GENERATION OF ELECTRICITY FROM MUNICIPAL SOLID WASTE USING HEATING PROCESS

[1]T. Subba Reddy, [2]T. Ajay, [3]B. Ankama Raju, [4]A. Bhanu, [5]J. Dimple Dinesh

[1]Assistant Professor,[2,3,4,5] Students

Department of Mechanical Engineering

Andhra Loyola Institute of Engineering and Technology, Vijayawada.

Abstract: Solid waste management has become a critical challenge worldwide due to rapid urbanization, population growth, and changing consumption patterns. In India alone, over 62 million tonnes of municipal solid waste (MSW) are generated annually, with nearly 50% ending up in landfills, often unmanaged. This project explores an innovative and sustainable solution to not only reduce the volume of solid waste but also to generate electricity using a controlled heating and filtering process.

The primary objective is to convert MSW into electrical energy through thermal conversion techniques. The proposed method involves the collection, manual segregation, and heating of waste materials such as paper, plastic, wood, and other combustibles. The heat generated during combustion is harnessed using heating sensors and panels, which convert thermal energy into electrical energy. Components like capacitors, resistors, and rechargeable batteries are employed to store and regulate this energy output. A pollution control filter system is integrated to minimize harmful emissions during combustion.

The process achieves electricity generation without relying on decomposition in landfills, thereby reducing methane emissions and curbing environmental pollution. Experimental results demonstrated that approximately 6V–8V of electricity could be generated from a 250g mixture of wood and plastic heated at temperatures ranging from 300°C to 600°C. The project highlights the technical feasibility of waste-to-energy (WtE) systems and their relevance in developing countries where conventional waste management infrastructure is limited.

The study further evaluates physical and chemical characteristics of MSW, such as density, moisture content, calorific value, and biodegradability, to optimize the energy recovery process. While the system cannot completely eliminate pollution, it significantly reduces the environmental impact of unprocessed waste. This project ultimately provides a practical approach for decentralized electricity generation while addressing the solid waste crisis.

Keywords: Municipal Solid Waste (MSW), Electricity Generation, Thermal

Conversion, Pollution Control, Waste-to-Energy (WtE), Heating Sensor/Panel, Environmental Impact, Solid Waste Composition, Energy Recovery.

1. Introduction

1.1 Solid waste:

Solid waste refers to the unwanted or discarded solid materials generated from human activities across households, hotels, institutions, laboratories, agriculture, industries, and commercial establishments. Managing this growing waste stream is a major global challenge due to increasing urbanization and population growth.

In India, metropolitan cities produce an average of **0.8 kg of solid waste per person per day**, contributing to an estimated **68.8 million tonnes** of municipal solid waste (MSW) annually. However, the **efficiency of MSW collection** in India varies widely, ranging between **22% to 60%**. Of this, around **70% (43 million tonnes)** is collected, **20% (11.9 million tonnes)** is treated, and **50% (31 million tonnes)** ends up in **landfills**, often unmanaged.

Globally, the situation is even more concerning. The world generates approximately **2.01 billion tonnes of MSW each year**, with a staggering **33%** not managed in an **environmentally safe manner**. The **average per capita daily waste generation worldwide is 0.74 kg**, ranging from **0.11 kg to 4.54 kg**. Despite comprising only **16% of the global population**, developed countries contribute to **34% (683 million tonnes)** of the world's total waste.

1.2 Types of solid waste based on origin:

Residential: The wastes which are refers to wastes which are from apartments, houses, dwelling, food, vegetables, plastic, books, cloths, glass, etc.

Instittutional: These are the wastes which are generated from the institutions like schools, collages, public buildings, etc.

Commercial: These are the wastes refers to mainly consists of glasses, metals, markets, restaurants, hotels, stores, malls, ashes, etc.

Municipal: The wastes which include treatment plant residual sludge, building wastes, dust, construction and demolition, landscaping, street cleaning, etc.

