AN INNOVATIVE APPROACH TOWARDS EXTRACTION OF ENERGY FROM WASTE HEAT

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Abstract: *In present, for generation of electricity 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 resulting new technology is needed for electricity generation, 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 can't 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. Heat source which is need for this conversion is less when contrast to conventional methods. By using this, energy is used to charge the mobile electronics, run home appliances, dc lighting.*

KEY WORDS- **Thermoelectric generator, see-beck effect, waste-heat recovery, alternative green technology, direct energy conversion, thermocouple, thermoelectric materials, thermo electric module.**

1. INTRODUCTION

As the title mention this system will prove to be an effective alternative for extraction/ generation of desired energy from waste energy. According to energy conversation law, energy can't be created or destroyed it will be transformed from one form to another but during transformation there is a energy loss. In our system we are going to use this energy in an efficient way i.e. one of the daily used vehicle is our private cars. So as most of the vehicles are using internal combustion engine this produces a considerable heat and dissipated into the environment. We have proposed a system with a thermo-electric generation technique in which a direct energy transducers are used which produces the electrical power proportional to heat difference maintain around the transducer. Basically this transducer are working on the principle of thermo-couple technique in which it states that whenever there is a difference between the two junction of a material made with a combined elements so that this temperature difference makes the electron flow between the two junction held at different temperature. To enhance the efficiency and utilization a post generation module is implemented which generates the different form of voltages to drive and satisfy our daily needs like mobile charging, home dc as well as ac lightening.

2. SYSTEM DESCRIPTION

As shown in diagram below, a system starts from a thermal electric energy generator which generates the electricity and supplied to the dc-dc boost circuit which then connected to charger for battery charging with tickle charging technique to feed up battery in very short time. In order to maintain the temperature difference between hot junction and reference cold junction, an aluminum fin heatsink is mounted on the cold side with cooling fan assembly for the demonstration at local level. In real implementation of vehicle system this cooling mechanism will be linked to the engine cooling system of vehicle. Also the battery health monitoring system is included in circuit. On the output side, battery protection circuit is used to prevent the deep discharge by the load to ensure long battery life. As suggested In the system for daily life utilization, we have incorporated the inverter circuit for generation of 230 Volts ac mains ac supply to drive ac load. At the same time USB charging ports are provided for smart phone charging directly to avoid ac-dc conversion losses from normal plug-in mains charger. This charger is considered to be one of the important part as, we all use a smart phones now a days generally consumes near about 900 Watts a month. So this system will help us to reduce that unnecessary wastage of the energy. With the same consideration of conversion losses in mobile chargers we have deployed a dedicated dc lightening source which can drive the dc lightening source directly. So all this design increases the overall efficiency of the system.

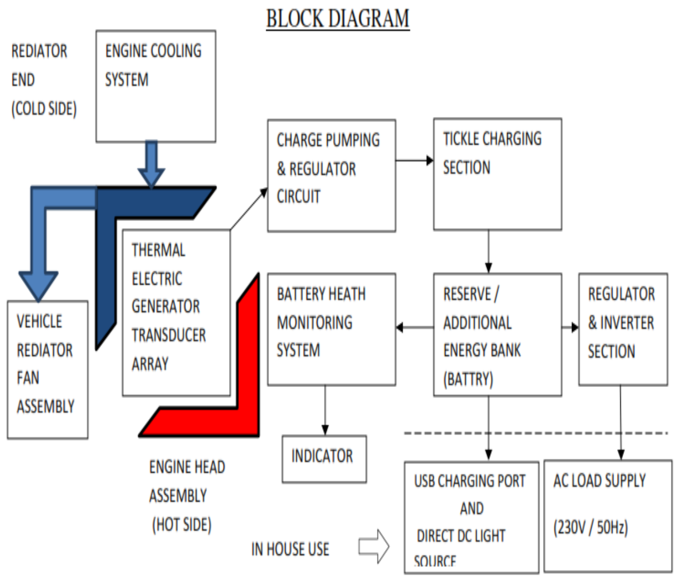

Fig. 2.1 (a) Block Diagram

2.1 Thermocouple:

A Thermocouple is a sensor used to measure temperature. Thermocouples consist of two wire legs made from different metals. The wires legs are welded together at one end, creating a junction. This junction is where the temperature is measured. When the junction experiences a change in temperature, a voltage is created. A thermocouple is a type of temperature sensor, which is made by joining two dissimilar metals at one end. The joined end is referred to as the HOT JUNCTION. The other end of these dissimilar metals is referred to as the COLD JUNCTION. The cold junction is actually formed at the last point of thermocouple material.

