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# WASTE TO ENERGY USING LOW CAPACITY INCINERATOR

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## Abstract

Waste disposal is a major problem everywhere in the world. The government believes that it is challenging to properly arrange wastes, both industrial and residential, as cities become more and more urbanised. While it is possible to dispose of domestic garbage at landfills in rural areas, this is not an option for the urban network. In developing countries like India, where the majority of households rely on urban/metropolitan labour, every one of these wastes is placed in landfills, which is the most common method of rubbish collection. However, these dumps pollute the air and water. Incineration and combustion are other methods for getting rid of trash. Here, wastes are burned under regulated circumstances. This method has its drawbacks, but it is still a better option than the long-term problems associated with landfills. However, incinerators are expensive, and the great majority of people are not informed of the benefits of using domestic incinerators. This goal of current work is to create a family-sized incinerator that can be transported about easily. Additionally, the garbage that is burned will be converted into thermal and electrical energy. It must also be mild.
Selection

*Keywords:* Incinerator, Electricity, Thermo Electric Generator (TEG), Population, Solid Waste, Heat

## 1. Introduction

Solid waste is undesirable or pointless stuff that is produced by human activity in residential, commercial, or industrial sectors. Metropolitan India, home to roughly 377 million people, generates 63 million tonnes of municipal stable waste (MSW) annually, of which about 31 million tonnes (or 50%) are disposed of in landfills, 11.9 million tonnes (or 20%) are processed, and 43 million tonnes (or 70%) are collected. The estimation of urban municipal stable waste (MSW) generation may rise to 165 million tonnes in 2030 and 430 million tonnes by 2050 due to changes in economic growth and consumption habits [4-6]. The frequent mention of solid waste as a major factor contributing to environmental degradation. 20 to 30 percent of the waste produced overall does not get collected on average, posing environmental problems in urban areas. Asian nations were the principal recipients of unmanageable solid waste as a result of unplanned development and rapid industrial expansion. In addition to helping with energy recovery, the waste incineration process transforms combustible and natural garbage to non-combustible materials like ash and causes weight loss that may be properly disposed of on land or in underground pits [1-4]In India, Municipal Solid Waste (MSW) is becoming a significant problem. The primary goal of this study was to reduce solid waste production through the

introduction of incineration, and the secondary goal was to recover and transmit the waste energy produced during combustion. The outputs are clean surroundings, power from a thermoelectric generator, and waste thermal energy. The inputs are fuel and readily available MSW. The project's ultimate goal is to recover the most energy possible from burning waste, produce thermal and electrical energy, minimise the volume of waste collected, and make use of waste leftovers. For the purpose of reducing environmental contamination, waste treatment is essential. All nations have strict regulations and laws in place to handle this garbage. Waste remediation systems must be rigorously evaluated with continuous in-cycle management to guarantee that minimal performance criteria are reproducibly satisfied. The production of waste is a never-ending process that is accelerating with urbanisation. For the garbage created to be handled effectively, waste management is absolutely necessary. The old-fashioned method of gathering waste and discarding it in an open area gradually contaminates the soil, water, and air around us [4-6].

## 2. Experimental and Methods

There are several factors influencing the input and output of the worth and capacity of the municipal solid waste incineration. Some of them are [7-8]:

- Production of waste from industrial, households and commercial sites.
- By preventing the production of waste both in industry and households, we will able to lower our waste generation.
- In addition to the waste collected by the municipal solid waste incineration process, it also incorporates residue from the waste treatment technologies.
- Separate collection of waste influences the quantities of the municipal solid waste incineration can be reduced by separate collection of small electrical appliances. Significant reduction in quantity of waste for treatment is observed through source separation of biogenic waste and recyclables and qualities of waste for incineration. For example, up to 80% of Cu content in the bottom ash

### *2.1. Municipal Solid Waste Incineration.*

During the incineration process, a variety of solid and liquid residual materials, as well as gaseous effluents are produced. As a general rule, approximately one-fourth of the waste mass remains as solids in a wet state. It sestimatedhat the residue volume corresponds to one tenth

of the volume of the original waste. Typical MSWI by-products from grate combustion include [9-10]:

- Bottom ash is gathered in a quenching/cooling tank near the combustion chamber's exit and is mostly composed of coarse non-combustible materials and unburned organic waste.

