International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 03 | March - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Review on Development of Power Generation from Waste Heat in Industries

Prof. L. Bopche[1], Harshda Kukade[2], Amit Varma[3], Toshil More[4], Roshan Chachere [5]

[1]*Project Guide, Department of Electrical Engineering, Priyadarshini College of Engineering, Nagpur*
[2345]*Students, Department of Electrical Engineering, Priyadarshini Gaikwad-Patil College of Engineering, Nagpur*

Abstract -
The issue of global economic expansion at a quick pace, relative energy scarcity, waste heat from internal combustion engine exhaust, and environmental pollution has received increased attention in the last several years. Approximately 30 to 40% of the total heat provided to the engine in the shape of fuel is turned into mechanical work that is useful. It is necessary to convert waste heat into productive activity because the residual heat is released into the atmosphere via exhaust gases and motor cooling systems, which leads to entropy growth and significant environmental damage. Because of the unique advantages of thermoelectric generators, waste heat recovery systems like the thermoelectric generator (TEG) have emerged as a potential alternative green technology.
Keywords: Waste heat from I. C. Engine, waste heat Recovery, TEGs, Electricity.

1. INTRODUCTION

For the last 100 years, the engine that burns fuel has been the main source of power for cars. These days, complicated engine designs are being developed in an effort to reduce fuel usage due to rising fuel prices and worries about reliance on foreign oil.
In this project, we are using heat energy in an unconventional way to generate electricity. Non-conventional energy technologies are crucial to our country right now. The process of turning mechanical energy into electrical energy is known as non-conventional energy use. This project involves the creation of a mechanical arrangement. Because embedded technology is used, this system is dependable and efficient. A microcontroller enables quicker and more dynamic control. The system's LCD (liquid crystal display) makes it easy to operate. The Arduino controller, which manages every function of the circuit, is its heart.

The transformation of thermal energy into electrical energy is the focus of this study. This energy is used to run a fan, and the energy can be saved in a battery. The control mechanism powers the inverter, which powers AC/DC loads, with a 12-volt battery supply, a unidirectional current controller, and an A.C. ripple neutralizer. The inverter is linked to the battery. The 12 Volt D.C. is converted to 230 Volt A.C. with this inverter. To turn on the loads, this 230 volt AC electricity is applied. Additionally, we use a traditional battery charger to deliver power to the circuits.

We are utilising TEP Transducer in this project.An apparatus that transforms one type of energy into another is called a transducer. This also applies to mechanical, electrical, light, and thermal energy. Although the word "transducer" typically refers to the usage of sensors or detectors, any apparatus that transforms energy is referred to as a transducer.

2. OBJECTIVE

• The technology that is the subject of current study may directly transform the thermal energy found in exhaust gases into electrical power. An exhaust gas-based thermal electricity generator was created for an industry use in this project proposal.
• The thermoelectric energy generator in this innovation receives its heat source from the exhaust fumes in the pipe. Thus, the goal of this project is to develop and put into practice a thermoelectric thermal energy recovering system using machine exhaust heat.
• Using a thermoelectric generator, the heat energy from vehicle waste heat must be directly converted to electrical energy. Even if the largest amount of electricity that such a system can produce is just 10 W from just one the TEG module, fast advancements in materials science can make the lofty goal of producing more watts by any means a realistic prospect.

3. LITERATURE REVIEW

The engine that burns fuel is the subject of this innovation. Waste heat recuperation (WHR) is the most researched area because it has the greatest availability and prevalence of relevant resources. The benefits of WHR, according to the India Directorate of Energy Efficiency, include a decrease in process costs and consumption, a decrease in pollutants and equipment dimensions, and a decrease in auxiliary energy use. Thermoelectric generators (TEGs) are among the devices that can complete WHR requirements; nonetheless, TEGs are mostly used in automotive applications.

1:- "Waste heat recovery from the emissions of low-power diesel engines using thermoelectric generators," in 20th international symposium on thermoelectric electricity (2001), pp. 413–417, Jihad G. Haidar, Jamil I. Ghojel We looked into recovering waste heat and using waste heat from various sectors from literature survey 1.

2:- A novel design of thermoelectric generator and health monitoring by Mariem SAIDA, Ghada ZAIBI, Mounir SAMET, and Abdennaceur KACHOURI, presented at the 2017 International Symposium on Smart, Monitored, and Controlled Cities (SM2C), held in Kerkennah, Tunisia, February 17–19, 2017, pages 59–63. We examined the specifications of a thermoelectric generator from the second literature review.

3:- Thermoelectric recuperation of waste heat with cooling system for low gradient temperature employing power conditioning to deliver 28V to a DC bus, Ahaad Hussein Alladeen, Shanshui Yang, Yazhu Liu, and Feng Cao, 2017 ITEC Asia-Pacific, an IEEE Transportation Electrification Symposium and Expo, was held in 2017. We looked at several cooling system types and coolant kinds from literature survey 3.

