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Design and Manufacturing of a Semi-Automatic Two Stage Organic Waste Processing Machine

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Abstract**: Tonnes of solid waste are disposed off at landfill sites every day, originating from homes, offices, industries, and other agricultural-related activities among which are the hotel and restaurant industries today; are presently practicing improper waste management practices in the scullery of hotels. If waste is not properly stored and treated, it can pollute the surrounding air and have a serious negative impact on human, wildlife, and environmental health. Lack of suitable facilities (equipment and infrastructure) and underestimates of waste generation rates, inadequate management, improper collection and route planning are responsible for poor collection and transportation of municipal solid wastes. This paper proposes an efficient method to reduce the size of organic hotel waste and to create sustainable byproducts at economical investment, thereby generating profit from waste. It reveals that proper processing of waste can lead to adequate profitability for hotels and prevent environmental pollution.

I. INTRODUCTION

Waste production in the hospitality sector has increased dramatically as a result of the tourism industry's explosive growth. Hotels generate a variety of garbage since they host large numbers of visitors every day. This waste includes hazardous materials, recyclable materials like paper, metals, and plastics, as well as organic waste from kitchens. waste management adds to environmental damage, such as greenhouse gas emissions and water contamination, in addition to increasing the load on landfills. Consequently, sustainable hotel operations depend on an efficient waste management system. Traditional methods of disposing of waste, such as landfilling and incineration, pose significant environmental risks. Landfills emit methane gas (CH4), a primary cause of climate change, and hazardous waste can contaminate water supplies, harming ecosystems. By encouraging segregation, recycling, and energy recovery, hotels may Drastically lessen these effects by implementing cutting-edge waste processing equipment. Since between 50 and 65 percent of hotel garbage may be recycled, waste can be turned into reusable resources with the help of cutting-edge technologies, guaranteeing sustainability.

II. LITERATURE REVIEW

1) Solid Waste Management in Hotels: Challenges and Opportunities in India

This review highlights the pressing issue of solid waste management (SWM) within India's hotel sector. As major contributors to the country's GDP and urban growth, hotels produce significant amounts of waste, much of which remains improperly managed, causing environmental challenges. Inefficient waste management is often due to poor segregation practices, inadequate infrastructure, and limited awareness. The study emphasizes the use of waste audits, the WARM model for emission evaluation, equivalency calculators, and cost-benefit analysis to measure waste impact and identify profitability opportunities through recycling and composting. It promotes adopting a waste hierarchy approach— prioritizing reduction, reuse, and recycling—to build a sustainable framework for hotels. Ultimately, the review concludes that efficient waste management not only enhances environmental responsibility but also increases profitability for the hospitality industry.

2) Waste Management in Hotel Industry in India: A Review

The European hospitality sector has adopted cutting-edge equipment to treat hotel garbage effectively, incorporating high-efficiency composting units, AI-driven segregation, and automated sorting systems. In order to promote sustainable energy options, research emphasises the use of food waste digesters, anaerobic digestion systems, and biomethanation plants to turn organic waste into compost and biogas. Robotic garbage sorters and sensor-based compactors are examples of innovative recycling technology that improve recyclable material recovery while reducing landfill waste. By monitoring waste generation trends, intelligent waste tracking systems help to optimize disposal procedures. Furthermore, hotels have been compelled to embrace sustainable practices by strict waste management laws and circular economy campaigns, which guarantee effective waste processing and resource recovery.

3) Review of the Research Paper: "Solid Waste Management with Emphasis on Hotel Waste – Pedigree"

This research paper delves into the increasing significance of managing solid waste generated by the hotel industry. Recognizing hotels as substantial contributors to urban waste streams, it examines the unique challenges they face, given the daily production of large quantities of food, plastics, paper, and general refuse. The study outlines the historical development ("pedigree") of waste management practices within the sector, showcasing the transition from conventional disposal techniques to more environmentally responsible methods such as recycling, composting, and waste reduction initiatives.

The paper also highlights the influence of governmental regulations, eco-certifications, and the evolving expectations of environmentally conscious consumers in shaping modern hotel waste management strategies. It sheds light on major obstacles hindering effective waste management, including financial limitations, low awareness levels, and operational challenges. Additionally, the study offers a set of best practices and actionable recommendations aimed at enhancing waste management systems. Ultimately, the research underscores the necessity for a comprehensive, proactive approach to waste handling in order to drive sustainability within the hospitality industry.

