WASTE PAPER COMBUSTION FOR STEAM POWERED ELECTRICITY

A MINOR PROJECT-III REPORT

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BONAFIDE CERTIFICATE

Certified that this**18ECP105L - Minor Project III** report **"WASTE PAPER COMBUSTION FOR STEAM POWERED ELECTRICITY"** is the Bonafide work of **"Harshini S-927622BEC071, Madhubala V-927622BEC105, Manimegalai M-927622BEC110, Nandhini S R-927622BEC129''** who carried out the project work under my supervision in the academic year 2024 - 2025 **ODD**.

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PROJECT COORDINATOR

INSTITUTION VISION AND MISSION

Vision

To emerge as a leader among the top institutions in the field of technical education.

Mission

M1: Produce smart technocrats with empirical knowledge who can surmount the global challenges.

M2: Create a diverse, fully -engaged, learner -centric campus environment to provide quality education to the students.

M3: Maintain mutually beneficial partnerships with our alumni, industry and professional associations

DEPARTMENT VISION, MISSION, PEO, PO AND PSO

Vision

To empower the Electronics and Communication Engineering students with emerging technologies, professionalism, innovative research and social responsibility.

Mission

M1: Attain the academic excellence through innovative teaching learning process, research areas & laboratories and Consultancy projects.

M2: Inculcate the students in problem solving and lifelong learning ability.

M3: Provide entrepreneurial skills and leadership qualities.

M4: Render the technical knowledge and skills of faculty members.

Program Educational Objectives

PEO1: **Core Competence:** Graduates will have a successful career in academia or industry associated with Electronics and Communication Engineering

PEO2: **Professionalism:** Graduates will provide feasible solutions for the challenging problems through comprehensive research and innovation in the allied areas of Electronics and Communication Engineering.

PEO3: **Lifelong Learning:** Graduates will contribute to the social needs through lifelong learning, practicing professional ethics and leadership quality

Program Outcomes

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO1: Applying knowledge in various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of Engineering application.

PSO2: Able to solve complex problems in Electronics and Communication Engineering with analytical and managerial skills either independently or in team using latest hardware and software tools to fulfil the industrial expectations.

Abstract	**Matching with POs,PSOs**
Waste management	**<<PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PO12, PSO1, PSO2>>**

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ABSTRACT

This project is designed to create a sustainable and effective approach for producing electricity from non-biodegradable waste materials, including plastics and various types of refuse, through the application advanced Waste to Energy (WTE) technologies. By utilizing thermal treatment methods such as pyrolysis, gasification, and incineration, the initiative aims to transform waste into valuable energy resources, thereby alleviating the environmental pressures associated with landfills and marine pollution. The emphasis is placed on enhancing the energy conversion process to achieve optimal output, thereby contributing to the generation of renewable energy. Ultimately, this project aspires to provide a viable, environmentally friendly solution for waste management, minimize ecological impact, and establish a scalable framework for communities around the globe.

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LIST OF ABBREVIATIONS

ACRONYM		ABBREVIATION
WTE	-	Waste To Energy
MSW	-	Municipal Solid Waste
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
ADC	-	Analog to Digital Converter
CCPP	-	Combined-Cycle Power Plant

CHAPTER 1

INTRODUCTION

This project aims to tackle the pressing environmental issue of non-biodegradable waste accumulation by creating a sustainable and effective Waste–to-Energy (WTE) approach. As plastic and various other waste materials continue to contaminate landfills and oceans, the initiative seeks to transform this waste into a valuable energy source, thereby lessening its ecological impact. The primary goal is to improve the efficiency of these processes to maximize energy output, thereby contributing to the generation of renewable energy while reducing negative environmental effects.

1.1 OBJECTIVE

The primary objective of this project is to develop a sustainable and efficient approach to managing non-biodegradable waste by converting it into renewable energy using advanced Waste-to-Energy (WTE) technologies. This initiative aims to optimize thermal treatment methods such as pyrolysis, gasification, and incineration to maximize energy output while minimizing harmful emissions. By addressing the environmental challenges associated with landfills and marine pollution, the project seeks to contribute to environmental conservation and reduce the ecological impact of waste disposal.

1.2 DESCRIPTION

This project focuses on utilizing non-biodegradable waste materials, such as plastics and other refuse, to generate renewable energy through advanced Waste-to-Energy (WTE) technologies. By employing thermal treatment methods like pyrolysis, gasification, and incineration, the project aims to transform waste into valuable energy resources while minimizing harmful emissions.

