IMPLEMANTATION OF THERMOELECTRIC POWER GENERATION USING PELTIER MODULE

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Abstract

The idea of this paper is to make a use of the waste heat energy being generated in automobiles or industry. It involves the confine of heat energy being generated from the heat source in vehicles and it convert to electrical energy which can be used for many appliances and homes. The heat energy and the temperature from the heat source is being discerned by the thermocouple and is converted to electrical energy by a device called Thermoelectric Generator which works on Seebeck effect. The electric potential give rise to in thermoelectric generator is enhanced by the boost converter thereby in raise the magnitude of voltage, required for charging battery. Remaining, the battery is connected to run the additional appliances in the system.

1. INTRODUCTION

In the modern world, the electricity is very important for our day to day activities in order to provide comfort to the human beings. Right from simple appliances to complex systems, the electrical energy plays an important role for the process and operation of these systems. There are some technologies which implement the recycling of waste heat energy, by which the waste energy produced at the exhaust can be stored and recycled into useful form. Every day, the heat energy is produced from its sources is wasted, which includes the hot voltage produced, thereby sufficient for charging the batteries. The battery once charged, can be used for operating the appliances combustion gases, hot products obtained in the industrial processes and heat transfer from hot equipment surfaces. It includes all kinds of human activities, natural systems and all organisms. The heat energy getting wasted can be stored and converted to useful electrical energy.

The EMF produced from the thermoelectric generator module may not be sufficient to supplement enough by the device called thermo-electric generator power to the system. Hence, the power must be soak up by the use of converters, which include the boost converter. These converters boost the input voltage produced, therefore sufficient for charging the batteries. The battery once charged can be used for operating the applications.

2. IMPLEMENTATION

2.1. HEAT ENERGY

The heat is a form of energy that is used in our day to day life. This heat energy can be seen in gas stoves at homes, engines in automobiles, compressors and in other various equipment. In the heat energy, when there is a suitable physical pathway, the heat flows from the hot surface to the cold surface. The pathway of heat can be direct, as in conduction and radiation, or indirect, as in convection. Therefore, the heat measure to the process of transfer, not to the property of a system. There is and discharge of heat due to various processes explode in the system. However the magnitude of heat generated at various sources is different; thereby the temperature of this operating equipment is not the same. The transfer of heat energy involves three different types, which include conduction, convection and radiation. This heat energy transfer is based upon the devices that emit or work on heat energy. All devices below the heat energy follow the laws of thermodynamics. Some of the devices emit heat energy include heat engine and heat pump. The heat engine is an appliance used to run the vehicle by heat energy generated. The waste heat energy is fabricates at the exhaust. These appliances work on the heat energy pattern, depending upon the system.

2.2. THERMOELECTRIC POWER

The Thermoelectric power is the power acquire by the change of the generated heat energy into electrical energy. It works on the principle of Seebeck effect, which can be express as, "When two ends of the conductor are held at different temperatures, the electrons at the hot junction at higher thermal velocities scattered into the cold junction." This defines that the thermal electrons move from the junction in the hot region to the junction in the cold region. Hence, the EMF generated in the thermoelectric module is proportional to the temperature difference.

2.3. THERMOELECTRIC GENERATOR

The Thermoelectric Generator is also known as TEG, it is a device that works on the principle of Seebeck effect, which is stated above. The TEG module consists of two semiconductor materials which is known as the Seebeck cells or thermo elements. This module has semiconductor thermo elements that are connected electrically in series in order to developed the resulting voltage and due to the temperature difference between the walls of the plate; the energy that is reproduced from thermally excited electrons. A single thermocouple consists of two thermo elements name as p-type and n-type elements. The thermo-elements of the n-type and p-type semiconductors are connected thermally in parallel and electrically in series.
The TEG module can be used for the generation of electric power, in case of lack of power. The efficiency of the thermo element depends upon the value of load resistance and the property of the semiconducting material. Most of the TEG modules are done by Bismuth Telluride (Bi_2Te_3) semiconductor. The heat flowing from one face of the module insert three effects: heat associated with Seebeck effect, the half of Joule heating and thermal conduction of the semiconductor materials. The heterogeneous material composition inside the thermo elements and the different geometry introduces variant in both p-type and n-type materials. Hence the analysis of different elements is considered during calculation.

