

THERMOELECTRIC MODULE AS A PRESENT METHOD OF POWER GENERATION BY RECOVERING WASTE HEAT ENERGY AND ITS UTILIZATION IN OTHER USEFUL SYSTEMS

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ABSTRACT: - The main objective of this study is to design and build an affordable solar thermoelectric twin chamber food storage and delivery box for the Bedouin people (e.g. deserts, Armed forces, farmers) living in remote parts where electricity is still not available. The twin chamber box could be used to store perishable items and facilitate the transportation of medications, biological material as well as food stuff and beverages that must be stored at low temperatures to maintain effectiveness. The design of the solar-powered food storage box is based on the principles of a thermoelectric module (i.e., Peltier effect & Seebeck effect) to create a hot side and a cold side.. The designed setup was experimentally tested for the heating purpose. Authors have been designed and developed an exploratory frame work of the thermoelectric generator system, it can also work on solar plate. It is found efficient to recover the energy from the solar plate, but solar plate is efficient only during sunshine hours so to increase the efficiency of power generation from solar plate^[9] some other waste heat emitters are utilized in order to generate electricity or to utilize waste heat to store it.

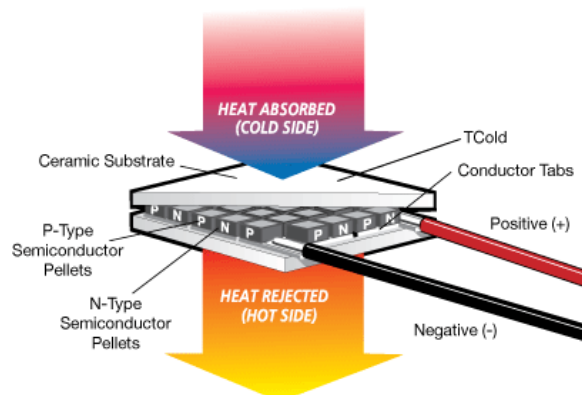
Keywords:- Thermoelectric generator, thermoelectric effect, waste heat, Thermoelectric module, Heat pipe.

INTRODUCTION: - Power creation is done from span of years. The sources of power generation are Coal, Natural Gas, Solar Wind, Petroleum Oil are the traditional routine.^[2] The sources like Coal, Gas, and Oil etc. Also the Solar energy is Available only sun shine haul^[9] .These are the most common form, but the issue is that they liberate pollutants from these sources and get discharged into air as well as create negative impact on water quality, air, and soil, harm wild life and affect human health also. Focusing over the places where power availability is still a problem, and recovering of wastage heat or energy through heat by using (TE) module can play a vital role. The activity of power creation through (TE) module is based on two different effects i.e. Seebeck effect and Peltier effect. This paper presents various method of recovering heat through from the different sources of wastage heat. First, let us know what is Seebeck effect and Peltier effect.

SEEBECK EFFECT: Thomas Johann Seebeck was a German Physicist who discovered the thermoelectric effect. He found in 1821 that the thermoelectric effect where a junction of two dissimilar metals

produces current when exposed to temperature gradient. temperature changes between opposite segments causes heat flow from higher region to lower region.

PELTIER EFFECT[8] : In 1834, Peltier found that when an electric current passed through a circuit of two dissimilar metals, heat is evolved at one junction and absorbed at other junction. This effect is opposite of seebeck effect . There is a flow of thermal energy or absorption of thermal energy at one different junction and discharged at other junction.



THERMOELECTRIC MODULE[8] : Thermoelectric module are a kind of heat pumps that worked on the principle of peltier effect. The device has two sides , when direct current (DC) flows through it, it transfers heat from one side to the other so one side gets hotter while other side get cold. Two semiconductors are placed parallel and electrically in series . p- type and n-type semiconductors. When voltage is applied from the two junction flow of current across the junctions of semiconductor causes temperature difference.

Sources Of Waste Heat:

1. Combustion exhaust
 - Glass melting furnace
 - Cement Kiln
 - Steam generator (BOILER) in thermal power plants.
2. Process exhaust
 - Steel electric arc furnace
3. Hot gasses from drying ovens
4. Cooling tower water
 - Furnace
 - Air compressors.

