

Thermo Electric Power Generation System Utilizing Heat from Municipal Solid Waste

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ABSTRACT

The increasing generation of municipal solid waste (MSW) and the growing demand for electrical energy create a need for sustainable waste-management and energy-generation approaches. This paper presents a prototype system for generating electrical energy from the heat obtained by combustion of combustible solid waste materials such as plastic, paper, rubber, and other waste. In the proposed system, waste is placed in a controlled fire box, and the resulting heat is transferred to a heating panel that produces electrical energy. The generated electrical energy is stored in a battery through an electronic circuit and is demonstrated using an LED load. A heating sensor is incorporated to control the output operation based on the thermal condition of the system. The proposed approach combines waste reduction with small-scale energy generation and incorporates a filtering arrangement intended to reduce pollution from the combustion process. The project demonstrates the feasibility of converting waste-derived heat into useful electrical energy for low-power applications.

Keywords— Municipal solid waste, waste-to-energy, thermoelectric power generation, heating panel, heating sensor, battery storage, LED, pollution control.

INTRODUCTION

The rapid increase in solid-waste generation and the continuous demand for electrical energy have created significant environmental and energy-related challenges. Municipal solid waste contains several combustible materials, including paper, plastics, rubber, organic matter, and other residual materials. Conventional disposal methods, particularly uncontrolled dumping and landfilling, require considerable land and may contribute to environmental pollution. Waste-to-energy (WtE) technology provides an alternative approach by utilizing the energy contained in residual waste to produce useful heat and electrical energy. The project report identifies the generation of electrical energy from waste materials and storage of the generated energy in a battery as the primary purpose of the proposed system.

Waste-to-energy systems can simultaneously address waste-management and energy-generation requirements. In a conventional WtE process, waste is collected, sorted, prepared, and subjected to controlled combustion. The resulting heat can be utilized for energy conversion, while appropriate emission-control and residue-management methods are required to reduce environmental impacts. The source document emphasizes that WtE should complement waste reduction, reuse, and recycling rather than replace them.

The proposed project develops a small-scale experimental setup in which combustible solid waste is burned in a fire box and the generated heat is applied to a heating panel. The electrical output is subsequently directed through a circuit for storage in a 4.5-V battery and demonstration through an LED bulb. A heating sensor is used for switching and controlling the output condition.

The main contribution of the project is the development of a simple prototype demonstrating the conversion of waste-derived heat into electrical energy. The system provides an educational and experimental platform for studying waste-to-energy conversion, electrical energy storage, thermal sensing, and low-power load operation.

LITERATURE SURVEY

Y. Sadif investigated waste-to-energy (WTE) and recycling for developing an integrated solid waste management system in Lahore. The study analyzed municipal solid waste composition and identified organic, paper, plastic, and other combustible fractions as potential sources for energy recovery. It examined anaerobic digestion and refuse-derived fuel (RDF) as possible WTE routes and reported considerable energy potential from the available waste stream. The study emphasized that combining recycling with energy recovery can reduce the quantity of waste reaching landfills while generating economic and environmental benefits. Abdul Aziz studied baseline solid waste management practices in Makkah, particularly during Hajj and Ramadan when waste generation increases significantly. The study considered waste collection, transportation, disposal, and recycling and highlighted the need for systematic waste-management practices to handle large quantities of municipal waste effectively [1], [2].

Ismail investigated waste-based biorefineries as an approach for developing countries and identified municipal solid waste as a potential source of renewable energy, recyclable materials, value-added products, and revenue. The study discussed several waste-to-energy technologies, including incineration, gasification, pyrolysis, and refuse-derived fuel, and emphasized the importance of selecting suitable technologies according to waste characteristics and available infrastructure. Dr. Abdul Sattar Nizami proposed a waste-based biorefinery concept for Makkah using technologies such as anaerobic digestion, transesterification, pyrolysis, and RDF to recover energy and useful products from municipal solid waste.

The study indicated that integrating recycling with waste-to-energy conversion could reduce landfill dependency and provide environmental and economic benefits. These studies establish the potential of municipal solid waste as an energy resource and provide the basis for the proposed system, which utilizes heat generated from the combustion of combustible waste to produce and store electrical energy [3], [4].

PROBLEM STATEMENT

Increasing electricity demand and the limited availability of conventional energy resources motivate the development of alternative energy-generation methods. At the same time, large quantities of combustible municipal solid waste require suitable treatment and disposal. The project therefore investigates the utilization of heat generated from solid-waste combustion for producing useful electrical energy.

