums to sump boxes through pipes located at the sides of the tunnel. Leach ate is pumped back on to the composting material from the sump box through pipe locate at sum box.

Ohio University's In-Vessel Composter

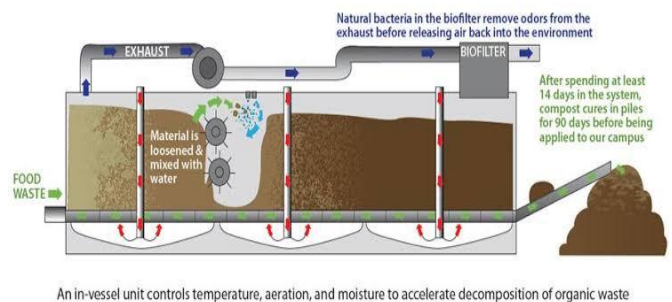


Fig-1.

When the compost is finally removed from the system, the compost need for at least 90 days. The windrows are turned regularly to offer a more homogenous mix to the compost. The resulting nutrient-rich soil is used on-campus intramural athletic fields, gardens used by Plant Biology students, Eco house community garden, etc.

The Earth Flow

The university has invested in a fully automated composting system called the Earth Flow. This composting machine is located at the foothills campus. Finished compost is used in landscaping project on campus

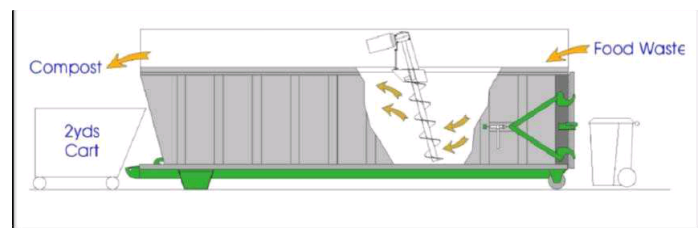


Fig-2.

The Earth Flow process 11 The Earth Flow Capacity is up to 900 Kg waste per day. Fig-2. Shows the Waste is loaded into

one end of the vessel by placing the collection container on an automated tipper. Every time food waste is added, bulking material is added in a 1 ratio. Straw, wood chips and horse manure from the Foothills campus are the primary bulking materials. The inclined auger mixes and advances the compost down the vessel with each pass. The control panel allows the operator to select the number of times per day that the compost is mixed as well as automatically adds moisture to the compost. Material composts in 1-21 days inside the machine. The auger discharges the finished compost through an end door of the vessel. The compost is to cure for at least 3-4 weeks before being used in landscaping projects on campus as a soil fertilizer.

Ridan Composter : The Ridan food composter uses natural ingredients and processes to create a warm environment in which food waste (nitrogen) and wood (carbon) can mix with air and water. Unlike other composters, all this happens without the need for electricity, making your Ridan cheap and easy to use Fig-3. shows that heat is created when micro-organisms, (including bacteria and fungi) break down the organic matter, bio food waste and wood. The heat attracts even more hyper active microbes. Which make the composting process quick and efficient. This creates the perfect composting condition. The food waste needs to stay inside the composter for a minimum of two weeks before it can be removed from the composter. Depending upon what sort of food is being composted it may be ready to spread straight onto the garden. However, it is usually best to mature the compost for 2-3 months in a maturation Bo

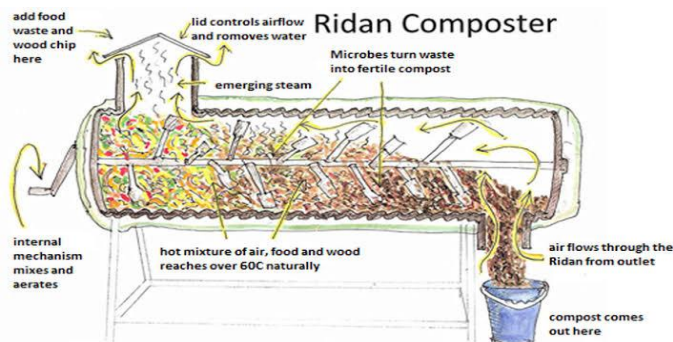


Fig-3

2.2 Comparative Study

We have identify many factors that should be looked at when comparing composting systems and machines but we will focus on what makes our designed project considered superior to the other two projects that we have discussed in section. One of the most important parameters in the composting process is the process time it we took a closer look we can see that the (Wright Environmental Management, Inc. WEMI-4UUU) system that was installed in Ohio university can process organic waste in no less than 14 days, after that the compost shall cure for at least 90 days before it can be used as soil fertilizer 151, while the Earth