Uses Of Power Generation :

- Combustion air – pre- heating.
- Boiler feed water pre heating
- Steam generation for use in : -
 - Power generation
 - Mechanical power

- Process steam
- Water pre-heating

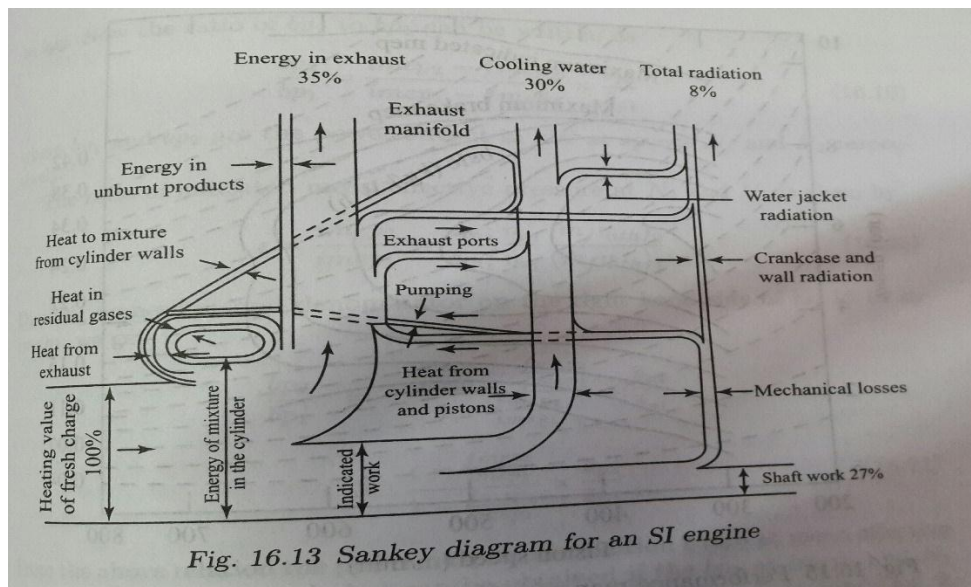
Thermo electric modules convert the waste heat into electricity and also uses the electricity for direct heating and cooling.

Preceding Researches

1. By Gregory P. Meisner [1]

In India transportation increasing day by day due to fast industrilization, fast transportation demand in short time. Use of Diesel vehicals than Gasolin has been increased in last 10 years.About 14 % of Green house gasses are emitted from these sector.95% of transportation energy comes from petroleum based fuels.

As illustrated in fig. (Sankey Diagram) given below , heat lost from an engine in many ways. The heating value of fuel is consumed.



Improbable thing is that only a part of energy is transformrd for usefull work.According to above diagram if 100 % fuel is supplied and heating value of fresh charge the energy is developed in the cylinder of an engine.Burning of fuel consequently respond in loss of heat in the form of energy through many ways like , energy loss from exhaust i.e 25 % , cooling water 30 % , surrounding 20 % of BP is available i.e power.So a big approach could be made to utilize these wastage energy for reuse.A modification was implimented on exhaust system, parts fabricated and (TEG) installed in it.A heat exchanger is used.One side is hot exhaust gas inlet into the heat exchanger and other side is exhaust gas outlet.Hence they have concluded that, there observation is on to achive 10 % fuel economy without increasing emmissions.

- 2 M.F REMELI^{a,b*}, L.KIATBODIN^a, ETAL[2]

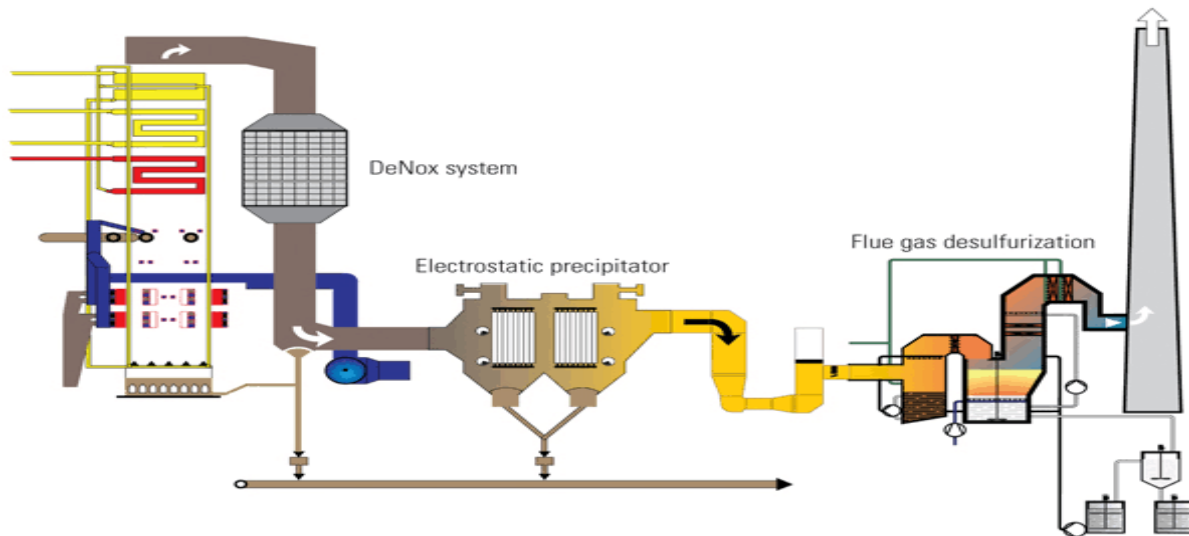
This proposed system is based on recovery of waste heat to power generation in various plants and industries uses thermal energy in there daily process. The setup includes heat pipe and thermo electric generator (TEG) . The (TEG) was developed for waste heat recovery. The system has two copper blockes, 4 heat pipes and (TEG) is placed between two blocks. Transferring the heat from hot duct through fixed speed fan from the inlet to heat up the one side of the (TEG) module, and discharged to upper duct [upper finned heat pipe that acts as condensing unit]. So that, upper side of (TEG) module cools down. The one fan is used on other end with different speed. A heater is placed next to the fixed speed fan, so it enables the flow of air over it and the incoming air get heated. The temperature difference between (TEG) module resulting power generation . The system is likely enables the recovery of waste heat.Hence we concluded from the above proposed setup that, they utilized the waste heat from the heat pipe and used to generate electricity with the use of thermo electric generator.(TEG).

