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A PATH FOR HORIZING YOUR INNOVATIVE WORK

WASTE HEAT RECOVERY BY THERMOELECTRIC GENERATOR

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Abstract: 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. Thermoelectric 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. In this paper, a background on the basic concepts of thermoelectric power generation is presented and recent patents of thermoelectric power generation with their important and relevant applications to waste-heat energy are reviewed and discussed.[6]

Keywords: Thermoelectric power generator, waste-heat recovery, alternative green technology.

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INTRODUCTION

If two dissimilar materials are connected to each other at two points to form an electric circuit, and the two junctions are maintained at different temperatures then, depending on the thermoelectric properties of the two materials, a current will flow in the electric circuit. If a resistive load is now included in the circuit, electrical energy will be dissipated in the load. A thermoelectric generator of this type may have application in systems where waste heat may be utilized by direct conversion into electrical energy and used to supply or control devices within the system. Since the thermoelectric effects are reversible they might also be applied to local refrigeration or temperature control systems.

It is the purpose of this note to examine the possibilities offered by thermoelectric devices and to discuss the present position and future prospects in the field.

THE NATURE OF THE THERMOELECTRICE EFFECT

When a circuit is formed by two dissimilar materials and the junctions are maintained at different temperatures by some external agency, two types of thermoelectric effect may be apparent:-

(1) The Seebeck effect :

This gives rise to an electromotive force in the circuit by virtue of the temperature difference between the two junctions. The reverse effect, known as the Peltier effect, causes heat to be emitted at one junction and absorbed at the other when an electric current is passed through the circuit.

(2) The Thomson effect:

This gives rise to an e.m.f. in any element of temperature gradient. This effect is usually small effect over the range of temperature difference for most usefully be employed.

The ratio of change of total e.m.f.in the circuit with change in temperature difference between the junctions is known as thermoelectric power α of circuit.

The efficiency η of thermoelectric generator is the percentage of rate of consumption of thermal energy which is delivered to the load as electrical power. Thus for the generator of high efficiency, materials are required which has a high value of thermoelectric power α and which has low value of thermal conductivity k, so that for a fixed temperature difference between the hot and cold junctions a minimum of heat will be lost irreversibly by conduction down the branches. For a given load the maximum efficiency is achieved with a generator having minimum internal impedance; this demands the thermoelectric material with low specific resistivity ρ.

It can be shown that the parameter = α2/kρ is a convenient figure of merit with which to describe thermoelectric materials.

Modern commercial thermoelectric semiconductor materials can be divided into three temperature ranges: Low temperature (< 450 K) alloys use bismuth in combination with antimony, tellurium and selenium, medium range (850 K) materials are based on lead telluride and high temperature (up to 1300 K) materials are based on silicon and germanium [2].

II. MATERIALS AND METHODS

A. Thermoelectric Generator:

Thermoelectric Generator is all solid state devices that convert heat into electricity. Unlike traditional dynamic heat engine, Thermoelectric Generator contains no moving parts and is completely silent. Such generator have been used reliably for over 30 years of maintenance free operation in deep space probes such as voyager mission of NASA.1 compared to large, traditional heat engines, thermoelectric generators have lower frequency. But for

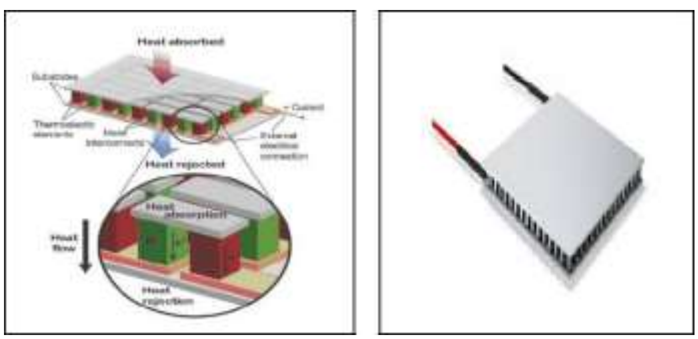

Figure 1: Thermoelectric Module

small applications, thermoelectric can become competitive because they are compact, simple (inexpensive)and scalable. Thermoelectric systems can be easily designed to operate with small heat source and small temperature differences. Such small generator could be mass produced for use in automotive waste heat recovery pr home co-generation of heat and electricity. Thermoelectric have even been miniaturized to harvest body heat for powering a wristwatch.[7]

