Electricity Generation from Waste Heat using Thermoelectric Generator

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Abstract— The idea of this project is to utilize the waste heat energy being generated in any heat source. It involves the trapping of heat energy being generated from the heat source in convert to electrical energy which can be used for many appliances. A Thermoelectric generator, or TEG (also called a See beck generator) is a solid state device that converts heat (temperature differences) directly into electrical energy through a phenomenon called the See beck effect (a form of thermoelectric effect). Thermoelectric generators function like heat engines, but are less bulky and have no moving parts. However, TEGs are typically more expensive and less efficient. Thermoelectric generators could be used in power plants in order to convert waste heat into additional electrical power and in automobiles as automotive thermoelectric generators (ATGs) to increase fuel efficiency. TEG can used in environments that are smaller or more saver than conventional generation. TEG has long life, and also it can be controllable by changing the input voltage or current. If this concept of thermoelectric system is taken to nano level or micro level then there will be huge amount of electricity can be generated which are just wasted into the atmosphere.

Key words: Thermoelectric Generator, Seebeck Effect, Waste Heat Recovery, Alternative Green Technology, Thermocouple

I. INTRODUCTION

Generating electricity in present there is a shortage of fossil fuel, oil, gas, etc. burning of these fuels causes environmental problem like radio activity pollution, global warming etc. So that these (coal, oil, gas) are the limiting resources hence,this project is to utilize the waste heat energy being generated in any heat source. By using thermoelectric generators to generate power as a most promising technology and environmental free and several advantages in production. Thermoelectric generator can convert directly thermal (heat) energy into electrical energy. In this TEG there are no moving parts and it cannot be produce any waste during power production hence it is consider as a green technology. Thermoelectric power generator convert direct waste heat in to generate electricity By this it eliminated emission so we can believe this green technology. Thermoelectric power generation offer a potential application in the direct exchange of waste-heat energy into electrical power where it is unnecessary to believe the cost of the thermal energy input .This method will have an maximum outcome. The application of this option green technology in converting waste-heat energy directly into electrical power can too improve the overall efficiencies of energy conversion systems.

The heat energy and the temperature from the heat source is being sensed by the thermocouple and is converted to electrical energy by a device called Thermoelectric Generator which works on See beck effect. The electric potential produced in thermoelectric generator is boosted by increasing the magnitude of voltage, required for charging battery. Further, the battery is connected to the invertor circuit to run the auxiliary appliances in the system which is A.C load

Recently we are depending upon fossil fuels for maximum electricity generation. However, the reserves of fossil fuels will be goes on depleting, since oil & gas are the least sources. Recent years .cost of unit electricity has increasing to unpredictable levels due the less supply of (oil gas coal). Thus the green energies are more attractive artificial to electricity generation, as it will also provide a pollution free and cost less. In this innovative project, we are using one device which is used to be created and introduced by human as a renewable energy that is thermo electric generator equipment to generate electricity As we know Renewable energies are, solar energy, wind energy, hydro energy, tidal energy, etc. above energies can produce electricity in different forms and way of generating method.

II. LITERATURE SURVEY

In recent years, global warming and the limitations in use of energy resources increase environmental issues of emissions. Also In industry, most of the expenses are due to energy (both electrical and thermal), labour and materials. But out of them energy would relate to the manageability of the cost or potential cost savings and thus energy management will help in cost reduction. The possibilities of thermoelectric systems' contribution to "green" technologies, specifically for waste heat recovery from industry exhausting flue gases. It results into extensive research on green technologies producing electricity. As waste heat recovering techniques, such as thermoelectric generator (TEG) is developed .Its implementation in automobile industry is carried out in many ways. Previous research shows that TEG as a waste heat harvesting method is useful. Due to distinct benefits of Thermoelectric generators, they have become a promising alternative green technology. Thermoelectric generator direct converts waste-heat energy into electrical power where it is unnecessary to consider the cost of the thermal energy input. The application of this technology can also improve the overall efficiency the of energy conversion systems. Even though output of TEGs are low with available techniques, feasible electricity generation is possible due to waste heat emitted from the automobile (internal combustion engine operation).

