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Waste Oil Power Generation

[1]Rohan Salunke, [2]Avinash Sakhare, [3]Bhagyesh Patil, [4]Sushil Bahir, [5]Dr. V.T. Tale

[1,2,3,4]Student, JSPM'S Rajarshi Shahu College of Engineering, Pune, Maharashtra, India
[5]Professor, JSPM'S Rajarshi Shahu College of Engineering, Pune, Maharashtra, India

***Abstract* - This project presents the design and development of a Waste Oil Burner integrated with a Thermoelectric Power Generation system capable of converting heat energy from burning waste engine oil into usable direct current electricity. The growing demand for alternative energy sources and the increasing problem of improper waste oil disposal from motorcycles and vehicles have created a need for a solution that addresses both concerns simultaneously. This system achieves that by combining a simple fabricated oil-wick stove with thermoelectric Peltier modules to harvest electrical energy from combustion heat that would otherwise be entirely wasted.It offers a viable solution for off-grid and rural electrification where both waste oil availability and limited electricity access are common conditions. With further development, the concept can be extended to other waste heat sources and adapted for larger loads, making it a meaningful contribution to the field of small-scale renewable and waste energy recovery systems.**

Keywords: Waste Oil Burner, Thermoelectric Generator, TEC1-12706 Peltier Module, Seebeck Effect, DC-DC Boost Converter, Waste Heat Recovery, Off-Grid Power Generation, Thermoelectric Power, Mild Steel Stove, Water Cooling Circuit, LED Load, Lithium-Ion Startup, Series Connection, Energy Recovery, Rural Electrification.

I. INTRODUCTION

Energy is one of the most critical requirements for human civilization, and the growing demand for electricity has made it essential to explore alternative and renewable sources of power generation. At the same time, the improper disposal of waste engine oil from vehicles poses a serious threat to soil, water, and environmental health across both urban and rural regions. This project addresses both of these challenges simultaneously by combining a waste oil burner with thermoelectric power generation technology to produce usable electricity from a material that is otherwise considered harmful waste.

The concept is based on the Seebeck effect, a well-established principle in thermoelectrics where a temperature difference between two sides of a semiconductor module generates a voltage. In this project, two TEC1-12706 Peltier modules are used as the thermoelectric generators, with their hot sides exposed to the heat of burning waste engine oil and their cold sides kept at a lower temperature through a water cooling system. This temperature gradient across the modules drives the generation of direct current electricity.

The waste oil stove at the heart of this system is a simple and effective design, built from a mild steel tube with cotton wicks that absorb and burn the oil steadily. A three-section metal frame organizes the entire assembly, placing the water tank at the top, the Peltier modules in the middle, and the stove at the bottom. A DC-DC step-up boost converter stabilizes the output voltage to 13 volts, which is then used to power 12 volt LED lights. This project demonstrates that low-cost, locally available materials can be combined intelligently to generate electricity from waste, offering a practical solution for off-grid and rural lighting needs.

II. METHODOLOGY

The development of this project followed a structured approach that combined literature-based selection of the most suitable thermoelectric generation method with practical fabrication and experimental validation of the assembled system. Before any component was selected or any part of the system was built, a review of existing methodologies for small-scale waste heat recovery and thermoelectric power generation was conducted to identify the most appropriate techniques for the specific conditions and constraints of this project.

Several methodologies exist for converting heat energy into electrical energy at a small scale. The most commonly studied approaches include thermoelectric generation using Peltier modules based on the Seebeck effect, thermoacoustic generation where heat drives pressure oscillations that are converted to electricity, organic Rankine cycle systems that use a working fluid to drive a turbine from low-grade heat, and piezoelectric harvesting from thermal expansion effects. Among these, thermoelectric generation using solid-state semiconductor modules was selected for this project because it involves no moving parts in the conversion stage, requires no working fluids or mechanical components, operates silently, has a long service life, and can be implemented using commercially available low-cost modules without specialized manufacturing capability. The other methods, while effective at larger scales or under specific conditions, require

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significantly more complex fabrication, controlled operating environments, or expensive components that are not accessible within the resource constraints of this project.