4) Innovative Waste Processing Technologies in Hong Kong

The hospitality industry, particularly in growing tourist cities like Hoi An, is a major source of solid waste, with larger hotels producing more waste due to extensive services like gardens and restaurants. In developed countries, solid waste management (SWM) in hotels evolved gradually with increased awareness and regulations, while in developing countries like Vietnam, challenges such as lack of infrastructure, funding, and training persist. Although many hotels in Hoi An have started practicing waste segregation and recycling, composting remains very rare. Key barriers include operational inconvenience, lack of skills, and space issues. To promote sustainable waste management in hotels, stronger regulations, training programs, and government support are urgently needed.

III. METHODOLOGY

A. Manufacturing Process

1) Designing Model: Use CAD software to produce a 3D model of the waste processing configuration.

2) Component Selection: Based on the design specifications, pricing, and availability, the required components were selected.

3) Production Method: -

- Step 1: Purchasing and Preparing Materials Mild steel rods, sheets, bearings, motors, and heating coils were sourced in accordance with design specifications.
- Step 2: Manufacturing Components Used a hand tool cutter to cut sheets to the necessary size. Shredder Blades: The cutter blades were made from stainless steel sheet that was 3 mm thick. The blades are machined to 40 mm in length. For durability, the blades were heat treated. Hopper & Frame: The hopper shape was created by welding cut steel sheets together. The shredder blade housing was made by using a cylindrical pipe of the appropriate diameter (50 mm). For added stability, weld to the hopper along with the support plates. A handle to open and close the shredder was provided. The outer shell: - rotor shaft mounting slots that have been cut holes drilled to secure a 12V motor to the cantilever plate.
- Step 3: The Process of Assembly: Arc welding can be used to connect structural elements. The exterior casing is welded, and the blade is firmly fixed to the shaft and support frame. Install the rotor shaft within the shredder shell, making sure it rotates freely thanks to bearings. The shredder casing was hinged. bolted the gear system and motor to the exterior case. Apply red oxide (an anti- rust coating) and heat paint to the exterior of the building.

IV. WORKING

1) Step 1: Gathering and sorting waste gather garbage that is solid, liquid, and semi-solid, to guarantee effective processing, separate waste into groups for organic and inorganic materials.

2) Step 2: Waste Pre-Treatment Eliminate any non-biodegradable elements that could obstruct processing, such as metals and plastics. remove extra liquid from semi-solid waste to maximize the effectiveness of shredding.

3) Step 3: The Process of Shredding to reduce the size of the organic waste, feed it into the shredder, assure consistent shredding to increase processing efficiency even more.

4) Step 4: Moisture Removal: To eliminate moisture from the shreds of garbage, use a heating coil system to achieve efficient drying and avoid nutrient loss, maintain the ideal temperature.

5) Step 5: Conversion to Powder Form: To create a fine powder, run the dried material through a secondary shredding or grinding machine.
6) Step 6: Utilizing Processed Waste: Storing powdered output in briquettes or in powder form for other applications like biomass fuel or organic fertilizers.