3. *Adhitya K¹, Rajeshwar Anand², ETAL[3]*

The heat from the heat source in automobile i.e engine is measured and controled by a device is known as thermocouple.This heat energy from the source is converted into electrical energy from 2V to 3V of smaller magnitutde range.With the help of voltage amplifier this voltage is elaborated upto 5V. This input voltage from the amplifier is boosted by using a boost converter[3]1.A switching device MOSFET[3] involved in a boost converter as a switched inductor. The Pulse Width Modulation [PWM] signal are provided from PIC microcontroller. The PIC is used to monitor the MOSFET driver circuit. High speed switching is provided for the MOSFET in the boost converter.The energy stored in the inductor is delivered to battery on the basis of MOSFET switching. From the boost converter a battery is connected of about 12V. The battery is charged by a DC input voltage from the boost converter. From the above operation the battery will get charged and is ready to operate the electronic appliances, fro ex. CFL lamps, fan etc.From the above experimental setup it is concluded that the electricity can be generated from the waste heat from the automobile engine, and can be utilized in electronic appliances.

4.*Sanja Boskovic^[1], mehrzad tabatabaian^[2] et al[4]*

The above reasercher's have tried to conclude and succesfully achived a result upon demonstration and uses of TEG electricity power generation from waste heat. Based upon their and study , they were able to found able to found during his school energy initiatives and focus theame. Their study concerend with reasearching on The BCIT power house a conventional thermal power plant.Their's focus was on sustainable energy resources and conversion of energy from the waste heat in electric energy form and their implimenting plans. The conventional plant includes (Boilers, condensor's , turbine, and exhaust stake). Are sources of waste heat.The waste heat can be generate using (Thermoelectric power generation) TPEG and further it can supply to electronics and other control systems. We know that electric voltage ('Pressure') say driving force which is responsible for driving current in the circuit or flow of electrons (e). Similarly, other forces like temp. difference would result in flow of heat / thermal energy may drive the electrons through the circuit.



(a) Fig: block diagram of boiler

Hence, they concluded from the above proposed setup by them, when observation carried out by successfully by them at BCIT power plant, they observed TEG module applied to available waste heat source.

5.Scott lee^[1][5]

His proposed was to seeking for a research carried out by NASA to store electricity for its components or equipments. The project is based on thermoelectric devices that convert heat energy into electric energy. The project carried out by NASA is “Thermoelectric Battery Charging Circuit”. From many years due to outrageous use of fossil fuels, the lack of fuel or crude oil will be end one day. This is due to addiction and human dependency on fossil fuels. Renewable energy is clean energy source and attractive too. The project has discussed itself about the introduction of way to humans to create renewable energy using TE modules.



Fig: TEG circuit block diagram

The above setup has three components connected in series i.e 1. TE generator 2. Lithium-ion Battery charger 3. Lithium – ion battery. This setup intended to built to serve as a power supplier to battery. A thermal gradient is created by placing one side of TE generator on a hot plate, and other part under a block of salted ice. A fibre glass sheet as a insulation has been placed at the centre of thermoelectric generator. It will act as a insulation between generator and hot plate. The temperature was 175°C. From the above setup he has concluded that experiments show that this will produce a sufficient voltage to power each of the two different lithium-ion chargers. After a lithium ion battery charger with TEG generator, the battery is connected for charging.