- The process of "grate sifting entails gathering the comparatively fine particulates that flow through the grate at the combustion chamber's base. Because it is typically not practicable to separate these two waste streams, bottom ash and grate sifting together make about 20-30% by mass of the original waste on a wet basis.

- Boiler and economizer ash, which will be representing the coarse fraction of the particles carried over by the flue gases from the combustion chamber, makeup 10% of the initial waste by mass on a wet basis. At the heat recovery stage, it will be collected.Before the gaseous effluents are subjected to any additional treatment, the fine particulate matter or fly ash is removed. An MSW incinerator produces the 1-3% of waste input mass on a wet basis amount of fly ash.

## 3. Design Methodology

Design becomes a crucial component in the building of the incinerator to reduce the effectiveness of the burning process. This will aid in the reduction of emissions, the avoidance of clinker formation and ash slagging (inside the main chamber), and the preservation of refractory materials. Small-scale incinerators are seldom used to achieve the desired temperature, residence duration, and other parameters. To effectively burn trash and properly handle the waste, however, small incinerators must be built. Also, they will handle garbage appropriately.

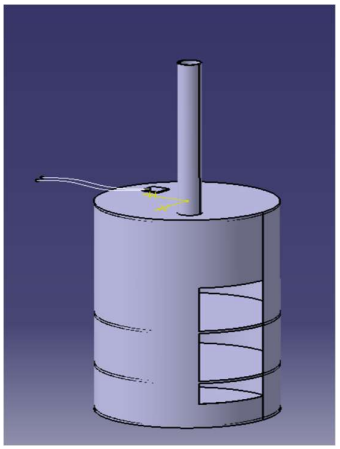
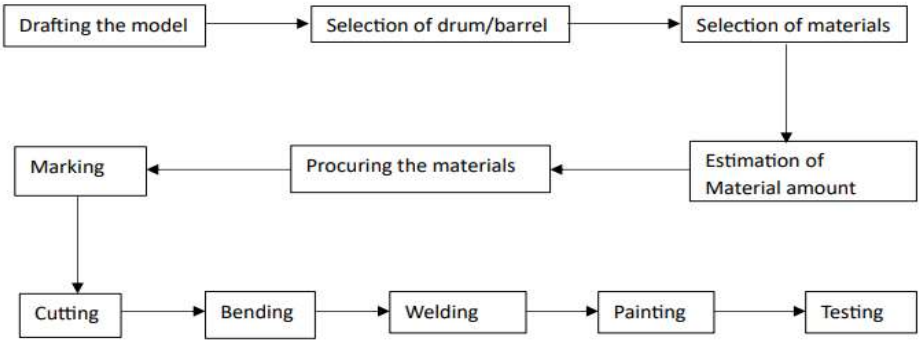


**Fig 1: 3D CAD Design of Model**

### 3. 1 Fabrication of Incinerator




### 4. Incinerator Components And Materials

The main components of small-scale incinerator consists of [1-4]:

a) Barrel Drum

b) Chimney

c) Thermo Electric Generators(TEG)

d) Ash and Residue collector

**Barrel drum:** One of the key parts that serves as an easily constructed and accessible incinerator for burning the waste is a barrel drum. Steel, laminated paper board, and plastic are used to make these drums. The steel drum can be used for incineration since it is simply adaptable to the needs. The 55 gallon steel barrel is chosen because it is ideal for the miniature incinerator.

**Chimney:** The chimney's primary function is to release the burned gases into the atmosphere. The small-scale incinerator's chimney is made of a hollow iron pipe.