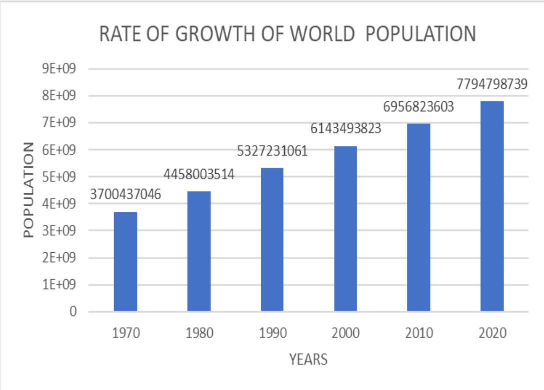
Industrial: It mainly consists of due to industrial activities such as wastes process, ashes, demolition and construction wastes, hazardous wastes, etc.

Agricultural: The agricultural wastes are mainly consists of spoiled food grains, orchards, vegetables, vineyards, farms etc.

Open-Areas: Open-areas waste that includes wastes from area such as parks, play grounds, high ways, beaches, recreational areas, etc.

1.3 Rate of growth of world population (implied context):

While isn't explicitly provided in the text, the initial statement about Fig



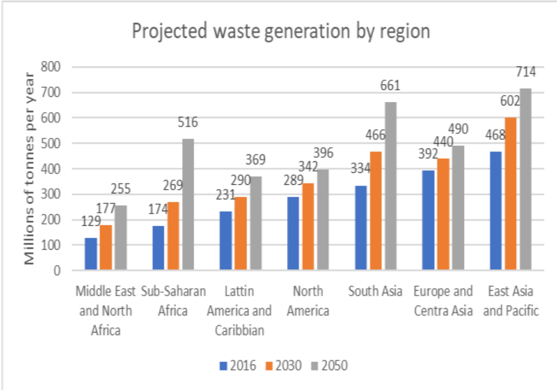
Rate of growth of world population

projected world waste growth being a doubling over the same period as population growth strongly implies a significant upward trend in the rate of world population increase. This population growth acts as a primary driver for the escalating volumes of waste generation anticipated globally. As the number of people on the planet increases, so too does the demand for resources and the subsequent creation of waste products across various sectors.

Furthermore, the text highlights that the correlation between waste generation and income level is a crucial factor to consider alongside population growth. High-income countries are projected to see a substantial increase in per capita waste generation, adding to the overall global waste burden. Simultaneously, the rapid urbanization and economic development in low- and middle-income countries are expected to lead to even more dramatic increases in total waste generated, further exacerbating the challenges posed by a growing global population.

1.4 Projected waste generation by region:

This not visually present, is described in detail within the text. The Fig



Projected waste generation by region

East Asia and Pacific region currently stands as the largest contributor to global waste, accounting for nearly a quarter of the world's total. In contrast, the Middle East and North Africa region generates the least amount of waste in absolute terms. However, the most significant growth in waste generation is anticipated in Sub-Saharan Africa, South Asia, and the Middle East and North Africa, where total waste is projected to double or even triple by 2050.

This rapid increase in waste in these specific regions presents significant challenges, particularly given that over half of the waste in these areas is currently openly dumped. The projected trajectories of waste growth will have profound negative consequences for the environment, public health, and overall prosperity if effective waste management strategies are not urgently implemented. These regions require immediate attention and tailored solutions to avoid an environmental and health crisis stemming from unmanaged waste.

2. Literature Survey:

C.F. King and L.C. Stuckenbruck (1976): Worked on Solid Waste As another for Power and warmth Generation. This paper shows that the theoretical potential of energy from municipal solid waste is adequate to 5 % of the desired fuel by all the utilities within the us; the energy that is made is adequate to twenty eighth of the oil made for delivery through the pipeline. within the paper, this standing of systems which is able to recover energy from solid waste is reviewed, the systems square measure grouping into four classes that square measure direct utilization of unprepared waste; utilization of separated waste; pyrolysis; and biomass conversion. The doable cases of future development and enlargement square measure examined with a read toward choice and implementation of a system and therefore the selling and salable energy recovered.