OBJECTIVES

The main objectives of the proposed system are:

1. To generate and store electrical energy by utilizing the heat produced from the controlled combustion of combustible municipal solid waste.
2. To demonstrate a small-scale waste-to-energy system with heat sensing, electrical indication, battery storage, and basic smoke/pollution-control provisions.

PROPOSED SYSTEM

The proposed system consists of a combustion/fire box, heating panel, heating sensor, electrical conditioning circuit, battery, LED load, and supporting electronic components. Combustible waste is used as the input energy source. The heat released during combustion is transferred toward the heating panel, which produces an electrical output. The generated output is processed by the circuit and directed toward the storage battery. The heating sensor provides switching/control according to the thermal condition, while the LED acts as an observable load and indication of generated power.

The system development involved reviewing the project scope, designing the mechanical and electrical structure, implementing the hardware and circuitry, programming/control activities associated with the heating-panel output and sensor operation, and troubleshooting the complete system.

BLOCK DIAGRAM

The Fig 1 illustrates the flow of the proposed waste-to-electricity system, where heat generated in the fire box is transferred to the heating panel to produce electrical energy. The generated energy is conditioned through the capacitor, stored in the battery, and used to glow the LED bulb, while the heating sensor monitors the thermal condition. The water-cooling filter and pump help control the smoke generated during the process.

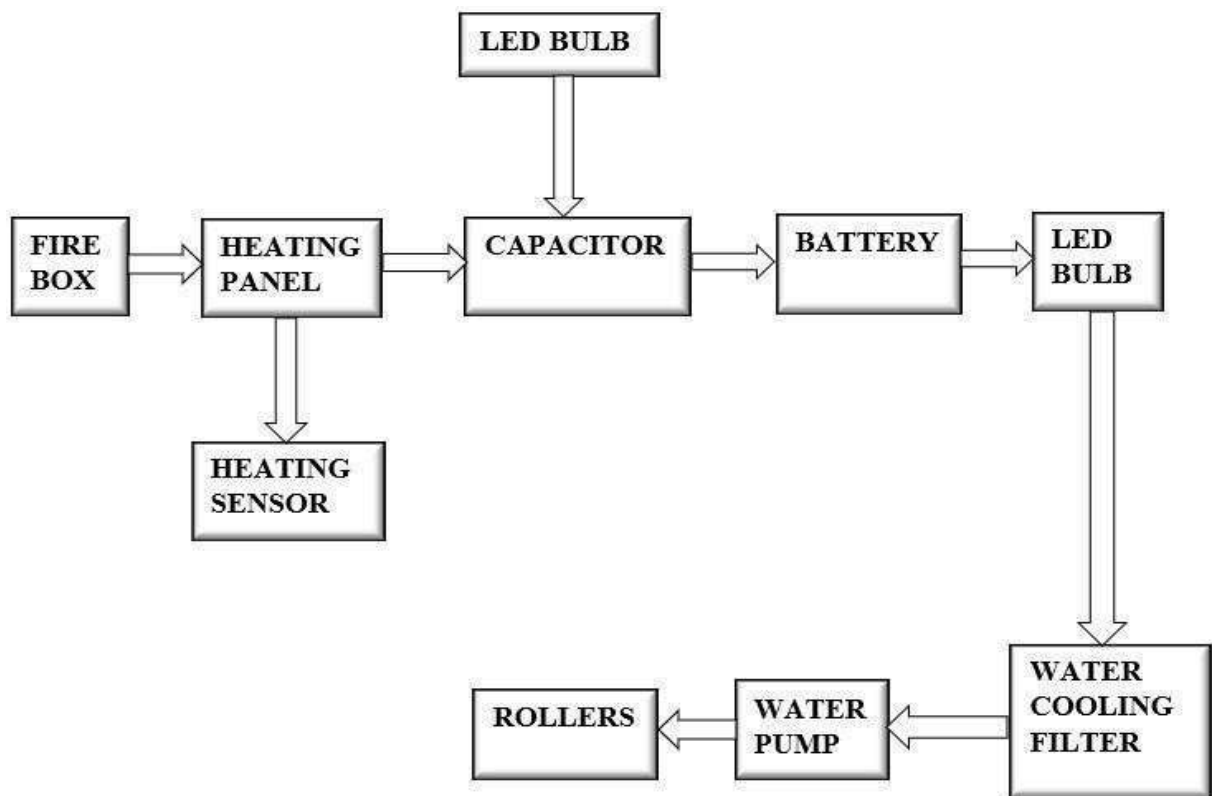


Fig 1 Block Diagram of Thermoelectric Power Generation

CIRCUIT DIAGRAM

The fig 2 shows the electrical interconnection of the solar panels, battery, LED bulbs, switches, motors, pumps, and supporting components used in the system. The generated electrical energy is supplied to the battery for storage and then distributed to the connected loads, while switches and push buttons provide control over the circuit operation.

