International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 04 | April - 2023 Impact Factor: 8.176 ISSN: 2582-3930

GENERATION OF METHANE GAS AND COMPOST BY EFFECTIVE USE OF DOMESTIC WASTE: A REVIEW

Mr. RUPESH KHORGADE[1], ANKIT KHOBRAGADE[2], NEHA BODHE[3], AKANKSHA DHADEL[4], VAISHANAVI BITNE[5], ANMOL GUPTA[6], ALI QUADRI[7], RISHIKESH KITKE[8]

([1]Assistant Professor, [2-8]Students)

Department of Mechanical Engineering, Nagpur Institute of Technology, Nagpur, Maharashtra (India)

Abstract- *A rotary drum composter made of cast iron was designed and used for composting the vegetable waste. The crushed vegetable waste is filled in the rotary composter. Cow dung is used as a catalyst to increase the rate of composting. The shaft is rotated by the DC motor and the mixing blade is used to mix it properly. It takes 10 to 12 days to get the compost and methane gas output with daily rotating the mixing blade for some duration of time. The compressor is used to vacuumize the small container which is attached to the rotary drum composter to collect the methane gas after the composting process.*

Keywords- *Rotary drum composter, Compost, Methane gas, Vegetable waste*

I. INTRODUCTION

Due to its crucial role in providing protection to human health and environment, waste management has become a global environmental priority and an important part of the urban infrastructure design. This important issue is also highly related to various aspects of human life [1]. With the huge production of waste, the need of land for landfilling is increasing. Landfilling process requires a large area of land and that land can be used for other purposes. The domestic waste generated contains about 70% of organic waste which are the kitchen waste, vegetable waste and fruit waste, etc. [2]. In India, every year, approximately 36.5 million tons of solid waste is generated and about 10–40% of the municipal budget is utilized for solid waste management. Yet, only 5% of solid waste is composted and 95% of waste is disposed off land [3]. Hence, reducing bio-waste at the source, before it is delivered to final disposal, can be done effectively and cheaply by using composting, an ancient technique. Via backyard gardening, compost marketing, and recycling, it gives people the chance to better their economic situation [4].

Pathogens may be eliminated during the composting process because of the heat produced during the thermophilic phase, and sewage sludge's organic parts will be transformed into stable humic substances by mineralization and humification with a large volume reduction [5]. Composting in rotating drums is an effective and promising technique because it enables the reuse of organic waste where it is generated, lowering the amounts of waste that must be transported and the costs associated with landfilling it. The

rotating drum provides agitation, aeration, and mixing of the substrate to produce a pathogen free compost without odor or leachate [6]. Because nitrogen starvation, anaerobic conditions, phytotoxicity of NH3 and some organics interfere with plant growth, compost maturity and stability are crucial [7]. The highest thermophilic activity is thought to be maintained in composting systems at 52 to 60 C. This temperature range suppresses the activity of pathogens during composting and lowers the viability of weed seeds [8].

II. WHAT IS COMPOST AND COMPOSTING ?

Compost is the organic matter that has been decomposed. This process recycles various organic materials or waste products and produces the compost (soil conditioner). Compost is rich in nutrients.

It is used in Gardens, Landscaping, Horticulture, Urban agriculture and organic farming.

Composting is known natural process, it occur by using microorganisms under specific conditions, which leads to the decomposition or organic waste.

III. TYPES OF COMPOSTING

There are two types of composting

1. **Aerobic Composting**

   Aerobic composting decomposes waste with the use of oxygen and bacteria.

2. **Anaerobic Composting**

   Anaerobic composting decomposes waste without the use of oxygen.

IV. INFORMATION OF METHANE GAS

- The chemical formula of methane gas is **CH4**
- Methane gas can be formed due to the breakup of organic matter at high temperature.
- Methane is the most important source of natural gas.

V. WHAT IS ROTARY DRUM COMPOSTER ?

Rotary drum composter is a cylindrical drum that uses different mixtures of organic waste for the composting process.

VI. DIFFERENT METHODS TO GET THE COMPOST

6.1 Vermicomposting

It uses earthworms to convert organic waste into compost.

6.2 Aerated (Turned) windrow composting

It uses organic matter to produce compost by piling it in rows (windrows).

6.3 In-Vessel Composting

It uses a closed vessel to produce compost from the organic waste.

6.4 Onsite Composting

It keeps the organic matter in it's original environmental system for the decomposition process.

VII. ADVANTAGES

- It reduces the landfilling problems.
- It reduces the greenhouse gas emission.