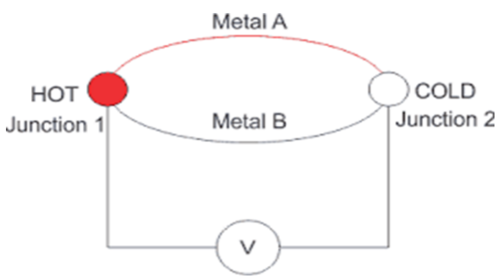

Fig 2.1(b): Temperature between two junctions

CONSTRUCTION:

Two unique semiconductors, one n-type and one p-type, are used because they need to have different electron densities. The semiconductors are placed thermally in parallel to each other and electrically in series and then joined with a thermally conducting plate on each side. When a voltage is applied to the free ends of the two semiconductors there is a flow of DC current across the junction of the semiconductors causing a temperature difference. The side with the cooling plate absorbs heat which is then moved to the other side of the device where the heat sink is. TECs are typically connected side by side and sandwiched between two ceramic plates. The cooling ability of the total unit is then proportional to the number of TECs in it.

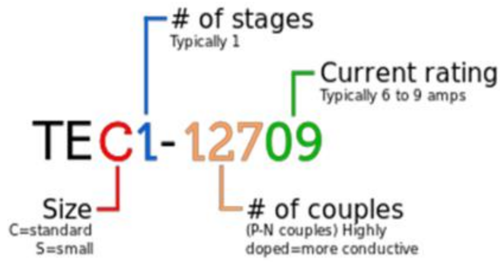

Fig 2.1(c): TEC plate rating

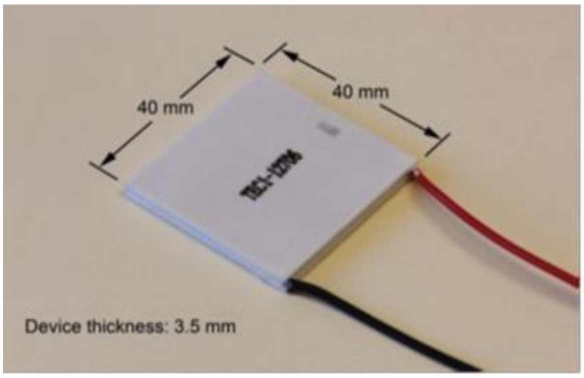

Fig 2.1(d): View of TEC thickness

A testing assembly was constructed such that a known heat could be added to "hot" side of the device. By measuring the power output of the thermoelectric device through a load, the efficiency of the thermoelectric device can be calculated as follows:

$$\eta = \frac{P_{out}}{Q_{in}}$$

Where, η = thermal efficiency
Pout = measured power output of the device (watts)
Qin = measured input heat to the device (watts)

2.2 Pelter structure:

A typical thermoelectric module consists of an array of Bismuth Telluride semiconductor pellets that have been "doped" so that one type of charge carrier–either positive or negative– carries the majority of current. The pairs of P/N pellets are configured so that they are connected electrically in series, but thermally in parallel. Metalized ceramic substrates provide the platform for the pellets and the small conductive tabs that connect them.

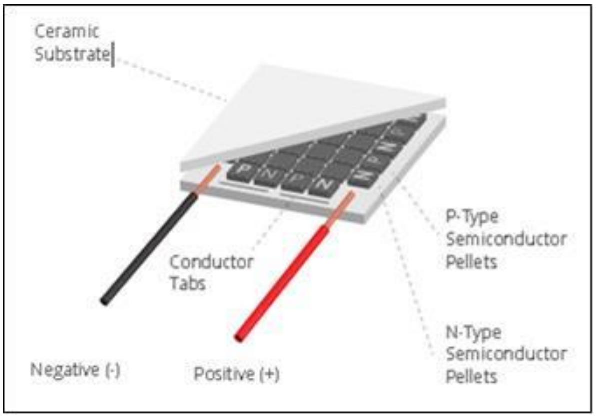

Fig 2.2(a): Pelters Structure

2.2.1 Pelter Theory:

When DC voltage is applied to the module, the positive and negative charge carriers in the pellet array absorb heat energy from one substrate surface and release it to the substrate at the opposite side. The surface where heat energy is absorbed becomes cold; the opposite surface where heat energy is released, becomes hot. Reversing the polarity will result in reversed hot and cold sides.