In the conventional method for generate electricity is converting thermal energy into mechanical energy then to electrical energy. In recent years, due to environmental issues like emissions, global warming, etc., are the limiting factor for the energy resources which resulting in extensive research and novel technologies are required to generate electric power. Thermoelectric power generators have emerged as a promising another green technology due to their diverse advantages. Thermo Electric Power Generator directly

converts this Thermal energy into Electrical energy. So number of moving and rotating part has been eliminated. By this it eliminated emission so we can believe this green technology. Thermoelectric power generation offer a potential application in the direct exchange of waste-heat energy into electrical power where it is unnecessary to believe the cost of the thermal energy input. The application of this option green technology in converting waste-heat energy directly into electrical power can too improve the overall efficiencies of energy conversion systems. Heat source which is need for this conversion is less when contrast to conventional methods.

III. SYSTEM DESIGN

Components of Proposed System:
Following are the main components required for the project;

1) Heat Source
2) ATMEGA328 Microcontroller
3) Thermoelectric Generator
4) LCD Display
5) Battery
6) Inverter

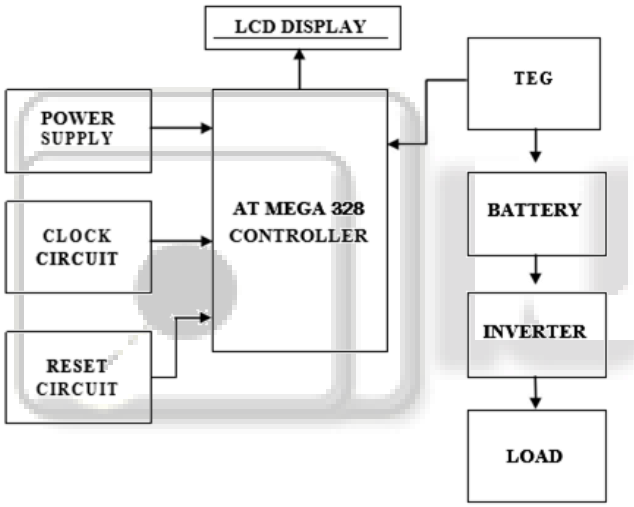

Fig. 1: Arrangement of TEG

Our work consists of following sections

1) Thermoelectric Generator
2) Seebeck Effect
3) ATMEGA 328 Microcontroller

A. Thermoelectric Generator

A Thermoelectric generator, or TEG (also called a See beck generator) is a solid state device that converts heat (temperature differences) directly into electrical energy through a phenomenon called the See beck effect (a form of thermoelectric effect). Thermoelectric generators function like heat engines, but are less bulky and have no moving parts. However, TEGs are typically more expensive and less efficient. Thermoelectric generators could be used in power plants in order to convert waste heat into additional electrical power and in automobiles as automotive thermoelectric generators (ATGs) to increase fuel efficiency. The thermal energy can be directly converted into electrical energy with the use of the device called thermoelectric generator. Though metallic TE materials are used early, nowadays n and p type semiconductor materials are used to manufacture TEGs. The thermo electric materials are "sandwiched" to obtain TEG structure. One of the thermo electric materials having high temperature represents the hot side of TEG whereas the other with low temperature represents the cold side of TEG. TEG materials have high electrical conductivity and thermal conductivity also. Heat transfer, the flow of energy in the form of heat, is a process by which a system's internal energy is changed, hence is of vital use in applications of the First Law of Thermodynamics. Conduction is also known as diffusion, not to be confused with diffusion related to the mixing of constituents of a fluid .The direction of heat transfer is from a region of high temperature to another region of lower temperature, and is governed by the Second Law of Thermodynamics. In order to do that, the system needs a large temperature gradient, which is not easy in real-world applications. The cold side must be cooled by air or water. Heat exchangers are used on both sides of the modules to supply this heating and cooling. There are many challenges in designing a reliable TEG system that operates at high temperatures. Achieving high efficiency in the system requires extensive engineering design in order to balance between the heat flow through the modules and maximizing the temperature gradient across them.