Flow composting system that is being used in Colorado university can compost the organic waste in 14 to 21 days after that the compost needs to cure for about 3 to 4 weeks before using 161. further look will show that t Ridan composter needs to compost the food waste for a minimum of two weeks before being removed, after that the compost needs mature in a maturation Box for 2-3 months17.If we took a look into our designed project we can see that the process shall not take more than 24 hours to be completed which is a huge milestone compared to the other projects, also the compost can be used immediately which is also wonderful compared waiting compared up W 3 months

When discussing compost an important matter shall be taking into considerations which is odors, if we looked closely to (Wright Environmental Management, Inc WEMI-4000) system we can sue that it filters the exhausted air so that it wouldn't smell bad, but it does not address the issue with odors coming from the compost itself 51. The Earth Flow composting system does not filter the exhausted air or the compost itself so the area next to the machine and the compost will be filled with odors [6]. The Ridan composter as well doesn't filter to the issue of odors to the compost17, When looking at our designed project we find that the exhausted air get filtered so that no odors will be on the site also the bacteria we use is able to suppress odors from the compost so we consider our design to have a big lead in this matter.

3. Project Analysis

This project helped us in several ways; it gave us good experiences in teamwork and gained the ability to work as team to accomplish something. As engineers our work environment needs teamwork skills to do projects and work at fields, so we gained the needed skills for the workplace. We also were able to improve the communication skills by sharing ideas and thoughts which will play good roles in the future job. To build the project we needed several skills, but most of the team had a lack of management skills, so we had tough time to gain these skills during this semester. One of these skills was time management skills which was very needed in order to finish our project in one desired time

By dividing tasks between group members, each one of the group gained the ability to take responsibilities to do ne his task in the prober time. At first we faced some delays in some tasks but eventually we could avoid it at the end of project. Doing marketing survey helped us to increase our knowledge in the costs of common mechanical parts welding, cutting and control systems parts. We also gained knowledge in the function of circuit printed bored and how to it is required to apply the control system to our machine. We gained the most skills by doing research in by reading about ternet other people experiences in doing projects and also by asking our graduated friends about their experiences in their senior project.

3.1.1 Functions and Functional Requirement

Design Requirements, Constraints and Specifications

As we know that food waste is a global issue that needs to be deal with. As government and communities try to manage and solve food waste, composting machines is one of best upon in this case, while leads to a reduction in die du 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 sol 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.

Our compost machine project is a reverse engineer for one of Oklin Company compost machines. We got interested with this design because it has an obvious advantage in processing time which is only 24 hours and that the final product could be used as soon as it comes out of the machine although it would sometimes need to be mixed to soil to be able to use it as soil amendment. Not only has that but Oklin paid great attention to lie filtration system within the machine. It uses a Nauru filtration system which with the help of microbes inside the machine can make the compost itself and the machine odorless and with a green gas emissions.

For the specifications of our machine. It based on our scale model. We needed an agitation motor with rate power of 36w to generate the require power to move the blades. We got an exhaust fan will a rate power of 9.5W which makes the process aerobic. To generate a high temperature, we got a heater with a rate power of 200W. That will lead the bacteria to start the process for the sensor we have there sensing function on the printed board circuit which are temperature humidity and overload .

Methodology

The block diagram of over designed composting machine Ho w its shows the machine works, it also shows the main component of the machine and the parameter controlling the machine

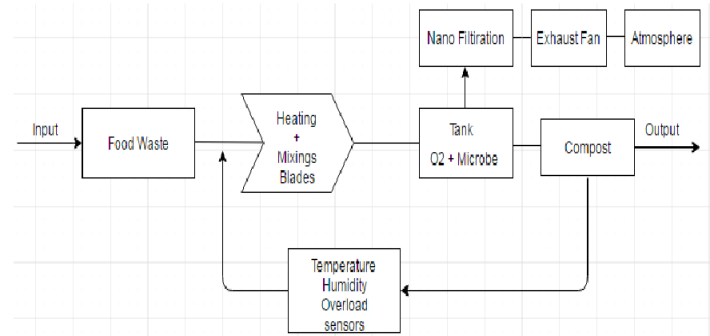


Fig-4.

3.1.2 Product Subsystems and Components

The main component of machine we used .We chose the specifications based on our calculations and the availability of the components in the market:

Agitation motor: Mixes the microbe sawdust and the food with 36w rated power.

Shaft: A long cylindrical rotating rod for the transmission of motive power in a machine.