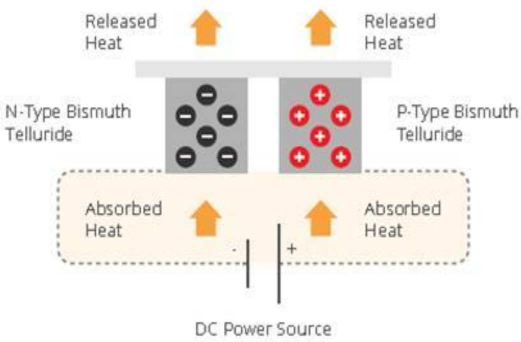

Fig 2.2.1: View of see beck effect

When heat is applied to one of the two conductors or semiconductors, heated electrons flow toward the cooler one. If the pair is connected through an electrical circuit, direct current (DC) flows through that circuit. The voltages produced by Seebeck effect are small, usually only a few microvolts (millionths of a volt) per kelvin of temperature difference at the junction. If the temperature difference is large enough, some Seebeck-effect devices can produce a few millivolts (thousandths of a volt). Numerous such devices can be connected in series to increase the output voltage or in parallel to increase the maximum deliverable current. Large arrays of Seebeck-effect devices can provide useful, small-scale electrical power if a large temperature difference is maintained across the junctions.

2.3 Radiator Fans:

Fig2.3 (a): View of Radiator fans

Radiators are heat exchangers used for cooling internal combustion engines, mainly in automobiles but also in piston-engine aircraft, railway locomotives, motorcycles, stationary generating plant or any similar use of such an engine. Internal combustion engines are often cooled by circulating a liquid called engine coolant through the engine block, where it is heated, then through a radiator where it loses heat to the atmosphere, and then returned to the engine. Engine coolant is usually water-based, but may also be oil. The radiator transfers the heat from the fluid inside to the air outside, thereby cooling the fluid, which in turn cools the engine. Radiators are also often used to cool automatic transmission fluids, air conditioner refrigerant, intake air, and sometimes to cool motor oil or power steering fluid. Radiators are typically mounted in a position where they receive airflow from the forward movement of the vehicle, such as behind a front grill. Where engines are mid- or rear-mounted, it is common to mount the radiator behind a front grill to achieve sufficient airflow, even though this requires long coolant pipes.

2.4 Heat Sink Assembly

A heat sink (also commonly spelled heat sink) is a passive heat exchanger that transfers the heat generated by an electronic or a mechanical device to a fluid medium, often air or a liquid coolant, where it is dissipated away from the device, thereby allowing regulation of the device's temperature at optimal levels. A heat sink is designed to maximize its surface area in contact with the cooling medium surrounding it, such as the air. Air velocity, choice of material, protrusion design and surface treatment are factors that affect the performance of a heat sink.

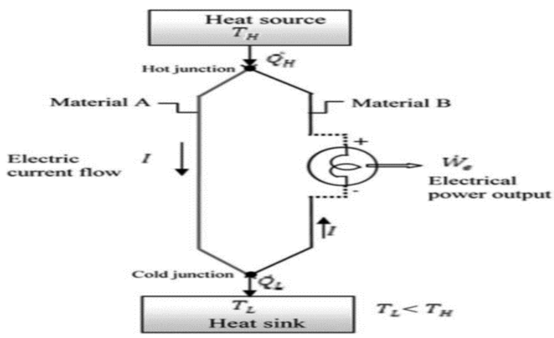

Fig 2.3 (b): Process and view of heat sink

2.4 Battery

The lead-acid battery was invented in 1859 by French physicist Gaston Planet and is the oldest type of rechargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, its ability to supply high surge currents means that the cells have a relatively large power to weight ratio. These features, along with their low cost, makes it attractive for use in motor vehicles to provide the high current required by automobile starter motor.

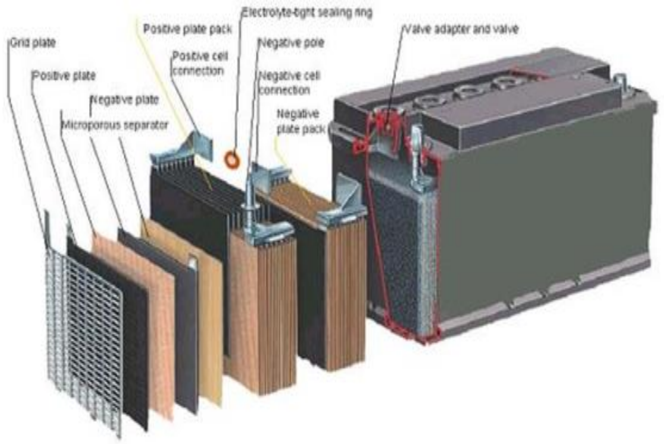

Fig 2.4: Internal view of battery

2.5 Charging Unit

Trickle charging means charging a fully charged battery under no-load at a rate equal to its self-discharge rate, thus enabling the battery to remain at its fully charged level. A battery under continuous float voltage charging is said to be under float-charging. For lead-acid batteries under no-load float charging (such as in SLI batteries), trickle charging is achieved naturally at the end-of-charge, when the lead-acid battery takes in a trickle charge to keep itself fully charged. The trickle charging then equals the energy expended by the lead-acid battery in splitting the water in the electrolyte into hydrogen and oxygen gases.