6. Nikolay Anatolyevich Khripach^[1], Boris Arkadyevich Papkin^[2], et al

Another way here it is included in this review article about recovering of heat from the exhaust system to efficient conversion into electricity. The modern exhaust system of commercial vehical carried 40% of burned fuel energy which is expelled easily to atmosphere. It can be a potential source of improvement to the engine effecency.

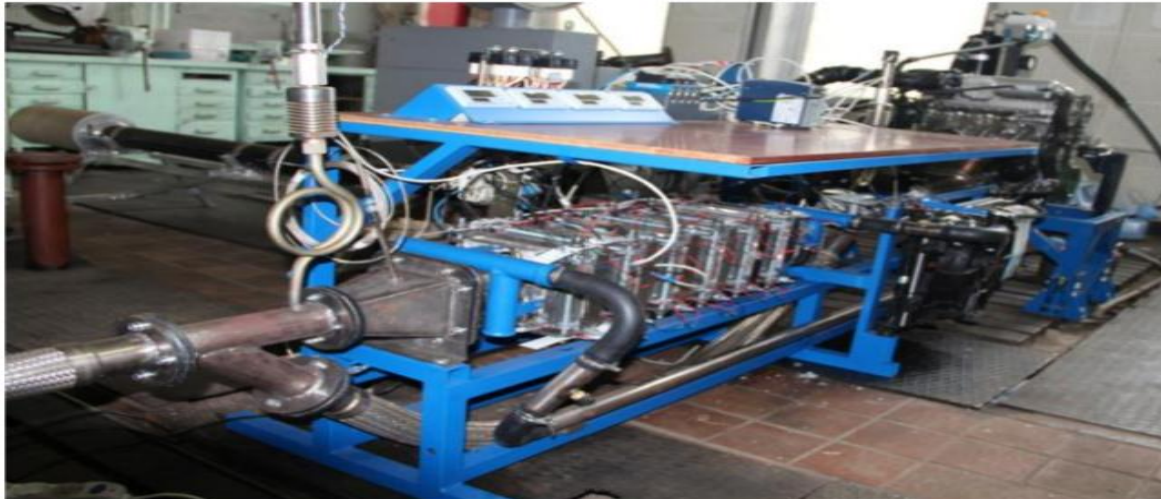


Fig: Test bench with installed TE generator during the research testing.

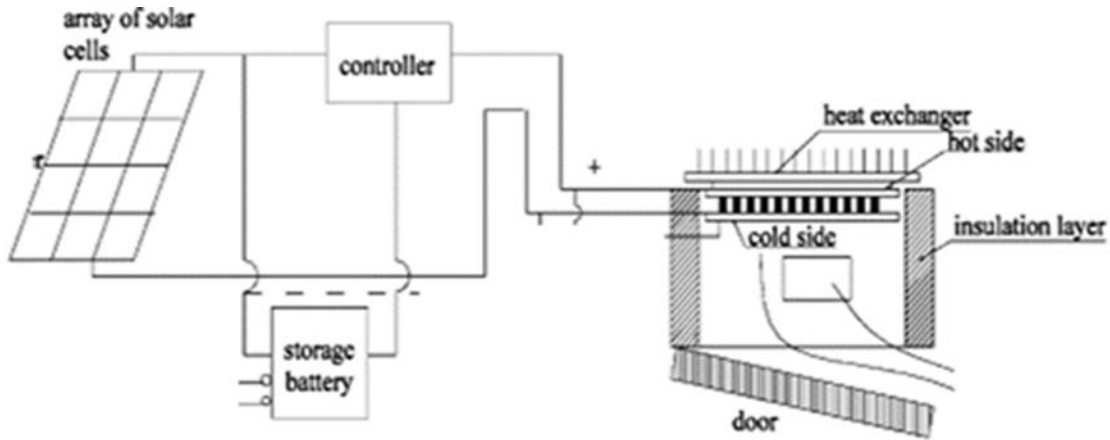
The TE generator were developed by them was tested succesfully in different operating modes of IC engine, which was used as a source for the hot heat transfer medium for the TEG. The propertion of heat energy converted to electrcity by IC engine reached to 20%. For certain operating modes. A TEG for exhauast system of IC engine has 3 elements which produces temp. difference in their hot and cold side. First, heat exchanger was used to take heat from exhaust gas and supplied it to TE module. It keeps the hot junction in the hot state constantly. The second heat exchanger is used to remove heat from the TE modules and dissipate it to the stream of on comming air. Currently the system is adopted by leading manufacturer of luxery car manufacturing companies, they are BMW, Hundayi, Toyota, and General Motors etc. From the above review it is concluded that there is 20% of recovery of waste heat from exhaust system into electricity.