**Thermo Electric Generator:** The heat energy must be transformed into electrical energy via TEGs. They can be utilised in large quantities in small incinerators. Power can be produced by connecting devices in series.

**Residue and Ash collector:** The Ash/Residue collector is located at the bottom of the incinerator. It is divided into two parts by mesh-style iron rods that were welded in place. The space will be kept open for debris.

### 5. Fabrication Process

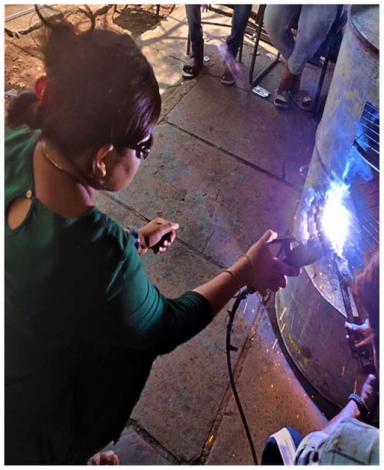
Going through many past journals and theories, it is observed that fabrication method of this small-scale incinerator inflicts collective efforts. To come up with a satisfactory viable outcome, various available papers had been taken as reference and going through at of each theoretical and sensible design is executed. The selection of materials is the first step in the fabrication process. The choice of a barrel drum as an incinerator nearly completes the fabrication process of the incinerator. The chosen drum is a steel 55-gallon open head (open on one end) drum with a 220-liter oil capacity. Square bars that have undergone thermo mechanical treatment (TMT) are taken into consideration when creating the mesh that will

support the weight of the garbage inside the drum and serve as a layer between wastes that has already been burned and waste that is still to be burned. As a chimney, a hollow iron pipe of the requisite height is chosen. To increase the flow of oxygen naturally for burning and to drain the water during times of rain, the air holes for the oxygen supply have been closed. The gate for the incinerator is secured with hinges to allow for free operation and rubbish disposal. The connections for the modules of the thermoelectric generator are provided as needed. The incinerator has finished being constructed and is now ready for testing as shown in fig.

(i) Cutting Door

(ii) Welding Grate

(iii) Removing Extra Material



(iv) Welding Grate to Drum

(v) Welding the Hinges and Door

(vi) Painting the Model

(vii) Finished Model of Incinerator

**Table 1: Incinerator specifications**

| Item | Dimensions | symbol |
|---|---|---|
| Outer diameter | 580 mm | D1 |
| Inner diameter | 572 mm | D2 |
| Inner diameter of Chimney | 70 mm | D3 |
| Outer diameter of Chimney | 75 mm | D4 |
| Height of Drum | 851 mm | H1 |
| Height of Gate | 485 mm | H2 |
| Total capacity | 220 lit | V1 |
| Chimney height | 630 mm | H3 |
| 1st Grate height (from base) | 185 mm | L1 |
| 2nd Grate height (from base) | 210 mm | L2 |
| Gate from base | 100 mm | L3 |

## 6. Experimental Setup

The constructed small-scale incinerator, the garbage placed inside of it, and the connections of the thermoelectric generator (TEG) modules are assembled to form the test setup. The waste is first burned by utilising some fuel for initial burning, and that burned waste creates thermal energy, which is computed in accordance with the temperature variations that occur as a function of time. At various locations throughout the incinerator, Thermo electric generator (TEG) modules are connected in parallel and series. The thermal energy (from heat from burning waste) of the garbage is converted into electricity by the TEG modules, who then produce voltage. With a multimeter, the electrical energy produced may be estimated.


Fig 2 . Experimental Setup

## 7. Results and Discussions

WASTE VOLUME REDUCTION: The waste products burned in the small-scale incinerator include dried twigs wood, paper, cardboards, and leaves, among other things. The amount of rubbish that was gathered and burned during the specified period is shown in the table below. To minimise the volume and weight of the garbage, it is burned in the incinerator's burning chamber.