CHAPTER 2

LITERATURE SURVEY

2.1 Overview of Waste-to-Energy Technologies

Waste-to-Energy technologies have gained significant attention as a sustainable solution to address the dual challenges of waste management and energy generation. Studies highlight thermal treatment methods such as incineration, pyrolysis, and gasification as effective techniques to convert non-biodegradable waste into energy. Incineration involves combustion to produce heat energy, while pyrolysis and gasification operate in oxygen-limited environments to generate syngas, bio-oil, and other byproducts useful for energy production. Research emphasizes the need for advanced systems to enhance efficiency and reduce emissions.

2.2 Pyrolysis for Waste Management

Several studies (e.g., Patel et al., 2020) demonstrate the potential of pyrolysis to convert plastic waste into liquid fuels, syngas, and char. This method offers a cleaner alternative to landfilling and incineration, with reduced greenhouse gas emissions. The scalability of pyrolysis is discussed, along with the need for optimization in feedstock preparation and reactor designs.

2.3 Gasification for Renewable Energy Production

Research on gasification (Smith et al., 2019) highlights its versatility in processing various waste types, including plastic and municipal solidwaste(MSW). The process produces syngas, which can be used to generate electricity or as a raw material for chemical synthesis. Recent advancements in gasification technologies focus on improving syngas purity and reducing tar formation for higher efficiency.

2.4 Environmental Impact of WTE Technologies

Studies (Kim & Lee, 2021) compare the environmental impacts of different WTE methods. While incineration remains the most commonly used, it generates higher emissions compared to pyrolysis and gasification. Advances in pollution control systems, such as flue gas cleaning, are essential to mitigate these impacts. Research also highlights the role of WTE in reducing landfill use and its contribution to the circular economy.

2.5 Economic Viability and Scalability

Economic analyses (e.g., Gupta & Sharma, 2022) suggest that WTE projects can be cost-effective when combined with government policies and incentives. The literature underscores the importance of public-private partnerships, subsidies, and carbon credits in promoting WTE adoption. However, the initial capital costs and technological complexity remain significant barriers.

2.6 Global Case Studies

Successful implementations of WTE systems in countries such as Sweden, Japan, and Singapore serve as benchmarks for the adoption of these technologies. These nations have integrated WTE into their waste management frameworks, achieving high efficiency and environmental compliance. Lessons learned from these case studies emphasize the importance of policy support, community involvement, and technological innovation.

2.7 Challenges and Future Prospects

Key challenges identified include the high energy demand of WTE processes, technological limitations in handling mixed waste streams, and public perception regarding safety and emissions.

CHAPTER 3

EXISTING SYSTEM

The current waste-to-energy (WTE) systems are designed to manage municipal solid waste (MSW) and non-biodegradable materials by converting them into usable energy. These systems rely on well-established thermal treatment methods and face various challenges and limitations:

3.1 Thermal Treatment Technologies

Incineration: The most widely used WTE method, incineration involves burning waste at high temperatures to produce heat energy. This energy is typically used to generate electricity or heat water for district heating systems. Modern incinerators are equipped with pollution control systems, but they still emit greenhouse gases and require careful management of ash byproducts.

Pyrolysis: This process heats waste materials in an oxygen-deprived environment, breaking them down into syngas, bio-oil, and char. Pyrolysis is more environmentally friendly than incineration, but its adoption is limited due to high costs and technical complexities.

Gasification: Gasification converts waste into syngas through partial oxidation. The syngas can be used to produce electricity or as a feedstock for industrial applications. Gasification offers higher efficiency and lower emissions than incineration but requires sophisticated feedstock management.

3.2 Biological Treatment Methods (Complementary)

Anaerobic Digestion*: Though not a primary focus for non-biodegradable waste, anaerobic digestion processes organic waste to generate biogas. This method is often integrated into WTE systems for comprehensive waste management.

3.3 Energy Recovery Efficiency

Current WTE systems have moderate energy recovery efficiencies, with incineration averaging 20–30% and advanced systems like gasification achieving up to 60%. However, inefficiencies arise due to mixed waste streams and the presence of non-combustible materials.

3.4 Environmental Considerations

Existing systems have made significant strides in pollution control, using technologies such as:

Flue Gas Cleaning: Reduces emissions of dioxins, furans, and particulate matter.