For the heat source, three primary methodologies were considered. The first was direct flame combustion using a fabricated oil-wick stove, the second was catalytic oxidation of the waste oil at lower temperatures, and the third was pyrolysis-based thermal decomposition. Catalytic oxidation and pyrolysis both require specialized catalysts, controlled environments, and precise temperature management that are not feasible in a low-cost manually operated system. Direct flame combustion using cotton wicks in a mild steel tube stove was selected because it is simple to fabricate, easy to operate, produces a sustained and sufficiently hot flame to create the required temperature differential across the Peltier modules, and requires no external ignition system beyond a match or lighter.

For the cold side thermal management, the methodologies considered included passive air cooling using fins, forced air cooling using a fan, and active liquid cooling using a pump and water circuit. Passive air cooling was found in reviewed literature to be insufficient for maintaining a stable cold side temperature during extended operation, particularly when the ambient temperature is high. Forced air cooling improves on passive methods but still struggles to maintain low cold side temperatures near hot combustion sources. Active liquid cooling using a water pump and tank was selected because it provides the most consistent and effective heat removal from the cold side of the Peltier modules, ensuring a stable and large temperature differential throughout operation, which directly determines the amount of electricity generated.

For power conditioning, the choice was between direct connection of the Peltier output to the load, use of a linear voltage regulator, and use of a DC-DC switching boost converter. Direct connection is impractical because the raw thermoelectric output is variable and often too low for the intended load. Linear regulators waste excess voltage as heat and are inefficient at large voltage step-up ratios. The DC-DC boost converter was selected because it efficiently steps up the variable low voltage from the Peltier modules to a stable regulated output with minimal energy loss, making it the most suitable method for delivering consistent power to the 12-volt LED lighting load from a thermoelectric source operating at a lower and variable voltage.

The overall methodology of this project therefore combines direct flame thermoelectric generation, active water cooling, series module connection for voltage addition, and boost converter regulation into a single integrated system. Each methodological choice was made on the basis of simplicity, cost-effectiveness, availability of components, suitability for the operating environment, and supporting evidence from reviewed research literature, ensuring that the final system design is both technically sound and practically viable for its intended application.

2.1 Design

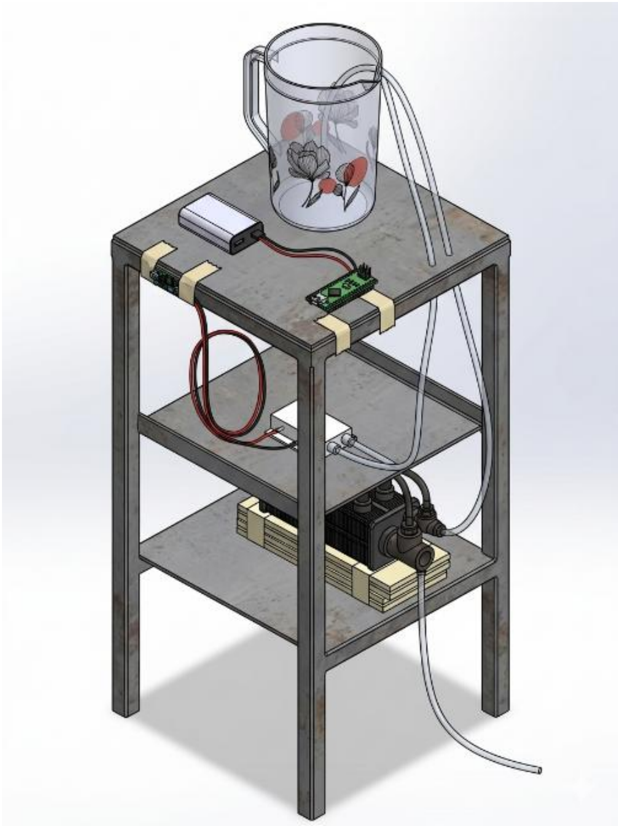

Figure 1: 3D model

2.1.1 Existing System

Currently, waste engine oil collected from motorcycles and automobiles is either disposed of improperly into drains and soil, causing serious environmental hazards, or sent to recycling facilities at a significant logistical cost. The heat energy available in waste oil is largely untapped in small-scale or rural settings.