B.UPS:

An uninterruptible power supply, also uninterruptible power source, UPS or battery/flywheel backup, is an electrical apparatus that provides emergency power to a load when the input power source, typically mains power, fails. A UPS differs from an auxiliary or emergency power system or standby generator in that it will provide near-instantaneous protection from input power interruptions, by supplying energy stored in batteries, super capacitors, or flywheels. The on-battery runtime of most uninterruptible power sources is relatively short (only a few minutes) but sufficient to start a standby power source or properly shut down the protected equipment. A UPS is typically used to protect hardware such as computers, data centers, telecommunication equipment or other electrical equipment where an unexpected power disruption could cause injuries, fatalities, serious business disruption or data loss.

C. Cooling fan:

While in earlier it was possible to cool most components using natural convection (passive cooling), many modern components require more effective active cooling. To cool these components, fans are used to move heated air away from the components and draw cooler air over them. Fans attached to components are usually used in combination with a heat sink to increase the area of heated surface in contact with the air, thereby improving the efficiency of cooling.

D. Heat Exchanger:

A heat exchanger is a device used to transfer heat between one or more fluids. The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact.[1] They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment. The classic example of a heat exchanger is found in an internal combustion engine in which a circulating fluid known as engine coolant flows through radiator coils and air flows past the coils, which cools the coolant and heats the incoming air.

E. Control Circuit:

Control circuit is the circuit in which the controlling of whole procedure is done. It includes various types of controlling devices like relay, contractor, LED light, microcontroller etc. It is used to control and protect whole assembly.

III. PROBLEM STATEMENT

- We have been wasting enormous amounts of heat from various sources, such as factories, transportation systems and even private houses or public buildings. The waste heat is difficult to use due to its nature of low temperature and low energy density, although the total energy amount is very large.

- Power plants have, however, a common disadvantage; the conversion of thermal energy into electric energy is accomplished by the utilization of moving and wear-subjected machine equipment. The massive bulk of equipment, the irreversibility and complexities of the operation involved in these conversion methods accentuate the desirability of some more direct method for conversion of thermal energy into electrical energy with no moving parts.

- Evaluation of power generation and symbiotic generation from renewable energy sources especially geothermal energy and waste heat recovery based on thermoelectric.

- The challenge for the future is to create a direct heat to electricity converter of high power and acceptable efficiency, but which is also capable of generating power over a relatively wide range of temperature.

IV. PROPOSED SOLUTION

Need of such a source which is abundantly available in nature, which does not impose any bad effects on earth. There is only one thing which can come up with these all problems is thermal energy.

Objective:

The main objectives are to utilize waste heat, to convert thermal energy into electric power, it is the portable form of energy,to use device that provides supplemental energy to the home or emergency electricity,Generator is that the combustion chamber is already available and safe, users know how to use it and fuel is readily available.

V. WORKING METHODOLOGY

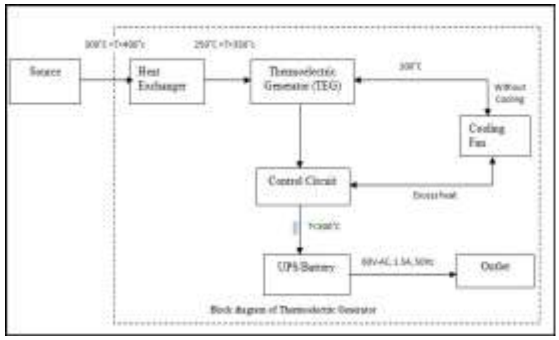

Figure 2: Block Diagram of Setup

According to block diagram, we are using furnace as a source of heat. It gives heat above 100˚C. This heat is provided to heat chamber. Heat chamber is used to store that heat, it will increase the temperature up to 300˚C to 400˚C. This heat is provided to heat exchanger. Heat exchanger decreases heat up to required temperature (i.e. 250˚C to 350˚C). Such heat is provided to thermoelectric generator. Thermoelectric generator converts that heat to electric power. This power is stored to battery. Control circuit is used to control both thermoelectric generator and UPS. It detects the excess amount of power stored in battery and overheating of thermoelectric generator. In case of overheating of thermoelectric generator and control circuit cooling fan is used to provide cooling to the both thermoelectric generator and control circuit. UPS contains battery and inverter. The stored heat in battery is used to convert into AC power by using inverter circuit.