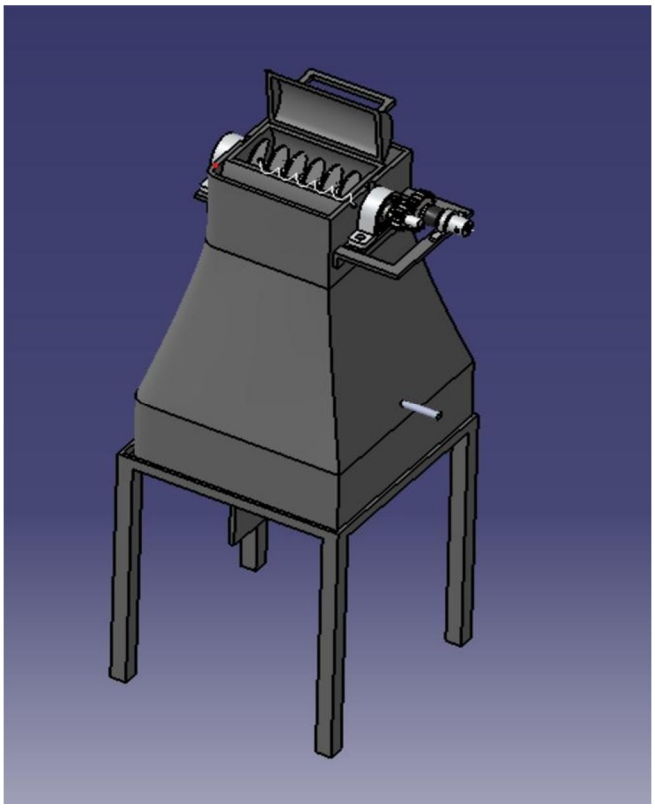


Fig no. 1

A. Design Calculation

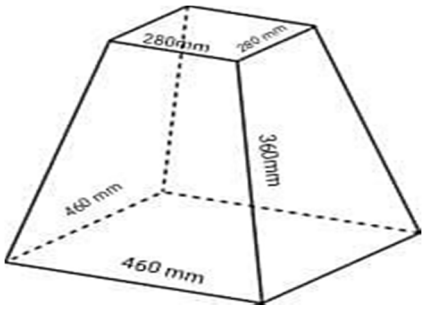


Fig no. 2

1) Base of Outer Casing

Parameters :-

Plate material: Mild Steel (JSW) Plate size: (A) $\mathbf{0.48\ m}$ × $\mathbf{0.48\ m}$ ($\boldsymbol{square\ plate}$) Plate length: (a) = 0.48 m Thickness:($\boldsymbol{t}$) = $\mathbf{0.012\ m}$
Support condition: All edges fixed
Uniformly Distributed Load ($\boldsymbol{q}$) = $\mathbf{500\ N/m^2}$ E = Young's modulus ≈ 210 GPa for mild steel E= 210×10^9Pa
Poisson's ratio (v) = 0.3 for mild steel

2) Flexural rigidity of the plate(D) is

D = $\boldsymbol{Et^3/1(1-\nu^2)}$

D= $\boldsymbol{210 \times 10^9 \times (0.012)^3/12(1-0.3^2)}$

D = $3.324 \times 10^6\ Nm$

For a square plate fixed at all edges under uniform load, maximum moment (M) is:-

$$\boldsymbol{M = \alpha\, q\, a^2}$$

$$= \boldsymbol{0.047 \times 500 \times (0.48)^2 = 5.4144 Nm/m}$$

Where,($\boldsymbol{\alpha}$) is dimensionless coefficient that depends upon poisson's ratio and boundary condition of plate

3) Maximum Bending Stress

$$\sigma = 6M/t^2\ \sigma = (6 \times 5.4144) / (0.012)^2$$

$$= 0.226\ MPa$$

Now, comparing yield strength:-

Yield strength of mild steel ≈ 250 MPa. Clearly : 0.226 MPa ≪ 250 MPa Thus, safe against yielding.

Max. Deflection

The maximum Deflection(Ωmax) for a fully fixed square plate under UDL

($\boldsymbol{\Omega max}$) = $\beta \times \boldsymbol{q\, a^4/D}$

$$= \boldsymbol{0.004} \times [(\boldsymbol{500} \times (\boldsymbol{0.48}))/ (3.324 \times 10^6]$$

$$= \boldsymbol{3.194 \times 10^{-8} m}$$

Where, β ≈ 0.004 (A dimensionless coefficient that depends upon the aspect ratio of plate and boundary conditions for fixed edges under UDL).