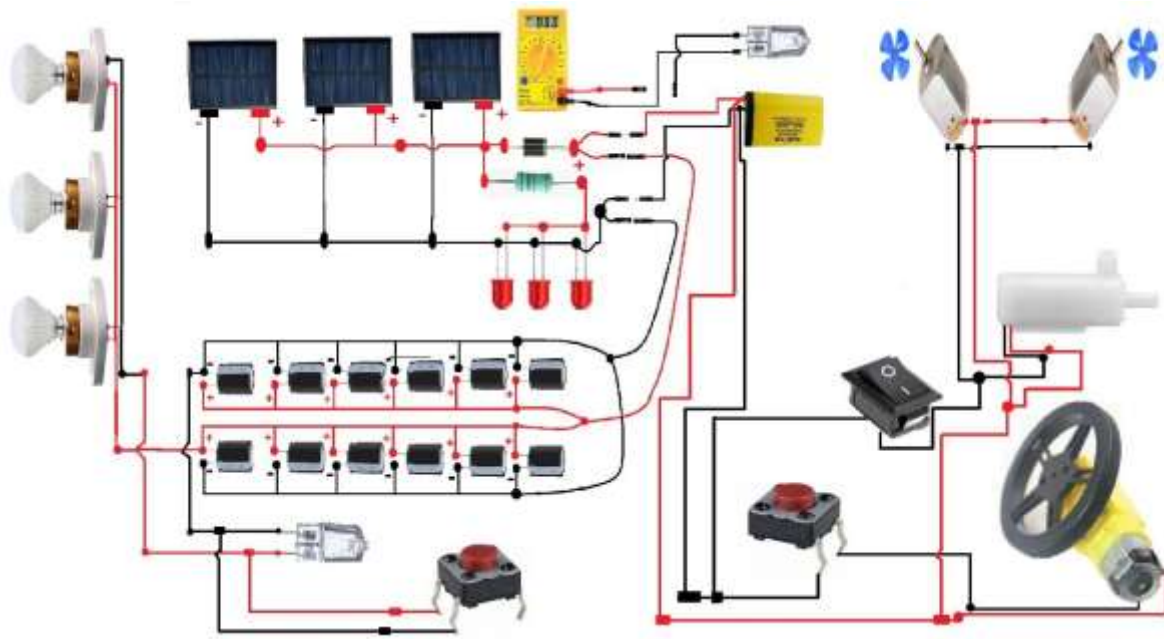


Fig 2 Circuit Diagram of Thermoelectric Power Generation

RESULTS AND DISCUSSION

The developed prototype demonstrates the basic feasibility of obtaining useful electrical output from the heat produced by combustible solid waste. The project reports that the generated electricity can be stored in the battery and that an LED can be illuminated to provide a visible demonstration of the output. The heating sensor provides an additional control mechanism for the output supply.

The system demonstrates the combined benefits of waste utilization and small-scale energy recovery. Instead of treating combustible waste exclusively as a disposal problem, its thermal energy can be utilized for electrical generation. The report identifies reduction in landfill waste, alternative energy generation, reduced dependence on conventional fuels, and potential environmental benefits as important advantages of WtE.

However, the available project report does not provide a detailed experimental dataset containing measured temperature, voltage, current, output power, conversion efficiency, or charging-time curves. Therefore, quantitative efficiency or performance improvements cannot be claimed from the source material. Further experimental characterization would be required to evaluate the electrical output under different waste compositions and thermal conditions.

CONCLUSION

This paper presents a prototype thermo-electric/waste-to-energy system for utilizing heat generated from combustible municipal solid waste to produce useful electrical energy. The developed system combines a combustion arrangement, heating panel, heating sensor, electrical circuit, battery storage, and LED output indication. The prototype demonstrates the fundamental concept of converting waste-derived thermal energy into electrical energy and storing the generated energy for subsequent use.

Waste-to-energy can contribute to both waste management and energy recovery; however, it should not replace the principles of waste reduction, reuse, and recycling. Proper waste segregation, combustion control, emission treatment, and residue management are essential for environmentally responsible operation. The project therefore provides a useful foundation for further development of a more efficient and quantitatively characterized waste-heat-to-electricity system.

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