4:- Arash IEEE Transactions on Transport Electrification, Edvin Risseh, Electrical Power Condition System for Thermal electricity Waste Heat Collection in Commercial Vehicles, 2018, p. 2-16 We learned how to recover waste heat from automotive applications via literature survey 4.

4. EXPERIMENTAL BLOCK DIAGRAM

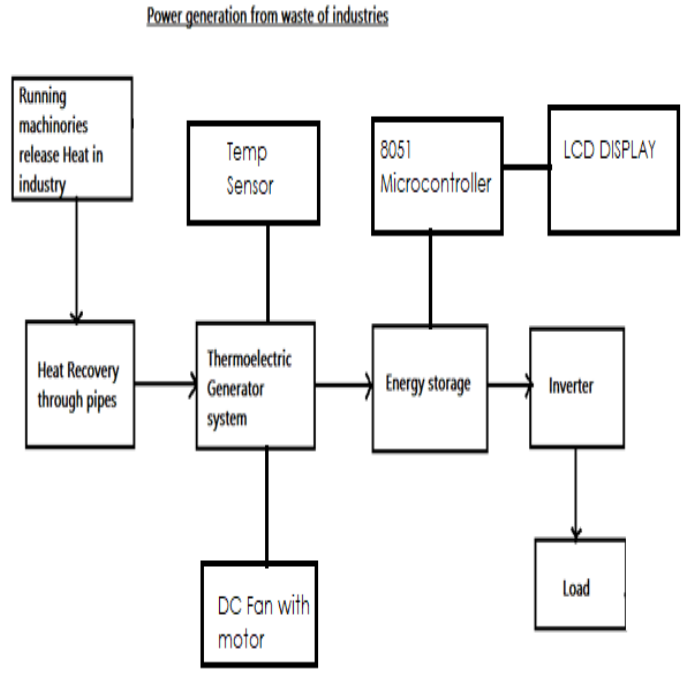

Fig.1. Block diagram of system

5. WORKING PRINCIPLE

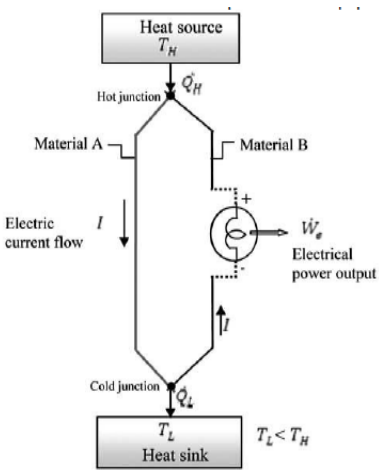

Fig.2. Working Principle

There is one hot side along with a cold side to TEG. A current will flow across the circuit as a result of the hot side's higher temperature driving electrons within the n-type leg towards the cold side's lower temperature. These electrons will then traverse the metallic connection and enter the p-type leg. A continuous electrical current will result from the dispersion of charge carriers forming a constant heat current if the temperature difference remains constant.

6. WORKING

- The process of transforming mechanical energy into electrical energy is known as non-conventional energy utilising. An arrangement for electricity generating is established in this project. This method is dependable and efficient since it uses the thermoelectric principle.
- Every industry uses machinery that runs constantly to produce goods. It generates a lot of heat. This heat is being wasted. We made use of this wasted heat to generate power. We can also reduce some air pollution in this way.
- When we use a heat sink module in conjunction with TEG to waste heat through a machine-operated heat pipe. TEG then begins converting thermal energy into electrical power simultaneously. The temperature sensor that is a part of the system allows us to measure this heat.
- To show how heat energy is flowing through the system and becoming converted into electrical energy, a DC fan is added. The fan's flow rises in tandem with temperature increases.
- Batteries are used to store electrical energy produced. The inverter uses this stored energy to switch DC to AC.
- An AC load is obtained at the output. In the same industry, this AC demand is used to run other loads like fans, air conditioners, lights, etc.
- Additionally, we connected an 8051 microprocessor (AT89S52) with an LCD display to gauge the voltage stored and left in the battery.
- This is how the entire system functions. Commence with the industrial waste of heat dissipated throughout the

production process. after which heat is converted to electricity. indication of power conversion using a DC motor and fan. electrical energy stored in batteries. use of an inverter to convert DC electricity to AC voltage.
- A microcontroller is connected to display the voltage at the battery. The final AC load is connected to the inverter.
- We could use a lot more heat waste if such a method was used in the vehicle sector. Additionally, reduced vehicle-related air pollution

7. COMPONENTS SPECIFICATION

Thermoelectric plate
Exhaust fan with Aluminum heat sink
Silencer
Heat source (Engine considered device)
DC motor with fan
Battery
Inverter module
Temperature sensor
Controller board (8051 controller)
LCD display (16*2)
wiring
switches
LED bulb
Metallic Frame
connector circuit board
Adapter

8. BENEFITS

• Because TEGs are solid-state devices, there are no moving parts involved in their operation. No chlorofluorocarbons and no moving components mean less frequent maintenance is needed. Very tiny size, flexible form, and temperature regulation to within decimals of a degree are all possible.
• Compared to traditional refrigeration, TEGs may be employed in conditions that are more harsh or smaller. TEG may be controlled by varying the input voltage or current and has a long lifespan.