In recent days, TEG has wide range of applications as mentioned below.

1) Remote and off-grid power generators for unmanned sites
2) Load of cars and other automobiles
3) Operation of medical server used for health monitoring system
4) Radio or television rebroadcasting systems
5) Military communication system

1) Types of TEG Devices

Large bulk Thermoelectric Module (TEM) selected for high power applications while thin film TEG is used for low power applications which are thickness thermoelectric elements that are commercially available. For better performances of the TEG and the bulk TEG, three important factors considered are:

1) Increase in thermal resistance of the generator
2) Decrease in thermal resistance and
3) Minimization of electrical resistance

B. Seebeck Effect

"The effect is a phenomenon in which a temperature difference between two dissimilar electrical conductors or semiconductors produces a voltage difference between the two substances." The thermoelectric effect is the direct conversion of temperature differences to electric voltage and vice versa via a thermocouple. A thermoelectric device creates voltage when there is a different on each side. This effect can be used to generate electricity, measure temperature or the change the temperature of objects. Because the direction of heating and cooling is determined by the polarity of the applied voltage, thermoelectric devices can be used as temperature controllers. The Seebeck effect is a best example of an electromotive force (emf) and leads to measurable currents or voltages in the same way as any other emf. Electromotive forces modify ohms law by generating currents even in the absence of voltage differences (or vice versa)

C. ATMEGA 328 Microcontroller

Micro controller is a true computer on a chip. Microprocessors are intended to be general-purpose digital computers whereas micro controllers are intended to be special purpose digital controllers. Generally microprocessors contain a CPU, memory- addressing units and interrupt handling circuits. Micro controllers have these features as well as timers, parallel and serial I/O and internal RAM and ROM. Like the microprocessor, a microcontroller is a general-purpose device, but one that is meant to read data, and control its environmental based on those calculations. The contrast between a micro controller and a microprocessor is best exemplified by the fact that microprocessors have many operational codes for moving data from external memory to CPU; microcontrollers may have one or two. Microprocessors may have one or two types of bit-handling instructions; micro controllers will have many. The microprocessor is concerned with the rapid movement of code and data from external addresses to the chip; the microcontroller is concerned with rapid movements of bits within the chip. The microcontroller can function as a computer with the addition of no external digital parts; the microprocessor must have many additional parts to be operational. Generally 8-bit microcontrollers are intended for use in large volumes as true 1-chipcomputers.

Typical applications consist of appliances and toys. Eight bit micro controllers represent a transition zone between the dedicated, high volume, 4-bit micro controllers and the high performance, 16 and 32-bit units. Eight bit micro controllers are very useful word size for small computing tasks. 16-bit controllers have also been designed to take the advantage of high level programming languages in the expectation that very little assembly language programming will be done when employing these controllers in sophisticated applications. 32 bit controllers are also used in high speed control and signal processing applications.

1) Advantages

1) Produced electricity by wastage of heat directly.
2) Maintenance less.
3) Capital investment less.
4) Space required less.
5) Handling easy.
6) Fast operation.

2) Disadvantages

1) Requires relatively constant heat source.
2) Lack of customer/industry education about thermoelectric generator.
3) Thermoelectric generator requires both high thermal resistance and low thermal conductivity.

IV. CONCLUSION

There is an increase in the demand for energy for our day to day activities, from simple devices to complex systems. All these systems depend on the electricity board or the power company for its operation. At one point of time, the scarcity for fuels occurs causing the scarcity in electricity. Hence, it is important to conserve energy. This project aims to conserve the electrical energy to some extent, by trapping the waste heat from the heat source This project can also be applicable in home appliances, where the heat from gas stoves can be trapped for producing electrical energy. By the efficient use of waste heat energy, we can save some amount of energy for operating appliances.

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