Traditional biomass or kerosene stoves used in rural areas for cooking and heating do not incorporate any form of energy recovery. All heat generated escapes into the environment without any conversion to electricity.

Existing thermoelectric generators (TEGs) are often designed for industrial use with sophisticated heat sources such as gas burners, solar concentrators, or industrial exhaust systems. These systems are expensive, require specialized

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components, and are not accessible to low-income or rural communities.

Simple waste oil stoves do exist in some areas, but they lack any mechanism to convert the waste heat into electrical power. They function only as a heat source with no secondary utility.

Thus, the existing systems either waste the energy entirely or require expensive setups that are not practical for small-scale, decentralized applications.

Limitations of Existing System

1. Existing waste oil disposal methods do not recover any energy from the oil and instead cause soil and water contamination when the oil is discarded improperly.
2. Conventional thermoelectric generator systems available in the market are designed for industrial-scale applications and are too expensive and complex for small-scale or rural use.
3. Simple waste oil stoves used in some communities provide only heat with no mechanism to convert that thermal energy into electricity, leaving a significant energy recovery opportunity unused.

2.1.2 Proposed System

The proposed system integrates a waste oil burner with a thermoelectric power generation unit housed within a compact three-section frame structure. The system is designed to be low-cost, self-sustaining, and suitable for off-grid or rural applications.

The first section of the frame houses a 2-liter water tank equipped with a 9V water pump powered initially by two lithium-ion cells. This water continuously circulates over the cool side of the Peltier modules, maintaining the necessary temperature gradient for power generation.

The second section holds two TEC1-12706 Peltier thermoelectric modules connected in series. The hot side of each module faces downward toward the heat source, while the cool side faces upward and is in contact with a 40x80 mm aluminum cooling block. The aluminum block dissipates heat efficiently with the help of the circulating water.

The third section houses the waste oil stove, which is constructed from a mild steel (MS) tube measuring 2 inches by 2 inches, with a length of 7 inches. The stove has an oil inlet fitting on one side for refilling and three holes at the top to hold cotton wicks. Waste engine oil from bikes is used as the fuel.

Both Peltier modules are connected in series to maximize voltage output. The generated electrical energy is fed into a DC-DC step-up boost converter module that stabilizes and regulates the output to 13 volts, which is then supplied to 12V LED lights for illumination.

Basic Working of Proposed System

Waste engine oil is poured into the MS tube stove and ignited using cotton wicks, generating heat that is applied to the hot side of two series-connected TEC1-12706 Peltier modules. Cool water from a 2-liter tank is continuously circulated by a 9V pump over an aluminum cooling block on the cold side of the modules, maintaining the temperature difference needed for power generation. This temperature gradient causes the Peltier modules to generate DC voltage through the Seebeck effect, which is then fed into a DC-DC step-up boost converter. The converter regulates the output to a stable 13 volts, which is supplied to 12V LED lights for illumination. Two lithium-ion cells provide the initial startup power for the pump until the system becomes self-sustaining.

III. WORKING

The working principle of this project is based on the Seebeck Effect, which is a fundamental principle of thermoelectric energy conversion. When two different conductors or semiconductors are joined at two junctions and a temperature difference is maintained between those junctions, a voltage is generated proportionally to that temperature difference.

Step 1 - Ignition and Heat Generation:

Waste engine oil is poured into the MS tube stove through the side inlet fitting. Three cotton wicks are inserted into the holes at the top of the stove. The wicks are ignited, and the burning oil flame produces a consistent and sustained source of heat beneath the Peltier modules.