Murphy,J.D and Mckeogh,E (2004): Has studied regarding Technical, economic and environmental analysis of energy production from municipal solid waste. during this study technologies area unit examined that manufacture energy from municipal solid waste area unit incineration, chemical process, generation of biogas, usage during a combined heat and powerhouse, generation of biogas and alter to move fuel.

Changkook Ryu and Donghoon Shin (2012): Worked on Current standing and problems on Combined Heat and Power from Municipal Solid Waste in Asian nation. This study states an outline of CHP by MSW to energy plants in Asian nation and mentioned the issuses associated with energy potency improvement. The necessary energy resource for combined heat and power production is Municipal solid waste. Generation of power in the WtE CHP plants was projected to be solely three.65% of the thermal input and warmth production was sixty.79%. The R1 potency for the CHP plants compared to it in europe was similar and better for warmth solely plants.

In 2010, around half the fifty one massive WtE plants were CHP, whereas others made heat. up of power generation potency for brand spanking new power plants manufacturing steam at pressure on top of the present level of 20-30 bar is needed. Transboundary centralization of WtE plants between neighboring native authorities is important for warmth utilization since several existing small-scale plants don't recover heat.

Wei Gu and Di Liu et al (2021): His studied the energy recovery potential of combusting municipal solid waste (MSW) in the National Capital, considering different levels of MSW source separation and composition. Projecting MSW management to developed country standards by 2025, six scenarios were created based on varying LHVs. With an expected 11.5 million tons of MSW, the findings offer insights for balancing WTE benefits and costs, and for guiding MSW source separation policies.

3.Methodology:

3.1 Collection of Municipal Solid Waste:

The initial stage involves gathering MSW from various sources such as households, surrounding areas, and other locations where solid waste accumulates before decomposition in landfills. This collection process is crucial as it provides the raw material for the subsequent energy generation process, diverting waste that would otherwise be left to decompose and potentially cause environmental harm. The emphasis is on utilizing waste that is typically discarded, transforming it into a valuable resource for energy production.

3.2 Separation of municipal solid waste:

Once collected, the MSW undergoes a separation process where it is manually sorted into different categories based on physical characteristics like size, shape, weight, and moisture content (dry or wet). This step is essential for preparing the waste for the heating process and ensuring that only appropriate materials are used. It's highlighted that this separation must be carried out with caution to exclude any toxic materials like medicines, injections, or glass, which could pose risks during the heating process.

3.3 Heating Process:

The separated solid waste is then subjected to a heating process within a designated heating box. During this stage, it is critical to ensure that the heating sensor and heating panel are properly connected, as these components play a key role in converting the heat energy into electrical energy. The heating process is described as analogous to the function of solar panels, where energy conversion takes place. This conversion of heat into electricity is identified as the core mechanism of the project.

3.4 Output Load:

The electrical energy generated from the heating process is stored in a battery and subsequently transferred to an external system, referred to as the output load. This step signifies the utilization of the energy produced from the waste, making it available for practical applications. The energy is directed through circuits that incorporate resistors to control the flow of current, and capacitors are used to store the energy until it is needed.

3.5 Disposal:

After the heating process, any remaining residue, typically in the form of ash, is removed and disposed of appropriately. The document mentions the possibility of using this residue for further processes if feasible; otherwise, it is discarded. This step addresses the management of by-products from the energy generation process, ensuring that they are handled in an environmentally sound manner