VI. RESULT AND DISCUSSION

The purpose of performing experiments was to ascertain experimental values for the transport coefficients and to obtain results to compare to the finite-volume model. The tests carried out with our experimental apparatus include measurements of the Seebeck Coefficient and conductivity of the thermoelectric module as a function of temperature and measurements in time of the open-circuit voltage while heating from room temperature for comparison to the model. In the experimental setup, two power resistors connected electrically in parallel are used to supply a constant heat flux to the hot side of the thermoelectric module. On the cold side, a heat sink and fan are used to remove heat. A hollow oven brick is placed over the heating elements and polyurethane foam insulation is placed beside the thermoelectric module to provide thermal insulation. It is assumed that the insulation is sufficient enough that nearly all of the electrical power put into the resistors (V^2 /R) is delivered to the thermoelectric module as heat.

A potentiometer connected to the terminals of the thermoelectric module allows the operating point to be varied. From this setup it is possible to perform tests to generate heat flux-voltage-current curves as well as measure the Seebeck coefficient and thermal and electrical conductivities.

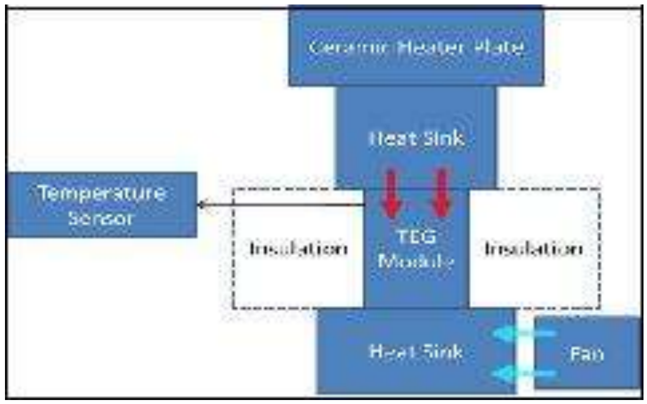

Figure 3: Overview of Experimental Setup

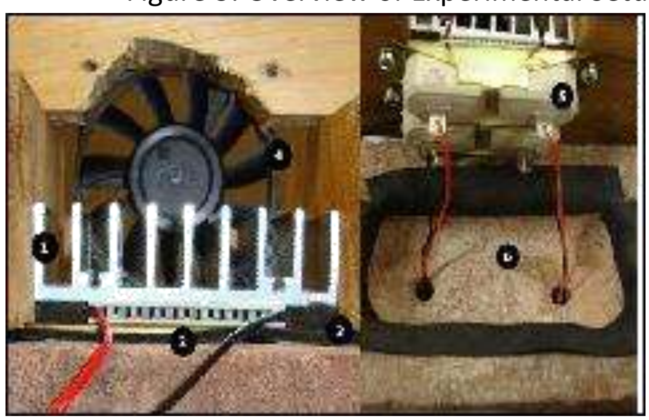

Figure 4: Experimental Setup

1. Heat sink
2. Thermoelectric module
3. Foam insulation
4. Cooling fan

5. Resistive heating element

6. Oven brick

In order to approximate the heat capacitance values of the components in the experimental apparatus, they were individually weighed and multiplied by their specific heat capacities. The measured values are given in the following table. A small, estimated value was used for the TE module because a value for Cp could not be obtained for it.[8]

Components	Materials	Mass (g)	Cp(kJ/kgK)	Capacitance
Resistors	Steatite Ceramic	72.0 (x2)	0.9	130
Heat sink	Aluminum	36.5	0.9	33
TE module	Bi2Te3 & Ceramic	19.0		20

Figure 3: Overview of Experiment

Table 1: Heat capacitance value of components

VII. CONCLUSION

Comparing the cost of this product with the existing products in the market, thermoelectric generator appeals better and affordable for common people. This thermoelectric generator perfectly suits for villages, college and hotels and thus an alternate to the power cut problems. It is ecofriendly and natural, electricity savers. Durability of the product is more thus minimizing the cost. No electricity is used so this product saves the energy and saves environment from getting polluted.

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