V. FINAL RESULT

Quantity	Value
Maximum Bending Stress σ	0.226 MPa
Yield strength	250 MPa
Max Deflection (Ωmax)	0.032 microns

Table no. 1

Plate is absolutely safe both against yielding and excessive deflection

Base support stand

TMT bar of Mild Steel having, Diameter = 15mm

E = 210 GPa

I = ($\boldsymbol{\pi}$/64)*d^4 = 2485.04 mm^4

Crippling load carrying capacity(Pe) = $\frac{\pi^2 EI}{4L^2}$ Pe = 3.576 KN

Base support reaction :

Weight of whole assembly = 500N No. of support legs = 4

Reaction on each leg = 500/4 = 125 N

3.567 KN ≫125 N

Therefore as,

Crippling load carrying capacity > Reaction force,

so the design is saf

VI. RESULT & DISCUSSION

The existing technology used in household / hotels flush the organic waste through a sink in fine shredded lumps, using " InSinkErator". Which aren't just expensive but are also unsustainable practices. Problem with alternative 'Shredding and Composting machines' is that they use high performance motors and shredding blades, involving high investment and high running cost.

The machine proposed herein, uses just adequate wattage motor and heating coil for the same purpose. To manage bio waste in a sustainable manner.

1) Effective Waste Reduction: Depending on the type of material, the machine effectively breaks down organic waste into smaller particles, lowering its volume by 30–40%.

2) Moisture Reduction: By reducing the moisture content to 40–50%, the integrated drying mechanism prepares the product for further processing into manure, briquettes, or cow feed.

3) Versatile Output: Waste-to-value activities are supported by the processed organic waste's ability to be recycled into a variety of beneficial items.

4) Analysis of Energy Consumption: The machine runs within an ideal power range, guaranteeing economical processing.

5) Operational Efficiency: The system operates reliably with few mechanical breakdowns or blockages, demonstrating strong construction and longevity.

Type of organic waste	Input waste (g)	Outpu t (g)	Processing time (Min)
Fruit peels	500	395	5
Cooked rice	500	380	5
Leafy vegetable	500	400	5