2.4. TOOLS USED TO IMPLEMETATION

To design and implement the program we used software name as Atmel Studio 6.1 and Cad soft EAGLE 7.1.

Atmel Studio 6.1:

Atmel studio 6.1 is the integrated development environment (IDE) for generate and debugging or run Atmel ARM Cortex - M processor-based and Atmel AVR microcontroller applications. Atmel Studio gives a complete set of features including project file management and version control integration(CVS);a C/C editor with syntax highlighting ,navigation and code completion debugger supporting run control including source and instruction-level stepping and breakpoint, registers, memory and I/O views and target configuration and management. Atmel Studio is built on Eclipse, enabling easy integration with third party plug in for increased functionality. Atmel Studio IDE also gives developers seamless and debug user applications written in C/C or assembly code. Atmel studio supports all 8-bit and 32-bit AVR, SAM3, and SAM4 microcontroller and connects seamlessly to Atmel debugger and development kits.

Cad soft EAGLE 7.1:

EAGLE stands for electronic design automation (EDA) application with schematic capture, printed circuit board (PCB) layout, auto router and computer aided manufacturing (CAM) features. EAGLE is stands for easily applicable graphical layout editor and is developed by Cad soft computer GmbH.

3. METHODOLOGY

The methodology of this paper involves TEG modules placed at the heat source. The output from this module is given as the input to the boost converter, boosting the voltage from TEG. This boosted voltage is a variable DC input voltage and it is used to charge the battery. For the operation of the boost converter, the PWM pulses must be provided to the MOSFET, which is provided by the MOSFET driver circuit. The whole process in this experiment is controlled by using microcontroller. Where heat sources are present then this circuit is used in simple applications. By this method, the waste heat produced at the source can be used for generating the electricity. The block diagram for this experiment is as shown below.

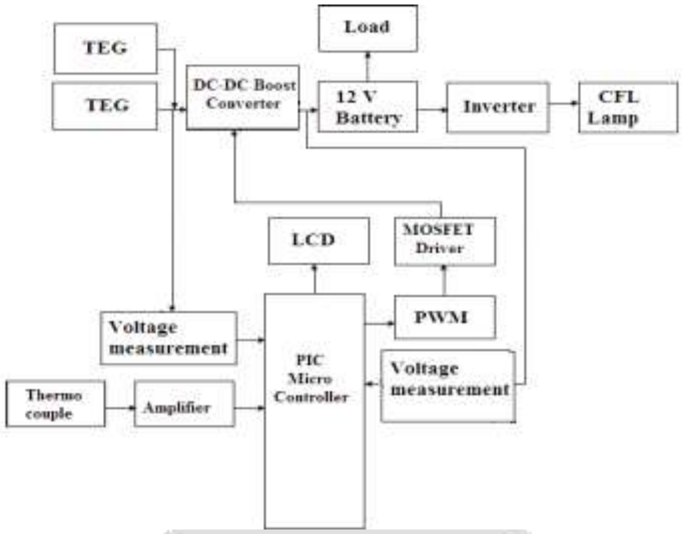


Fig.2.3.1. Block diagram of experiment setup

3.1. THERMOELECTRIC MODULE

The thermoelectric module is known as the thermoelectric generator, which is used to convert the heat energy into electrical energy. They consume the heat energy present in the source, and by this heat energy, the electrons at the hot junction gets excited. The excited electrons move to the cold junction. With the motion of electrons from the hot junction to the cold junction, the EMF is produced. This project works on the principle of Seebeck effect. The Normal thermoelectric modules are made up of Bismuth Telluride (Bi_2Te_3) and sometimes and also made up of Ceramic Plates.