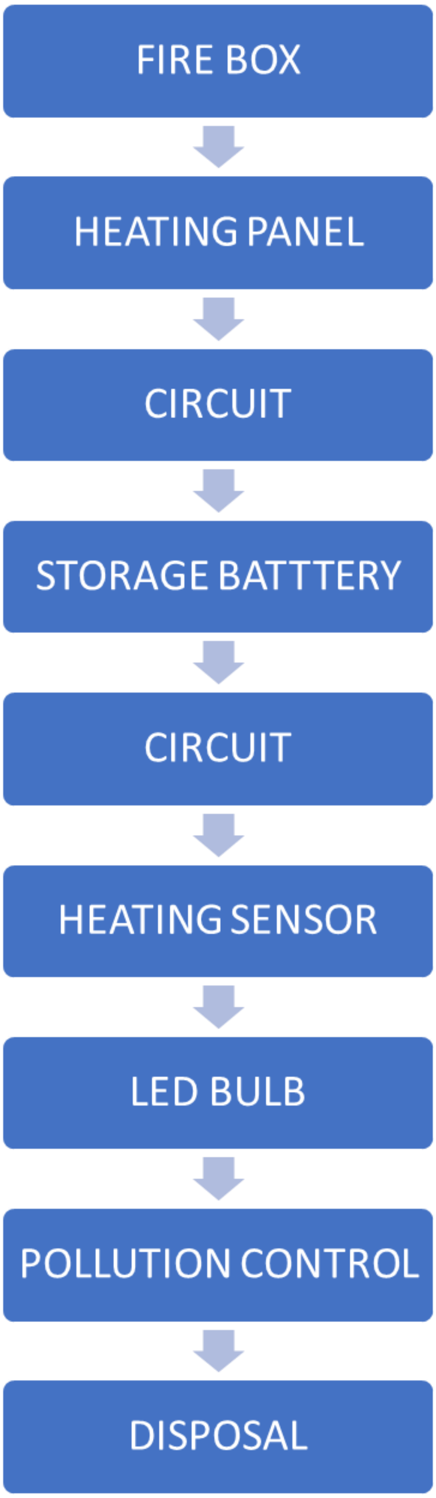
3.6 Pollution Filter Process:

To mitigate the environmental impact of the heating process, a pollution filter system is employed to treat the smoke generated during heating. This filter is designed to control and reduce the pollution released into the atmosphere, addressing concerns about air quality and environmental safety. The inclusion of this step underscores the project's aim to not only generate energy but to do so in a manner that minimizes harmful emissions.

4. Work Procedure:

- Municipal solid waste (MSW) is collected from various sources like households and surroundings.
- The collected MSW is manually separated based on physical properties (size, shape, etc.).
- Separation is done carefully to remove toxic materials (medicines, glass, etc.).
- Separated MSW is placed in a heating box for the heating process.
- Heating sensors and panels convert heat energy into electrical energy.
- This conversion is compared to how solar panels generate electricity.
- Electrical energy is stored in a rechargeable battery.
- Circuits with resistors control the flow of the current.
- Capacitors are used to store the 0 electrical energy.
- Stored energy is transferred externally as an output load.
- Remaining residue (ash) is disposed of or used for further processes.
- A filter control is used to manage smoke from the heating box.
- The process aims to generate electricity from solid waste.
- The system includes pollution control to reduce environmental impact.
- The project seeks to reduce landfill waste and biogas production.