9. SCOPE OF THE STUDY

- Thermoelectric generators (TEGs) can be connected in series or parallel to generate power at maximum levels. They can also be installed in vehicles above the radiator to allow the vehicle's battery to charge itself. Even body heat produces heat that can be used to generate power for portable devices like laptops and mobile phones.

10. ADVANTAGES

• Less expensive, less noise, and cleaner.
• This is not a typical system; fuel is not needed.
• Low maintenance requirements, portable, and quick charging (maximum temperature)
• Technology that offers a feasible solution to the electricity dilemma.
• Pollution-free, easy to manufacture, and lower gearbox losses.
• Broad application domains# Less space was needed. # It may be used whenever needed.
• Requires less parts overall.
• Every electrical gadget may be charged by us.
• There are several uses for electricity.
• Effective and do away with grid searches.

11. DISADVANTAGES

The TEG may be harmed by improper temperature gradient change or complex design.

12. APPLICATIONS

• Thermal-electric In general, generators are utilised in areas with lower power generation.
• A lot of heat is generated and wasted in many sectors. With TEG, we may use this here to generate power.
• In a car, create heat that may be utilised to employ TEG to generate power.
• Wherever waste heat is obtained, recharge the battery.
• By attaching the TEG to the radiator or the two-wheeler silencer pipe, the battery may charge itself.

13. CONCLUSION

The process of collecting and repurposing waste heat from industrial machinery in order to produce electricity is known as waste heat recovery. Recognising the machines' improved emissions and performance would also be beneficial if the producing sectors used these innovations. A significant amount of electricity that can be utilised to power industrial loads directly will be produced if the thermoelectric system idea is implemented in practice. A significant quantity of waste heat for pollutants is also continuously used in this system. Additionally, these industries in some way lessen environmental pollution.

References

[1] Taguchi, Tomanari. “Exhaust heat recovery power generation device and automobile equipped therewith”, US Patent- US20070193617 (2007). (Conference)
[2] Ramesh Kumar C, Ankit Sonthalia, and Rahul Goel. (2011), “Experimental study on Waste Heat Recovery from an Internal Combustion engine using Thermo Electric Technology”, Journal of Thermal Science Vol .15, Vol. 15, No. 4, pp. 1011-10220. (Journal)
[3] Engr. Bony Francis Rozario, Dr. Mohammad Abdul Mannan, ”Designing Oil Fired Power Plant Incorporated with Renewable Energy and Analyzing Capacity Improvement”, International Journal of Scientific & Engineering Research, Volume 5, Issue 7, July-2014, ISSN 2229-5518.(Journal)
[4] Chethan R Reddy, Shrikantha S Rao, Vijay Desai, Karthikeyan Ramachandran, “Modeling of an Automotive Thermo Electric Generator (ATEG)”, International Journal of Science and Research (IJSR), India Online ISSN: 2319-7064. (Journal)
[5] Adavbiele A.S. (2013), “Generation of Electricity from Gasoline Engine Waste Heat”, Journal of Energy

Technologies and Policy Vol.3 | Issue 3 | ISSN 2224-3232 (Paper) | ISSN 2225-0573 (Online)
[6] Ajay Chandravanshi, Suryavanshi J.G. (2013), "Waste Heat Recovery from Exhaust Gases through I C Engine Using Thermoelectric Generator", International Journal of Applied Research Volume: 3 | Issue: 7 | ISSN - 2249-555X. (Journal)
[7] Baskar P, Seralathan S, Dipin D, Thangavel S, Norman Clifford Francis I J and Arnold C. (2014), "Experimental Analysis of Thermoelectric Waste Heat Recovery System Retrofitted to Two Stroke Petrol Engine", International Journal of Advanced Mechanical
Engineering - ISSN 2250-3234 | Volume 4 | pp. 9-14. (Journal)
[8] Jadhao J S, Thombare D G. (2013), "Review on Exhaust Gas Heat Recovery for I.C. Engine", International Journal of Engineering and Innovative Technology | Volume 2 | Issue 12 | June 2013 | ISSN: 2277-3754. (Journal)
[9] Birkholz E, Grob U, Stohrer and Voss K. (1988) 'Conversion of waste exhaust heat in automobiles using FeSi2 thermo-elements", Proceedings of 7th International Conference on Thermoelectric energy conversion, University of Texas, March 16-18, 1988, pp.124-128. (Conference)
[10]Xiaodong Zhang, K. T. Chau, and C. C. Chan. (2009), "Design and Implementation of a Thermoelectric-Photovoltaic Hybrid Energy Source for Hybrid Electric Vehicles", World Electric Vehicle Journal | Vol. 3 |May 13-16, 2009| ISSN 2032-6653 | (Journal)