Ash Management: Fly ash and bottom ash from incineration are treated to extract recyclable materials and minimize hazardous waste. Despite these efforts, emissions and residual waste remain challenges.

3.5 Global Adoption

Developed Countries: Nations like Sweden, Japan, and Singapore have successfully implemented advanced WTE systems, integrating them with recycling and landfill diversion strategies.

Developing Countries: Limited infrastructure, high costs, and inadequate waste segregation hinder the adoption of WTE technologies in many regions.

3.6 Economic and Operational Challenges

High Initial Costs: Establishing WTE plants requires significant capital investment, particularly for advanced technologies like pyrolysis and gasification. **Feedstock Quality:** Mixed waste streams often include non-combustible or hazardous materials, reducing system efficiency and increasing operational complexity.

CHAPTER 4

PROPOSED SYSTEM

4.1 Advanced Thermal Treatment Technologies

Enhanced Pyrolysis: Use of high-efficiency reactors with precise temperature control to convert plastic and non-biodegradable waste into syngas, bio-oil, and char with minimal emissions.

Improved Gasification: Integration of advanced gasifiers capable of processing mixed waste streams to produce cleaner syngas for electricity generation or industrial applications.

Hybrid Systems: Combining pyrolysis and gasification to maximize energy recovery while reducing waste-to-residue ratios.

4.2 Automated Waste Segregation and Pre-Treatment

Deployment of automated sorting systems using AI and machine learning to segregate non-biodegradable, recyclable, and organic waste more efficiently.

Pre-treatment processes such as shredding, drying, and homogenization to enhance feedstock quality and energy conversion rates.

4.3 Energy Recovery and Utilization

Optimization of energy conversion processes to achieve higher efficiency, aiming for energy recovery rates exceeding 70%. Use of waste heat recovery systems for district heating, steam generation, or industrial applications. Storage and utilization of syngas and bio-oil for continuous energy supply, even during peak demand.

4.4 Emission Control Systems

Advanced flue gas treatment technologies to ensure compliance with international environmental standards by significantly reducing emissions of pollutants like dioxins, furans, and particulate matter. Capture and utilization of carbon dioxide for industrial or agricultural use, contributing to a circular carbon economy.

4.5 Integration with Renewable Energy Sources

Hybridization with renewable energy systems like solar or wind to enhance sustainability and reduce dependency on fossil fuels.

4.6 Scalable and Modular Design

Development of modular WTE plants tailored to specific community sizes and waste generation levels, enabling scalability for rural and urban areas alike. Portable units for remote or underserved regions with limited waste management infrastructure.

4.7 Economic Viability and Policy Alignment

Emphasis on reducing operational costs through energy-efficient technologies and resource recovery (e.g., metals, glass, and reusable ash byproducts). Alignment with government incentives, carbon credits, and public-private partnerships to ensure financial sustainability.

4.8 Community Engagement and Education

Programs to educate communities about waste segregation and the benefits of WTE technologies. Collaboration with local stakeholders to ensure smooth implementation and acceptance of the system.