Table no. 2

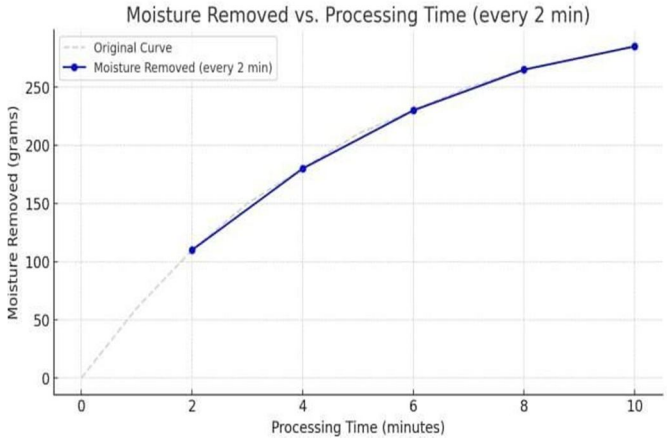


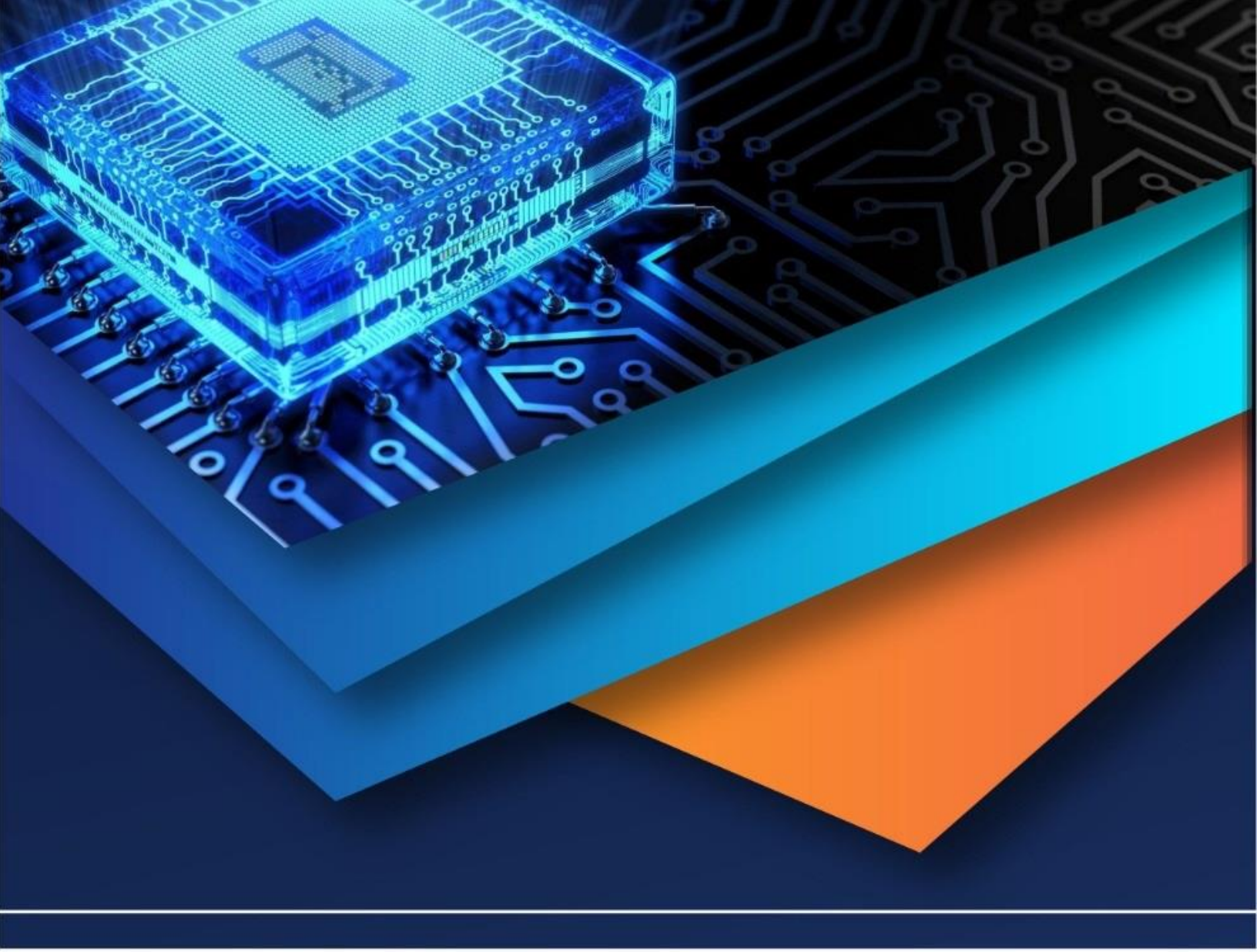
Chart no. 1

VII. CONCLUSION

Due to improper garbage treatment, one of India's biggest issues is the amount of waste generated by the hospitality industry. Therefore, creating a thorough waste management framework is essential to optimize every waste product in the hotel sector. The majority of hotel waste may be composted or recycled, According to the report, hotels that implement efficient recycling practices may eventually generate revenue in addition to helping the environment. GHG emissions can be significantly reduced by recycling and disposing of waste at its source. As a result, it can reduce pollution and halt global warming, two major problems that humanity is now dealing with. Based on the results, this study has shown that using stabilized, sterilized, and ground-up restaurant food waste as an alternative to organic chicks is feasible. Thus, this might ensure that the public is consuming a balanced diet and boost poultry production at a lower cost. Future research is encouraged by the results of this study to support the use of recovered food waste as chicken feed while maintaining environmental protection and current livestock standards.

REFERENCES

[1] M. Wadhwa, Utilization of fruit and vegetable wastes as livestock feed and as substrates for generation of other value-added products.
[2] Experimental investigation of solar drying for orange peels by forced convection.Review on Solid Wast
[3] Management in Hotel Industry in India Kamna Vaidya1 Prof. Dr. Ashit Kumar Saxena2
[4] Waste Management in Hotel Industry in India: A Review Afsanehsadat Omidiani, SeyedMohsen HashemiHezaveh
[5] Analyzing solid waste management practices for the hotel industry S.T. Pham Phu1, M.G. Hoang2, T. Fujiwara
[6] Integrated sustainable waste management in densely populated cities: The case of Hong Kong Ming Hung Wong
[7] Estimating solid waste generation by hospitality industry during major festivals: A quantification model based on multiple regression
[8] Solid Waste Management Emphasis on Hotel Waste pedigree Abhijeet S.Gaikwad1, Tanuj B.Mapari2, Dipak N.Meher3, Pratik V. Sarkate4, Dr. Ayub Shaikh5.



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