VIII. APPLICATIONS

- In restaurant, hotel and in temple kitchens.

IX. REVIEW OF WORK CARRIED OUT

Tahseen Sayara, Mahmoud Shadouf, Hour Issa, Hanan Obaid, Ruba Hanoun [1] In this study, the utilization of home composting system as an alternative approach for household organic waste management was investigated. A composter made of galvanized steel was used for the composting. It consists of two chambers of about 170 L each, several holes are provided for aerobic conditions and valves for drainage of leachate. They studied, Different parameters, including using waste to bulking agent ratio, co-composting using animal dung and use of charcoal with the feedstock were investigated. According to the observed results concerned with the degradation of the organic waste with operation and monitoring. The reduction volume (85%) in the composted materials was in treatment of 1:0.5 waste to bulking agent, whereas co-composting using animal dung better improved the organic matter degradation, as the highest decrease in the C/N ratio (about 62%) was observed in this treatment. Satisfactory effect of the charcoal was not recorded concerning the degradation process, but helps to reduce odors.

Dayanand Sharma & Kunwar D. Yadav [2] In this research, The flower waste generated from different sources is either mixed with municipal solid waste or thrown into the river in India. Flower waste is rich in organic contents and can be converted into nutrient-enriched compost. They found out the changes in chemical and biological changes during the composting by using rotary drum technique. For composting the flower, waste was mixed with cow dung, sawdust, and wheat bran. Four different trials were performed, in which 0.5 wt% of sawdust and wheat bran was added in each trial. From the series of trials 1–4, the different ratios of flower waste and cow dung were 5:4, 6:3, 7:2 and 8:1, respectively. Finally, the compost produced by all the trials were found to have pH 7.23–7.51, electrical conductivity 5.5–6.12 mS/cm, reduction in the

percentage of total organic carbon 22–33%, the percentage increase in total nitrogen 2.17–2.66%, C:N ratio 13–17, sodium 2.14–2.60 g/kg and calcium 13.35–15.58 g/kg. The analytical hierarchy manner was used for the ranking of the trials to find the satisfactory proportions from the different combinations performed in this study.

Ajay S. Kalamdhad & A.A. Kazmi [3] In this study, The combination of Domestic waste, cattle manure and saw dust was used to increase the rate of composting in a household composter. It was found that temperature remained above 55°C for a period of two days, Faecal Coliforms and Faecal Streptococci decrease from 7.5 × 10 8 to 5 × 10 2 and 1.5 × 10 7 to 5 × 10 3 bacteria/g, respectively. Negligible VFAs production indicated full aerobic conditions. Nitrification observed after sixth day when temperature dropped below 40°C. BOD/COD ratio decreased up to 12 days and remained stable thereafter, indicating the stability of compost in terms of biodegradation.

Fatima Zahra Siti, Mustafa Elalami, Fatima Zahra Beraich, Moha Arouch, Salah Dine Qanadli [4] The problem of domestic waste is Increasing day by day with the economic development that Morocco (country) has experienced. In addition, the waste management is one of the biggest problem for the municipalities and household waste is increasing with time. Hence, in this work they presented the design of the mechanical and photovoltaic study of a autonomous solar composter which was introduced mainly for domestic waste. It allows to convert organic waste into compost that will act as a soil conditioner, in a very short period of time than any other composting systems, not more than 4 weeks. This innovative technology will reduce the amount of waste going to landfill, and produces the compost for gardening and horticulture, This will be a very effective solution for domestic waste in Morocco.

Ashish Kumar Nayak & Ajay S. Kalamdhad [5] This study explains about the sustainable practices to transform sewage sludge into beneficial agricultural product due to the fact it's miles wealthy in natural matter, micro- and macronutrients, that is vital for flora increase and soil fauna to live. Therefore, the existing look at turned into to recycle the sewage sludge via way of means of rotary drum composter. Five units of experiments (C/N 15, 20, 25, 30 which includes control) have been done withinside the reactor, wherein sewage sludge turned into coupled with sawdust and farm animals manure to reap the most excellent feedstock. The system became monitored with admire to physico-chemical traits and balance parameters at some stage in 20 days of composting period. In addition, the kinetic parameters ok m and r m were evaluated withinside the gift work. The effects advised that composting of sewage sludge with top of the line percentage of farm animals manure and noticed dust, particularly in C/N 30, can produce solid compost inside 20 days of composting.