CHAPTER 5

HARDWARE DESCRIPTION

5.1 BLOCK DIAGRAM

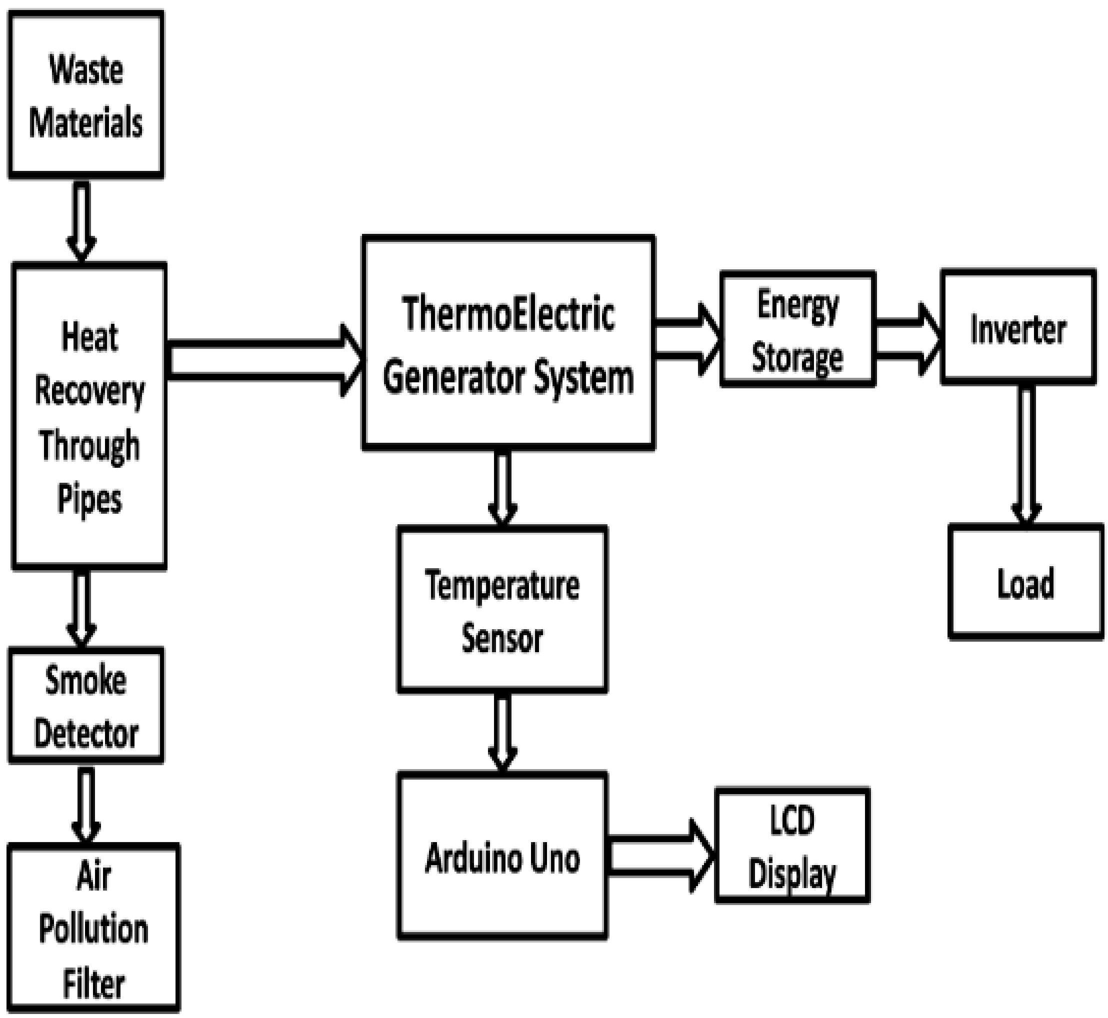

Fig 5.1.1

5.2 COMPONENTS

5.2.1 Solar Panel

The incorporation of solar panels into waste-to-energy generation systems effectively combines renewable energy with waste management, resulting in a sustainable and energy-efficient framework. Solar panels are essential for supplying supplementary power, which is necessary for the operation of conveyor systems utilized in waste sorting, as well as for air filtration and ventilation systems aimed at pollution control, and various control and monitoring devices. They enhance the off-grid capabilities of waste-to-energy facilities by providing energy during periods of inactivity or acting as backup power during grid outages, thus decreasing dependence on external energy sources.

5.2.2 Microcontroller

In a system designed to convert waste into electricity, the microcontroller serves as the essential processing unit, tasked with the responsibilities of monitoring, controlling, and presenting real-time information, such as the generated voltage, on an LCD display. It interfaces with critical components, including voltage sensors that assess the output voltage and LCDs that exhibit the processed information. The microcontroller utilizes its analogue to digital converter (ADC) or a voltage sensor module to read the voltage output from the generator. In instances where the voltage exceeds acceptable levels, scaling methods, such as a voltage divider, are employed to adjust it to a manageable range. Subsequently, the microcontroller translates the analogue voltage measurement into a digital format and processes this data to determine the actual voltage, taking into account the ADC resolution and scaling factors. This information is then transmitted to the LCD, which provides a real-time display of the voltage.

