Development Of an Odorless Rapid Composting Machine For Domestic Use

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I. INTRODUCTION

In the current world, the escalating waste problem has reached an alarming level. With the rapid growth of the population, the amount of waste generated has also increased, leading to significant challenges in its organic decomposition. Like many other regions, Sri Lanka is also facing many challenges due to inadequate waste management practices. One of the areas that help to solve this problem effectively is the development of waste recycling technology. Municipal solid waste takes a long time to decompose naturally and often produces unpleasant odors. Therefore, it is essential to develop an appropriate technology to accelerate their decomposition to manage the problem at the grassroots level. This research aims to provide a technical solution to these pressing issues in waste management and recycling.

The scope of this research is to improve an ordinary kitchen garbage composting machine by introducing controlling variables such as temperature and humidity, heating capacity, aeration, and optimization of the local climate within the composting chamber to develop a conducive environment for microbial activities. This would enhance the microbial growth rate and increase the quality of compost while reducing the residence time of garbage. Other than this the research aims to reduce the odor during the recycling.

II. LITERATURE REVIEW

Composting techniques can artificially accelerate and enhance the effectiveness of the process. They include open-air composting, direct composting, vermicomposting, etc. [1]. The materials used, moisture level, temperature, and the aeration of the pile are affecting factors to the success of the composting process [2]. Composting additives can also be used to improve the quality of the compost. Additionally, the sections will cover the possibilities for composting machinery in Sri Lanka and the different heating methods that can be used in the composting process, such as band-type heaters or blanket-type heaters [3]. The structure of the machine, including the mixing mechanism, instrumentations, and quality control of the compost. Odor is a common issue in composting, both in large-scale and small-scale operations. Several technologies can be used to treat odors in composting operations. These technologies can be categorized as biological, physical, and chemical [4]. To identify the quality of the compost have to check moisture content, visual screening, organic matter, C-N ratio, pH, etc. [5].

III. MATERIALS AND METHODS

A. Materials

Drum and mixer - Mild steel, Odor filtration system - Active carbon, sheet metal and steel pipe

B. Methods

The setup includes a circular drum with a volume of 0.334m^3. The final product can be retrieved from the lower door after the process is completed by adding garbage through the upper door.

Fig. 1. The drum with garbage

Electric heating blankets are used as the heating source to control the temperature inside the drum. The heating blanket is a surface heating system with an Ordinary electric heater and thermostat, silicone and resin insulation, and fiberglass fabric sheathing [3].

Fig. 2. Container with heater pads

Active carbon was inserted into the filtration system. Active carbon absorb odor from exhaust air. 100g of active carbon enough for 24 months.

Fig. 3. Active carbon filtration arrangement

Cooling fan was maintained a maximum air supply flow rate of 50 m^3/h.

Fig. 4. Air supply system assembled to the machine

The mixing mechanism utilizes a double ribbon mixture. The optimal rotational speed for this mixture is 25 revolutions per minute.

Fig. 5. Double ribbon mixture

IV. Results and Discussion

A. Results

1) Effect of temperature

The required temperature range of the garbage is between 50°C and 65°C to maximize the bacterial growth rate. Testing was conducted with and without load and supplying air until the desired inside temperature of garbage was achieved.

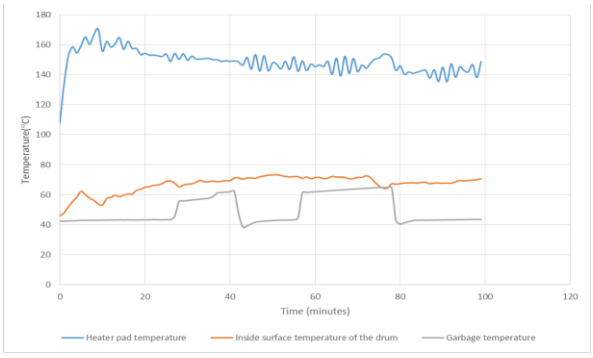

Fig. 6. Temperature variation of garbage at 120 °C supply temperature

2) Effect of additives

The study found that compost fertilizer produces high-quality compost. Additionally, it was observed that the quantity of additives affects both degradation time and quality. The optimum ratio was identified 10:1 of garbage to compost fertilizer.

Fig. 7. Nature of additives added garbage

3) Quality test results

pH = 4.5, Moisture content = 45%, Bulk density = 1428 kg/m^3 ,Organic matter = 99%, Total Nitrate = 0.009 mg/l, Total Organic Nitrogen= 0.008-0.1w/w%, Total phosphate = 0.54 mg/l

B. Discussion

The final product can be taken after 3 days of machine process. While the continues heating operation, and the mixing operation 4 hours per day, and should be supplied air 8 hours per day to control the moisture of the garbage.

V. Conclusion

The implementation of an active carbon filtration system was utilized as an effective strategy to mitigate unpleasant odors. To ensure the efficient operation of the composter, a minimum of 7kg of garbage was required. For optimal performance, it was recommended to incorporate 10:1 ratio of garbage to compost fertilizer, factoring in considerations such as availability and cost. Attaining the desired internal temperature within the waste unit was accomplished by setting the heater pads to a rated temperature of 120°C. Moreover, recirculation of air could help in maintaining a uniform moisture level, resulting in the production of compost with a relatively high quality, meeting the required moisture level, and reduced electricity consumption. Through the operation of the machine. The operation of the machine continuously for three days and then removing the compost from the machine to an open place has improved the compost quality with reduced odor generation. This machine can be used as the best solution for winter to manage food waste.

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References

[1] F. A. Azis, M. Rijal, H. Suhaimi, and P. E. Abas, “Patent Landscape of Composting Technology: A Review,” Inventions, vol. 7, no. 2, 2022, doi: 10.3390/inventions7020038.

[2] S. Ding et al., “Improving kitchen waste composting maturity by optimizing the processing parameters based on machine learning model,” Bioresour. Technol., vol. 360, p. 127606, Sep. 2022, doi: 10.1016/J.BIORTECH.2022.127606.

[3] “Heating blankets, heating jackets, drum heaters, tank heaters.” https://www.elementoscalefactores.com/products-en/heating-blankets.htm (accessed Oct. 26, 2023).

[4] “Methods for managing industrial odors - BioAir.” https://www.bioairsolutions.com/methods-for-managing-industrial-odors/ (accessed Oct. 26, 2023).

[5] “Compost quality indicators 2 Index,” 2020.