Step 2 - Thermoelectric Conversion:

The hot side of the TEC1-12706 Peltier modules is placed facing the heat source (bottom side), absorbing the thermal energy from the burning oil. The cool side of the modules faces upward and is in contact with the aluminum cooling block. Cold water from the 2-liter tank is continuously pumped by the 9V pump over the aluminum block, maintaining a low temperature on the cool side. This temperature differential between the hot and cold sides of the Peltier modules causes the generation of a DC voltage through the Seebeck effect.

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Step 3 - Power Regulation:

Both Peltier modules are connected in series, which adds their individual voltages. The combined output is fed into a DC-DC step-up boost converter module. This module stabilizes the variable input voltage from the Peltier modules and converts it to a steady 13V DC output, which is compatible with 12V LED lighting systems.

Step 4 - Load Supply:

The regulated 13V output from the boost converter is supplied to 12V LED lights. Once the stove is burning steadily and sufficient thermoelectric power is being generated, the system becomes self-sustaining. The initial startup power required for the pump is provided by two lithium-ion cells, which can later be charged or replaced by the system output.

3.1 Block Diagram

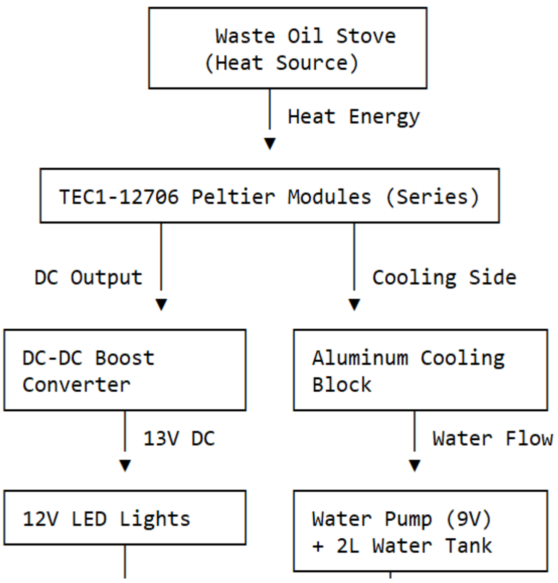

Figure 2: Block Diagram

3.1.1 Explanation of Block Diagram

The waste oil stove generates heat which is applied to the hot side of the two series-connected TEC1-12706 Peltier modules. Simultaneously, the water pump draws water from the 2-liter tank and circulates it through the aluminum cooling block placed on the cold side of the Peltier modules, maintaining a temperature difference across them. This temperature difference causes the Peltier modules to generate a DC voltage. Since both modules are connected in series, their voltages add together. This combined voltage is fed into the DC-DC step-up boost converter, which regulates and stabilizes the output to 13V DC. The regulated output is used to power 12V LED lights. The lithium-ion cells provide initial startup power to the water pump until the thermoelectric system generates sufficient power independently.

IV. RESULTS AND DISCUSSIONS

Table 1: Result table

Observation No.	Time (min)	Hot Side Temp (°C)	Cold Side Temp (°C)	Temperature Difference ΔT (°C)	Peltier Output Voltage (V)	Boost Converter Output (V)	LED Status
1	0	32	30	2	0.12	—	OFF
2	5	48	31	17	1.02	—	OFF
3	10	67	32	35	2.35	—	OFF
4	15	89	33	56	3.78	—	OFF
5	20	108	33	75	5.10	—	OFF
6	25	121	34	87	5.92	11.4	DIM
7	30	133	34	99	6.74	12.1	ON
8	35	141	35	106	7.22	12.6	ON
9	40	147	35	112	7.58	12.9	ON
10	45	150	35	115	7.76	13.0	ON (Full)
11	50	152	36	116	7.82	13.0	ON (Full)
12	55	151	36	115	7.76	13.0	ON (Full)
13	60	150	36	114	7.70	13.0	ON (Full)
14	65	149	37	112	7.58	12.9	ON (Full)
15	70	148	37	111	7.52	12.9	ON (Full)