Blades: Component cutting and mixing waste materials

Cylinder: Providing structure for cutting ,mixing, and grinding.

Motor structure: Base of cylinder, holding motor for mounting shaft over it.



Fig -5: Original Model

3.1.3 Parts Specifications

Motor: Power -0.3hp; Rotation-800 rpm

Shaft: Dia-25.4mm; Length-925mm

Blades: Dia-305mm

Cylinder: Dia-360mm; Length-770mm; Sheet dia-6mm

Motor structure: Side-360mm; Length: 350mm

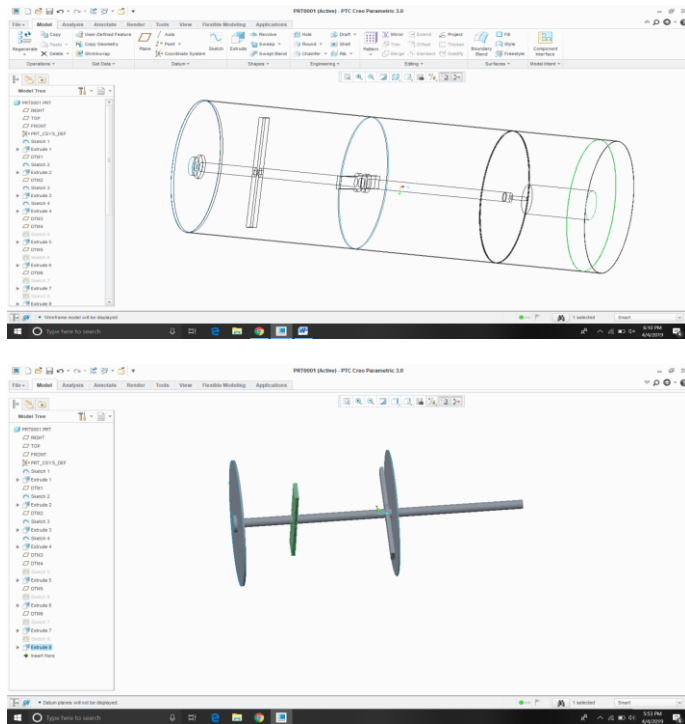


Fig-6: Model On CreoParametric

3. CONCLUSIONS

The outcome of this report is the basic knowledge of working of heavy duty machines and the criteria behind their working in a brief manner.



Fig -7: Organic Compost

REFERENCES

- [1] CEC. Decision No 1600/2002/EC of the European Parliament and of the council of 22 July 2002 laying own the Sixth Community Environment Action Programme. Official Journal of the European Communities L 242, 2002.
- [2] COM. Communication from the Commission to the Council and the European Parliament. Strategy paper for Reducing methane emissions. COM (96)557final.Brussels: Commission of the European Communities.1996.
- [3] UN .Kyoto Protocol to the United Nations framework. Convention on climate change. United Nations. 1998.
- [4] VanderGheynst, J.S., Pettygrove, S., Dooley, T.M. and Arnold, K.A. Estimating electrical conductivity of Compost extracts at different extraction ratios. Compost Science and Utilization 12 (3), 202-207.2004.
- [5] Diener, R.G., Collins, A.R., Martin, J.H. and Bryan, W.B. Composting of source-separated municipal solid waste for agricultural utilization a conceptual approach for closing the loop. Applied Engineering in Agriculture 9 (5),
- [6] Smith, A., Brown, K., Ogilvie, S., Rushton, K. and Bates, J. Waste management options and climate change. Final report to the European Commission, DG Environment. Luxembourg: European communities. (2001)
- [7] Amlinger, F. Götz, B. Dreher, P.Gesztzi, J. and Weissteiner, C. Nitrogen in biowaste and yard waste compost: dynamics of mobilisation and availability a review. European Journal of Soil Biology 39, 107-116.2003.
- [8] Kashmanian, R. M. Rynk, R. Agricultural composting in the United States Compost Science and Utilization, 3, 3
- [9] Yvette B. Guanzon, Robert J. Holmer, Composting of Organic Wastes: A Main Component for Successful Integrated Solid Waste Management in Philippine Cities. (2000).
- [10] Fauziah S.H. and Agamuthu, P. Sustainable Household Organic Waste Management via Vermicomposting
- [11] Romeela Mohee, Ackmez Mudhoo . Analysis of the physical properties of an in-vessel composting matrix (2005).
- [12] James I. Chang, Tin-En. Hsu . Effects of compositions on food waste composting. (2008).