Fatima Zahra Siti, Moha Arouch [6] In this study, the layout of a shredding shaft are presented. Before starting the composting, this shaft allows shredding the organic matter inside the rotary composter to increase the rate of composting Process, increasing the surface between the wastes to get aerobic degradation and bring splendid compost. Moreover, this shaft of 30 mm diameter, crafted from stainless steel, does less energy consumption, 2.55 Kw. It rotates at a Speed of 350 rpm for as much as five min earlier than the begin of the

composting method. The electric powered motor is used to transmit the power to the Shredder shaft via a pulley-belt transmission system. It permits the shaft to bear maximum stress of up to 420 MPa, With the factor of safety 2 . This design has been properly studied and authorised in step with the 3D design software SolidWorks Simulations.

Mamta C. Burile, Bhagyashri Thele, Dr .P. S. Lanjewar [7] In this research, the presence of combined natural substrates is a privilege of composting. The process of Composting involves microbial decomposition of organic matter. They studied the in-vessel composting process. The Objectives of this research were to gather and examine data about in-vessel composting and anaerobic digestion, and Compiling a top level view of this process. This paper also present the versatility and multivariable profile of these processes, showing The biological, chemical and physical factors which is effected by composting process having with its different ranges. In-vessel composting offers poultry farmers a sort of benefits like low operational costs, speedy processing Time.

Fahad N. Alkoaik, Ahmed M. Abdel-Ghany, Mohamed A. Rashwan, Ronnel B. Fulleros, Mansour N. Ibrahim [8] This study presents the analysis of energy in a laboratory-scale, batch-operated, the rotary bioreactor is used for composting the tomato plant remnant. The bioreactor was taken into consideration as a thermodynamic system operating under unsteady conditions. The composting process explained, the input and lost in terms of energy relative importance of each term were evaluated, and identified the composting phases. Results showed that the temperature of compost peaked at 72 h of operation reaching 66.7 °C with a heat generation rate of 9.3 W·kg−1 of organic matter. While the composting process, the total heat generation was 1.9 MJ·kg−1 of organic matter; only 4% heat was obtained by the composting material, and 96% was lost to the outer side of the bioreactor. Contributions of thermal radiation, aeration, cylindrical, and side-walls surfaces of the reactor on the total heat loss were 1%, 2%, 69%, and 28%, respectively. The data obtained can be used in the management, design and control of composting operations and in improvement of bioreactor effectiveness and productivity.

Shasheen S. Gupta, Rajesh D. Bisen, Shubham H. Badole, Vaibhav Nandagawali, Praful Dewalkar, Nehal Marathe [9] In this study, the examine goals to boost up the manner of decomposition of Food waste and produced a fine fertilizer product. Bulking Agent bio activator bacteria from cassava, And bio drying technology are used to boost up the Decomposition. They studied, The rotary drum composting method of combined natural waste produced appropriate compost consisting of 2.1% NT and 3.5% total Phosphorus within a time period of 20 days. The temperature lasts above 55°C for a period of two days, During the Thermophilic phase. Satisfying the regularity requirement for the destruction of pathogens. The moisture content reduced from 61% to 43% and the BOD/COD ratio reduced from 0.94 to 0.23 during the total composting period of 20 days the nearly non existing amount of VFA concentration that we saw during the composting method showed complete aerobic condition while the composting process.

Shreya Dhande, Trupti Dongarwar, Dhirajkumar Tarone, Chetan Gahukar, Nilesh Ukey, Kushal Yadav [10] In this research, optimum moisture, temperature, with optimum input feedstock ratio of organic

waste and continuous supply of air maintained in the rotary drum which accelerates the composting process, the key requirements for rapid aerobic composting. Three combinations of trials were carried out to identify the best recipe in composting, using cooked wastes, uncooked wastes separately and with the mixed combination of cooked and uncooked wastes. Out of these three combinations of trials, the maximum C/N reduction was found out in the combination of cooked and uncooked wastes along with bulking agent rice husk and cow dung. The composting of a combination of cattle manure, vegetable waste and sawdust (mixture B) yielded 2.23% total nitrogen and 3.57% total phosphorus after 20 days of composting in a rotary drum. However, in the case of a waste mixture of cattle manure, food waste, vegetable waste and paper waste (mixture C), compost yielded 4.42% total nitrogen and 2.52% total phosphorus after 20 days. On the other hand, treatment of a grass cuttings and vegetable waste mixture (mixture A) affected the behavior of a number of important parameters significantly during composting of mixed organic waste. During the thermophilic phase, the temperature remained above 50 °C in all mixtures satisfying the regularity requirement for the destruction of pathogens. The negligible amount of VFA concentrations found in all composting mixtures indicated the full aerobic condition during the composting period.