3.2. BOOST CONVERTOR

The boost converter is a device which is used to boost and increase the magnitude of the DC input voltage. It converts the fixed input DC voltage into changing DC voltage. The boost converters use the switched inductors, with a switching device which can be the MOSFET. The metal-oxide-semiconductor field-effect transistor is by far the most common field-effect transistor in both digital and analog circuits. The MOSFET is excited of a channel of n-type or p-type semiconductor material and is accordingly called an NMOSFET or a PMOSFET. This boost converter is also known as step-up converter as the magnitude of the output voltage is greater than that of input voltage. Whereas, the power (P=VI) must be maintain, the magnitude of output current is lesser than the source current.

3.3 PIC MICROCONTROLLER

The PIC microcontroller is also called as the Peripheral Interface Controller. It is a controlling device for the whole circuit process. It plays a important role in providing the PWM pulses to the MOSFET driver circuit. The commonly used PIC microcontroller is PIC 16F877. The core features of PIC microcontroller consist of high performance RISC CPU, eight level deep hardware stack, low power consumption (around 2mA, for 5V, 4MHz), wide operating voltage range. It is a 40 pin device, with 5 ports. Port A uses 6 pins, ports B, C and D uses 8 pins and Port E has 3 pins. The port D is 8 bit with Schmitt triggered input buffers. The ports B and C are 8-bit bi-directional ports. The 3 pins of Port E are individually configurable as inputs or outputs, these pins also have Schmitt triggered input buffers. The buffers are Schmitt trigger inputs, when they are configured as external interrupts, when used in serial programming modes, when configured as general purpose inputs and TTL input when operated in Parallel Slave Port Mode. Some pins in the microcontroller are multiplexed with alternate function for the peripheral/output features of the device. The other devices are used in this circuit for include the voltage measuring device, which is used to measure the voltage produced at the TEG module, and the voltage at the boost converter; the Amplifier for amplifying input voltage from the TEG module; thermocouple for measuring the input temperature of the heat source and the LCD display for displaying the parameters in the circuit.

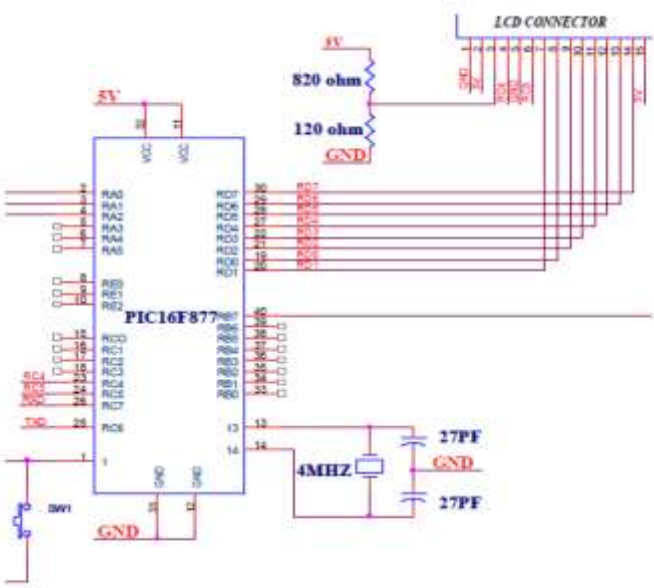


Fig.3.3.1 Microcontroller and its wiring.