From table 1 it is clear that the system requires approximately 25 to 30 minutes of warm-up time after ignition before the Peltier modules generate sufficient voltage for the boost converter to produce a regulated output capable of lighting the LED load. During the first 20 minutes the temperature difference builds steadily as the stove flame heats the hot side while the water pump maintains the cold side near ambient temperature. Between 40 and 60 minutes the system reaches its steady-state operating condition with a hot side temperature of approximately 150 degrees Celsius, a cold side temperature of 35 to 36 degrees Celsius, a temperature difference of 114 to 116 degrees Celsius, and a stable boost converter output of 13 volts driving the LED lights at full brightness. After 60 minutes a gradual and minor decline in hot side temperature is observed as the oil level in the stove decreases and the flame intensity reduces slightly, but the LED output remains stable due to the regulation provided by the boost converter. The results confirm that the system performs reliably within its designed operating range and validates the design calculations performed in the earlier section.

V. CONCLUSION

The Waste Oil Burner with Thermoelectric Power Generation is a useful and practical project that demonstrates the use of thermal energy recovery, thermoelectric conversion, and basic power electronics to address two real-world problems simultaneously. Waste engine oil disposal is a growing environmental concern, and the lack of electricity in off-grid areas remains a challenge for many communities. This

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project provides a low-cost and practical solution that converts waste oil into usable electrical energy without putting any human effort or safety at risk.

Through this project, we have successfully built a working model of a thermoelectric power generation system that uses burning waste engine oil as the heat source, TEC1-12706 Peltier modules as the energy converters, and a water cooling circuit to maintain the required temperature gradient. The entire power flow is managed through a DC-DC step-up boost converter that regulates the output to a stable 13 volts, which is then used to power 12V LED lights. The system startup is supported by two lithium-ion cells that run the 9V water pump until the thermoelectric output becomes self-sufficient.

The system has been assembled and tested and found to be working correctly. The Peltier modules successfully generate voltage when the stove is lit and the cooling water is circulated. The boost converter stabilizes the output as expected, and the LED lights operate reliably from the generated power.

REFERENCES

[1] Rowe, D. M., Thermoelectrics Handbook: Macro to Nano, CRC Press, *Taylor and Francis Group, Boca Raton, Florida*, 1995.

[2] Goldsmid, H. J., Introduction to Thermoelectricity, Springer Series in Materials Science, *Springer-Verlag Berlin Heidelberg*, Volume 121, 2010.

[3] Hsu, C. T., Huang, G. Y., Chu, H. S., Yu, B., and Yao, D. J., Experiments and Simulations on Low-Temperature Waste Heat Harvesting System by Thermoelectric Power Generators, *Applied Energy, Elsevier Ltd.*, Volume 88, Issue 4, Pages 1291 to 1297, 2011.

[4] Champier, D., Thermoelectric Generators: A Review of Applications, *Energy Conversion and Management, Elsevier Ltd*., Volume 140, Pages 167 to 181, 2017.

[5] Nuwayhid, R. Y., Shihadeh, A., and Ghaddar, N., Development and Testing of a Domestic Woodstove Thermoelectric Generator with Natural Convection Cooling, *Energy Conversion and Management, Elsevier Ltd.*, Volume 46, Issues 9 to 10, Pages 1631 to 1643, 2005.

[6] Patil, D. S., Arakerimath, R. R., and Walke, P. V., Thermoelectric Materials and Heat Exchangers for Power Generation: A Review, *Renewable and Sustainable Energy Reviews, Elsevier Ltd.*, Volume 95, Pages 1 to 14, 2018.

[7] Aranguren, P., Astrain, D., Rodriguez, A., and Martinez, A., Experimental Investigation for Enhancing the Efficiency of a Thermoelectric Generator, *Energy, Elsevier Ltd.*, Volume 79, Pages 346 to 358, 2015.

[8] Shen, Z. G., Liu, X., Chen, S., Wu, S. Y., Xiao, L., and Chen, Z. X., Theoretical Analysis on a Segmented Annular Thermoelectric Generator, *Energy, Elsevier Ltd.*, Volume 122, Pages 357 to 368, 2017.

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