X. CONCLUSION

In this review, the rotary drum home composter was found to be appropriate for composting process and it can be effectively use for composting the organic waste. The flower waste composting research shows that the rotary drum produces matured and nutrient enriched compost within thirty days of the composting period. However, for more degradation of the organic matter, co-composting with animal manure gives better results is obtained on various studies. The greater research has been made in the preparation of compost. Therefore, research is being directed towards acceleration, improved quality of compost. The Review also indicates that, with proper planning the small amount of flammable Methane gas can be formed due to the degradation of organic matter at high temperature. The rotary drum composter will produce the compost within 10 to 12 days and the produced methane gas were collected in the small container with the help of valve.

REFERENCES

[1] Tahseen Sayara, Mahmoud Shadouf, Hour Issa, Hanan Obaid, Ruba Hanoun, **"Home Composting of Food Wastes Using Rotary Drum Reactor as an Alternative Treatment Option for Organic Household Wastes,"** 2022 Journal of Ecological Engineering ISSSN 2299-8993 DOI: https://doi.org/10.12911/22998993/147873

[2] Dayanand Sharma & Kunwar D. Yadav, **"Application of rotary in-vessel composting and analytical hierarchy process for the selection of a suitable combination of flower waste,"** March 2018 Geology, Ecology, and Landscapes Volume 2, 2018 - Issue 2 https://doi.org/10.1080/24749508.2018.1456851

[3] Ajay S. Kalamdhad & A.A. Kazmi, **"Mixed Organic Waste Composting Using Rotary Drum Composter,"** January 2008 International Journal of Environment and Waste Management 2(1) DOI:10.1504/IJEWM.2008.016989

[4] Fatima Zahra Siti, Mustafa Elalami, Fatima Zahra Beraich, Moha Arouch, Salah Dine Qanadli, **"Design and Production of an Autonomous Rotary Composter Powered by Photovoltaic Energy,"** October 2020

International Journal of Engineering Trends and Technology ISSN: 2231 – 5381 /doi:10.14445/22315381/IJETT-VXXXX

[5] Ashish Kumar Nayak & Ajay S. Kalamdhad, **"Sewage sludge composting in a rotary drum reactor: stability and kinetic analysis,"** September 2015 International Journal of Recycling of Organic Waste in Agriculture https://doi.org/10.1007/s40093-015-0104-4

[6] Fatima Zahra Siti, Moha Arouch, **" Integration of a Shredding Shaft to the Autonomous Rotary Composter,"** September 2022 International Journal of Engineering Trends and Technology Volume 70 Issue 9, 131-137 ISSN: 2231 – 5381 / https://doi.org/10.14445/22315381/IJETT-V70I9P213

[7] Mamta C. Burile, Bhagyashri Thele, Dr .P. S. Lanjewar, **"In-Vessel Composter Technique For Municipal Solid Waste Composting,"** 2017 International Conference On Emanations in Modern Engineering Science and Management (ICEMESM-2017) ISSN: 2321-8169 Volume: 5 Issue: 3

[8] Fahad N. Alkoaik, Ahmed M. Abdel-Ghany, Mohamed A. Rashwan, Ronnel B. Fulleros, Mansour N. Ibrahim, **"Energy Analysis of a Rotary Drum Bioreactor for Composting Tomato Plant Residues,"** February 2018 Journals/Energies/Volume 11/Issue 2/10.3390/en11020449 https://doi.org/10.3390/en11020449

[9] Shasheen S. Gupta, Rajesh D. Bisen, Shubham H. Badole, Vaibhav Nandagawali, Praful Dewalkar, Nehal Marathe, **"A REVIEW PAPER ON DECOMPOSITION OF FOOD WASTE BY ROTATITNG DRUM METHOD,"** February 2020 International Research Journal of Engineering and Technology (IRJET) Volume: 07 Issue: 02 e-ISSN: 2395-0056

[10] Shreya Dhande, Trupti Dongarwar, Dhirajkumar Tarone, Chetan Gahukar, Nilesh Ukey, Kushal Yadav, **"REUSE OF FOOD WASTE BY DECOMPOSING BY ROTATING DRUM METHOD,"** June 2021 International Research Journal of Engineering and Technology (IRJET) Volume: 08 Issue: 06 e-ISSN: 2395-0056