4. WORKING

The heat from the heat source in automobiles is monitored and measured by a device which is called thermocouple. This heat from the source is converted to electrical energy of a less magnitude ranging from 2V to 3V. This voltage is amplified by using a voltage amplifier, around to 5V. This input voltage from the amplifier is boosted by using a boost converter or amplifier. The boost converter having switched inductor, with MOSFET as a switching device. The PWM signals are produced from the PIC microcontroller, which is used to operate the MOSFET driver circuit. The MOSFET driver circuit gives high speed switching for the MOSFET in the boost converter. Depends on the switching, the energy is stored in the inductor and is delivered to the battery. A battery of the order of 12V is fetched across the boost converter. The variant
DC input voltage from the boost converter is used to charge the battery. After the battery is charged, is used to operate the load. The load circuit in this experiment required the CFL lamps and a fan, which is operated form a single 12 V battery. The performance of the circuit depends on the magnitude of heat at the source.
The output of the project is obtained experimentally as shown below.

Fig.4.1 Experimental output

5. RESULT

The magnitude of the input voltage from the TEG module based on the temperature of the heat source.

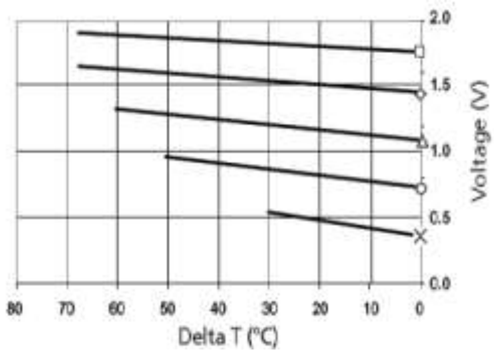
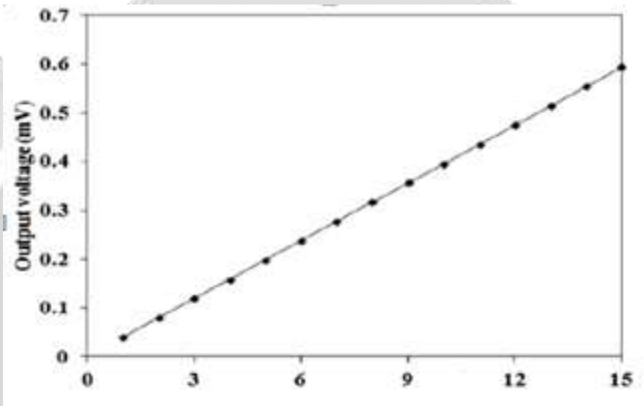


Fig.5.1 Temperature difference VS Voltage Graph

The input voltage increases with an increase in the temperature difference of the source. The graph is plotted, for temperature difference and voltage, as shown.



Temperature Difference (K)

Fig.5.2. Temperature difference VS Voltage Graph

The voltage is amplified by the amplifier, this amplified voltage is boosted to a magnitude of higher or large voltage, and this depends upon the speed of MOSFET switching.

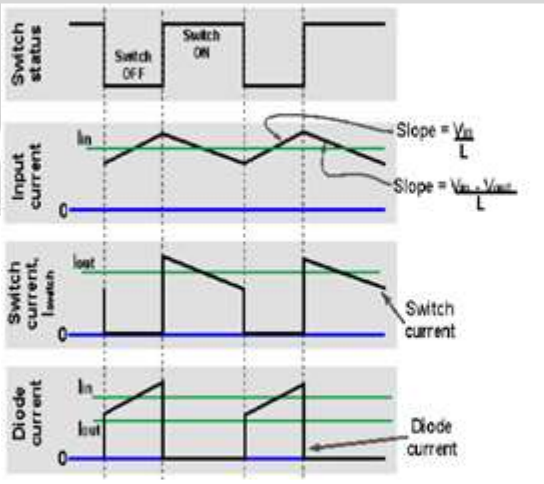


Fig.5.3 Boost Converter

Hence the result found from the fig.4.1.shows, when the temperature is increased heat is generates and this heat is converted into electrical energy which helps to operate or glow the light or more household appliances.

6. CONCLUSION

There is an increase in the requirement for energy in our day to day life, from simple devices to complex systems. All this setup depends 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 paper aims to preserve the electrical energy to some extent, by trapping the waste heat from the heat source in automobiles. This paper can also be used 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 and additional systems in vehicles.

7. REFERENCES

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