Objective:- The aim of the project is to investigate experimentally and numerically the COP the thermoelectric food chamber box using Peltier modules. The twin chamber box has its unique features to maintain at a time two temperatures. One side can be maintained at hot and other side can be maintained in cold condition. One of its major characteristics that it is portable and light weight so that it can carry away any ware we want. The TE module has certain limitation's too, that its maxi. Operating temp. on the hot side is up to 60°C. Beyond that it will stop operating to extract heat from the atmosphere or may the module will tear.

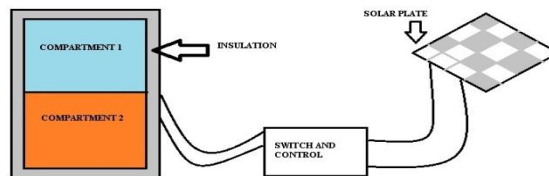
Working of Twin Chamber Food Storage Box

Solar panel is of 300*350 mm in dimension & is consists of 72 cells and efficient way of converting solar energy into useful electric energy. The unit produces electricity when exposed to sunlight. Maxi. Power 10W. Charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries. It prevents overcharging and may protect against over voltage, which can reduce

battery performance or life span and may pose a safety risk. The controller saves the energy and sends the power to the battery for a limited power or volt. Hence, battery will get charged. A rechargeable battery was used of 12 V, 8.0 Ah sealed lead acid battery and can be recycled or disposed properly. The convertor circuit is used to convert AC source to DC or vice versa. A convertor switch is installed which may require switching the current source as required. The convertor circuit has two switch, one for changing the current source and other for changing the polarity of current so as to obtain heating in one chamber and cooling.



(1) Fig: Block diagram of Setup



(2) Line diagram

Formula to be used :-[8]

1). $Q = \Delta T \times A$

$$\frac{1}{\frac{1}{h} + \frac{L}{K}} \quad \text{unit :- W}$$

where, Q = Heat transfer from the module ambient temp. to the inside of the box

h = convective heat transfer co- efficient.

A = Area

K = Thermal conductivity of insulation placed between two chambers and aluminium pot

L = Length of the box.

ΔT = Temp. difference

$$2). Q = \Delta T \times A / 2 \times (1/h_{\text{air}} + l_1/K_p + l_2/K_{\text{Al}}) \quad \text{Unit :- W}$$

$$3). \text{TE module power} = (V \times I). \text{ W}$$

4). Coefficient of performance of the heating (COP_h)

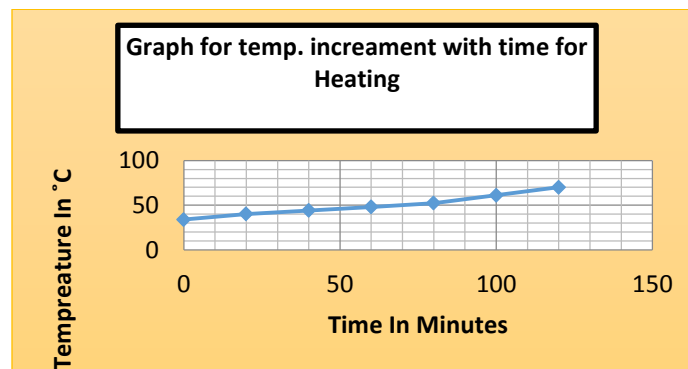
$$\text{COP}_h = C_{\text{heating}} / W_{\text{in}}$$

5). Power given to the system for working,

$$W_{\text{in}} = V \times I + \text{fan input}$$

Result & Discussion:-

Some readings were recorded during experiment is carried out i.e heating of one chamber with increment of temperature w.r.t. time. The ambient temperature was found to be 34 °C.



From the graph, the results were recorded shows an increase in temperature in every 20 min of time interval.

Conclusion:-

From the above preceding researches it is concluded that the thermoelectric module and the generator as well can play a vital role in future power generation. From waste heat energy that can be waste from the heat emitting devices present around us where it could be from the industries, home (kitchen), automobile vehicles, kiln, furnaces etc. is used in order to generate electricity.

Another means of saving energy due to day-by-day expulsion of flue gasses and heat from radiation and many such examples that heat can be recovered in many different ways. One side of our setup may be called as “Compressor less refrigerator” as we have used with axial flow module fan connected with heat sink and TE module. From the above literature review we have concluded that the efficient way to gain energy and it can be used for many such sources to create power. Hope it will foster the use of peltier module in near future and become cheap renewable source energy creation soon.

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