**Table 2: Voltage produced for 1 kg of MSW incinerated.**

| Sl. No. | Temperature in °C | Voltage produced | | | | |
|---|---|---|---|---|---|---|
| | | 1 MODULE | 2 MODULE | 3 MODULE | 4 MODULE | 5 MODULE |
| 1 | 40 | 290 mV | 360 mV | 550 mV | 900 mV | 1.1 V |
| 2 | 60 | 0.5 V | 0.9 V | 1.5 V | 2.1 V | 2.5 V |
| 3 | 80 | 0.875 V | 1.3 V | 1.9 V | 2.4 V | 2.9 V |
| 4 | 100 | 0.95 V | 1.5 V | 2.2 V | 2.8 V | 3.3 V |
| 5 | 120 | 1.2 V | 1.9 V | 2.6 V | 3.2 V | 4 V |

**Table 3: Current produced for 1 kg of MSW incinerated.**

| Sl. No. | Temperature in °C | Current produced | | | | |
|---|---|---|---|---|---|---|
| | | 1 MODULE | 2 MODULE | 3 MODULE | 4 MODULE | 5 MODULE |
| 1 | 40 | 66.97 mA | 83.10 mA | 127 mA | 207.8 mA | 0.25 A |
| 2 | 60 | 0.15 A | 0.2 A | 0.35 A | 0.5 A | 0.6 A |
| 3 | 80 | 0.2 A | 0.3 A | 0.43 A | 0.55 A | 0.7 A |
| 4 | 100 | 0.21 A | 0.34 A | 0.50 A | 0.64 A | 0.8 A |
| 5 | 120 | 0.3 A | 0.43 A | 0.6 A | 0.73 A | 1 A |

**Generation Of Thermal/Heat Energy**

In the small-scale incinerator, the generation of heat energy depends upon various factors like waste burnt, the calorific value, the moisture content present in waste and type of the waste burnt. The overall capacity of the small-scale incinerator can be of 200 kg but the construction made that it can burn only up to 80 kg, of which varying in between 40 to 70 kg of waste is burnt for effective burning. By burning each kg of waste, the temperature achieved is about 80 to 160 ° C. The supply of waste will be through the gate of the incinerator and is placed over the mesh and is burnt. The heat energy i.e. temperature can be calculated by measuring instruments of heat.The heat energy produced by burning waste can be used for cooking, heating water, drying, etc. as shown in the figure.

**Generation Of Electrical Energy**

The amount of TEGs used and the temperature difference between the hot and cold sides of the TEG modules determine how much electricity is produced by this incinerator. The TEG Module, which can produce up to 4 volts, generates electricity based on the temperature difference and the maximum voltage. Different voltages can be generated by different temperature variations.

The parallel current (in Amps) generated by thermoelectric generator modules.

**CONCLUSION**

Like we observe in other nations, waste of every kind is produced in Indian cities as well. Yet, there is a lack of waste management due to improperly planned and scientific techniques of waste control. The leftover waste at the dump yards is typically made up of a greater number

of inert and putrescible natural resources thanks to any of the strong regulations on waste burning and recycling. A straightforward solid waste incinerator was created, constructed, and successfully tested in order to generate thermal and electrical energy through the burning process.

In addition to the releases of flue gases and other byproducts like fly ash and bottom ash, the solid waste incineration process takes into account the reduction in weight, size, and smell of garbage. The public's health is being negatively impacted by the prevalent waste management procedures due to the developing problems with waste control in urban areas. Incineration is a noteworthy option because there is a constant need to enhance the waste management system and apply modern, scientific waste disposal techniques.

According to test results, the system can be used for energy recovery and garbage disposal. Despite the fact that the concentrations of several dangerous gases in the flue gases were over the required criteria, it is necessary to show that the device and combustion chamber require similar work before it can be certified for use in large-scale applications.

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