2.5.1 Trickle Charger

To trickle charge or maintain charge your 12-Volt lead-acid batteries with a smart charger is a decision that might affect the health and life cycle of your batteries. While both are designed to slowly emit low-voltage charges to your vehicle battery, Restoring the battery to a full charge status over several hours, the critical difference lies in the chargers' ability to automatically shut off the charge current and not overcharge batteries, which can lead to overheating and serious damage. Another important difference is the ability of some maintenance chargers to disulphate and clean battery plates, restoring them to normal operation and extending battery life. Trickle chargers are designed to maintain a charge equal to the self-discharge rate of the battery (2.23 to 2.25 volts per cell) Leaving an unattended trickle charger on for too long might lead to overheating, causing the battery to boil the electrolyte. The outcome would be a dead battery or a worst case scenario— a possible fire/explosion. A maintenance charger (also called a float or smart charger) however, is a true plug- and-play product that takes the human error element out of the battery charging function. Maintenance chargers can be left connected to the battery indefinitely without risk of damage to the battery.

2.6 Boost Converter:

A boost converter (step-up converter) is a DC-to-DC power converter that steps up voltage (while stepping down current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) containing at least two semiconductors (a diode and a transistor) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter).

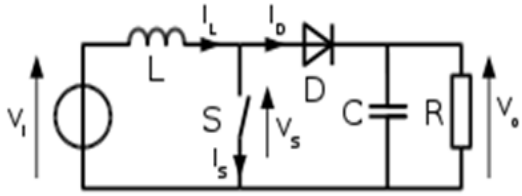

Fig 2.5: Boost converter schematic

2.6 Inverter:

DC to AC power inverters, which aim to efficiently transform a DC power source to a high voltage AC source, similar to power that would be available at an electrical wall outlet. Inverters are used for many applications, as in situations where low voltage DC sources such as batteries, solar panels or fuel cells must be converted so that devices can run off of AC power. The method in which the low voltage DC power is inverted, is completed in two steps. The first being the conversion of the low voltage DC power to a high voltage DC source, and the second step being the conversion of the high DC source to an AC waveform using pulse width modulation. Pure sine wave inverters, on the other hand, produce a sine wave output identical to the power coming out of an electrical outlet. These devices are able to run more sensitive devices that a modified sine wave may cause damage to such as: laser printers, laptop computers, power tools, digital clocks and medical equipment. This form of AC power also reduces audible noise in devices such as fluorescent lights and runs inductive loads, like motors, faster and quieter due to the low harmonic distortion.

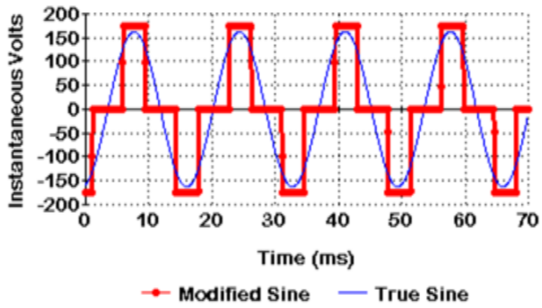

Fig 2.6: Inverter waveform

Advantages:

• TEGs are solid-state device, which means that they have no moving parts during their operations.

• No moving parts so maintenance required is less frequently, no chlorofluorocarbons.

• Temperature control to within fractions of a degree can be maintained, flexible shape, very small size.

• TEGs can be used in environments that are smaller or more severe than conventional refrigeration.

• TEG has long life, and also it can be controllable by changing input current and voltage.

Future Scope:

• As currently we have proposed a system for utilization of own level so it can be incorporated in smart grid concept to provide unused energy by us to the grid so others can use this energy we can reduce the bills.

• If it is cold outside and you are wearing a jacket made of material embedded with thermoelectric modules, you could recharge mobile electronic devices off the heat of your body.

• In fact, thermoelectric generators have already been used to convert body heat to power wrist watches.

CONCLUSIONS:

• Thermoelectric developer is used to provide electric power which is designed from spend warmed produce by different equipment in industry, transmission line etc. In this paper we provided our suggested analysis in which we use a converging reflection for concentrating warmed on thermopiles.

• The number of thermopiles in our project is three (3) which provide two junctions, which are connected electrically in series and thermally in parallel. The voltage at the junction is (3.9 to 4.2) volts. At 75°C our system give maximum output, and the calculated efficiency of our system is 4.2%.

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