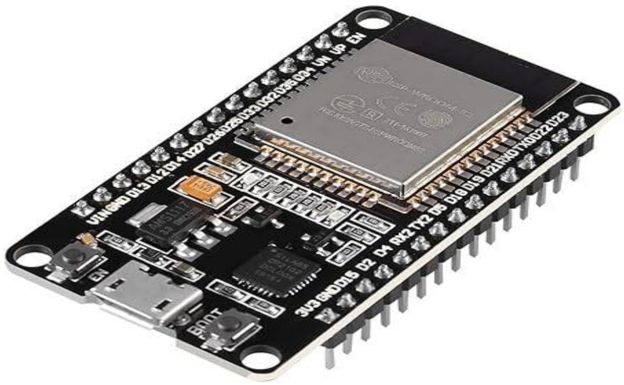

Fig 5.2.2

5.2.3 LED Bulb

In steam powered electricity generation systems using waste paper combustion, LED bulbs do not generate power but serve important supportive roles. They act as indicator light for monitoring combustion status, steam production, and safety systems, providing crucial visual feedback for operators. Their energy efficiency makes them ideal for general lighting, reducing overall energy consumption compared to traditional incandescent bulb.

Fig 5.2.3

5.2.4 Storage Battery

Storage battery are typically used in waste paper combustion for steam powered electricity generation, which primarily focuses on converting waste paper into steam to drive a generator. However batteries can support related applications like providing uninterruptible power supply for control systems, storing excess energy for grid stability, and serving as backup power for auxiliary system. Batteries serve multiple functions in the electricity generation process from waste materials. These devices are capable of chemically storing electrical energy and can discharge it as required to operate electrical equipment . A prevalent application of batteries in waste-to-energy facilities is to accumulate surplus energy produced by the plant during specific intervals.

Fig 5.2.4

5.2.5 LCD Display

An LCD display utilized in a waste paper combustion system that produces steam-powered electricity would present critical information necessary for process monitoring. This data would encompass the temperature within the combustion chamber, steam pressure, and the electricity generated by the system. . For instance, it could exhibit readings such as “Combustion temperature: 1200 degree C” or “Power generation: 500kW.”Furthermore, it would provide information on fuel levels, for example, “paper Waste Fuel:75% full,” along with system status notifications like “System Operational” or “Error: Inspect Boiler Additionally, it would display emission levels to ensure compliance with environmental regulations such as “CO2 Emission:45 ppm.”.

Fig 5.2.5

CHAPTER 6

RESULT AND DISCUSSION

In this prototype, we initiate the heating of waste material within the combustion chamber, allowing the generated heat to be harnessed by specialized heating panels. The panels effectively convert heat energy into electrical energy, which is subsequently directed to a circuit board. This circuit board is constructed using IN4007 diodes, as well as capacitors configured in both series and parallel arrangements to enhance the energy output, which is then stored in a battery. A heating sensor continuously monitors the temperature, activating the circuit to power LED bulbs. These bulbs will emit light as long as the energy generation persists and while the sensor detects active energy production. The illumination from the bulbs will remain uninterrupted during both energy generation and battery charging phases. The stored energy produced through this process can be utilized for various applications. Currently , we observe that waste materials can be effectively collected and processes through this innovative prototype, facilitating energy generation for practical use. Through this project, we have gained insights into the ease of energy generation with necessary precautions. This prototype not only highlights the potential of waste utilization but also opens avenues for industrial applications, helping us cater to our energy needs more sustainably.

CHAPTER 7

CONCLUSION AND FUTURE WORK

The incineration of waste paper as a means of generating electricity through steam presents a practical and environmentally sustainable solution for waste management and energy production. This process transforms waste paper into energy, thereby decreasing the volume of waste directed to landfills while simultaneously harnessing a renewable energy source that contributes to a reduction in dependence on fossil fuels. This process generates steam that powers turbines to produce electricity, while also lowering greenhouse gas emissions when executed with proper management. Furthermore, innovations in combustion technology and emissions regulation can significantly improve the environmental advantages of this method. In summary, incorporating waste paper combustion into energy production strategies supports broader objectives of sustainability and resource recovery, thus contributing to a more sustainable energy future. This initiative focuses on transforming non-biodegradable waste, including plastics, into electricity through thermal processes such as pyrolysis, gasification, and incineration. This method significantly diminishes the volume of waste directed landfills while generating a cleaner and renewable energy source. By tackling the escalating challenges of waste management, this strategy promotes a more sustainable energy production framework, thereby offering a valuable solution for environmental preservation and energy requirements. This waste-to-energy initiative offers a viable and environmentally sustainable approach to tackle two critical issues: waste management and energy requirements. By transforming non-biodegradable waste into electricity via thermal methods, it alleviates the pressure on landfills and lessens the detrimental impact of plastic waste on the ecosystem.

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OUTCOME

<<Conference Proceding Abstract / Journal Paper (First Page) / Participation Certificate with Project Title / Patent>>