4.1. Block Diagram

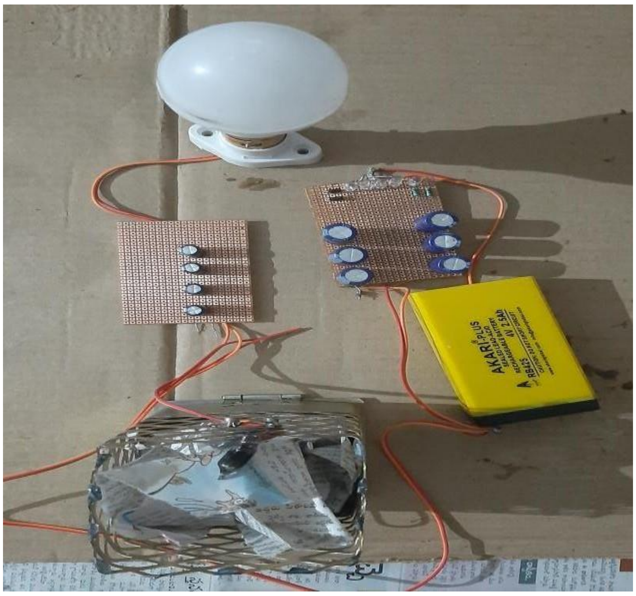


4.2 Output Load

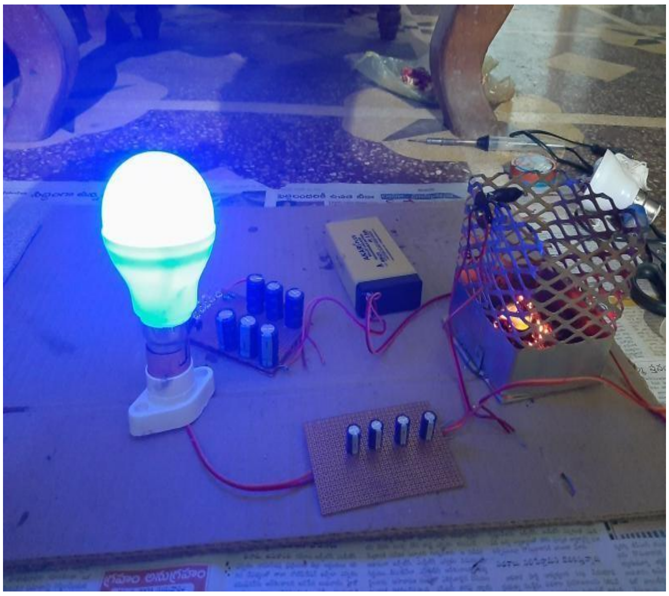
MATERIAL	TIMING	TEMPERATURE	MAXIMUM ELECTRICITY GENERATING VOLTAGE	ELECTRICITY GENERATING TIME	ELECTICITY GENERATING MINMUM TEMPERATURE
250 gm wood	20 – 30 min	300 degrees	6 V	30 min	100 degrees
250 gm wood + plastic	25 – 40 min	300 – 600 degrees	8 V	40 min	100 degrees

4.3 Power Generation

AMP HOURS	VOLTAGE	KILO-WATT HOUR
5	3.7	0.0185
10	7.4	0.0370
20	14.8	0.0740

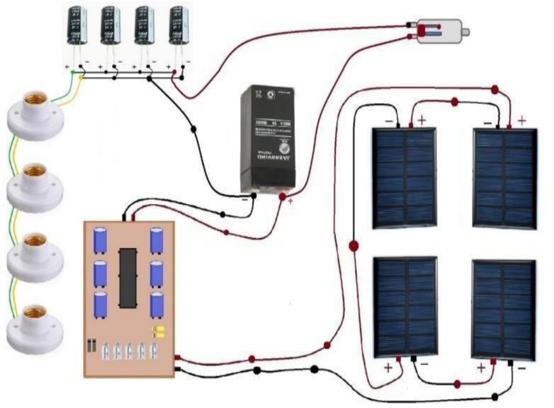


Before Start



After Starting

Pollution Control Process



Connections

5. Advantages:

- We can waste reduction and diversion from landfills.
- We can energy recovery from waste.
- We can utilization of mixed waste streams.
- We can potential for decentralized energy generation.
- We can reduction of biogas production in landfills.

5.1 Disadvantages:

- We can only generated Electricity from burning waste.
- We cannot control 100% pollution.
- We cannot burn petroleum products.

5.2 Summary:

This project explores generating electricity from municipal solid waste (MSW) through a heating process, aiming to reduce landfill waste and biogas production while controlling pollution. The methodology involves collecting and separating MSW, heating it to convert heat energy into electrical energy using heating panels and sensors, and then storing and utilizing this energy. A pollution filter is integrated to mitigate emissions from the heating process. While the project demonstrates the feasibility of generating electricity from solid waste, it acknowledges limitations in complete pollution control.

5.3 Conclusion:

The project demonstrates a viable method for generating electricity from solid waste through heating, contributing to both energy production and waste reduction. Although achieving complete pollution elimination is difficult, the filter control process significantly reduces harmful emissions. This approach offers a more sustainable alternative by diverting waste from landfills, curbing biogas release, and providing a source of power.

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