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Department of Biomedical Engineering

Course Name: 19BM0302 & WEARABLE TECHNOLOGIES

Topic :Energy Harvesting Wearable Devices

Semester :6

19BM0302/ Energy Harvesting Wearable devices /Dr.S.Prince Samuel /AP/BME



INTRODUCTION



What does Homeotherm mean?

Homeothermy or homothermy is thermoregulation that maintains a stable internal body temperature regardless of external influence. This internal body temperature is often, though not necessarily, higher than the immediate environment.

What animals are Homeotherms?

mammals, including humans, as well as most birds are homeotherms



PRINCIPLES OF ENERGY HARVESTING BY USING HUMAN BODY HEAT

- ❖ Warm blooded animals, or homeotherms, including humans constantly generate heat as a useful side effect of metabolism.
- ❖ However, only a part of this heat is dissipated into the ambient as a heat flow and infrared radiation, the rest of it is rejected in a form of water vapor.
- ❖ Furthermore, only a small fraction of the heat flow can be used in a compact, wearer's friendly and unobtrusive energy scavenger.
- ❖ For example, nobody would like to wear a device on his or her face.
- ❖ Therefore, the heat flow from the face cannot be used. The heat flow can be converted into electricity by using a thermoelectric generator (TEG), the heart of which is a thermopile.
- ❖ It is known from the thermodynamics that the heat flow observed on human skin cannot be effectively converted into electricity, although a human being generates more than 100 W of heat on average.
- ❖ The human body is not a perfect heat supply for a wearable TEG. The body has high thermal resistance; therefore, the heat flow is quite limited. This

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DIFFERENCE BET . WARM & COLD BLOOD ANIMALS

What is difference between warm and cold blooded animals?

Cold-blooded animals require less amount of energy as compare to Warm-blooded animals, as Warm-blooded produces heat by their own and regulate their consistent body temperature in any environment, whereas Cold-blooded animals maintain their body temperature according to changes in an environment.

Examples : all mammals and birds are warm-blooded, and all reptiles, insects and fish are cold-blooded.

Is man a warm blooded animal?

Actually humans are warm-blooded. They have a capacity to manufacture their own heat. Mammals all are warm-blooded. Reptiles are cold-blooded.

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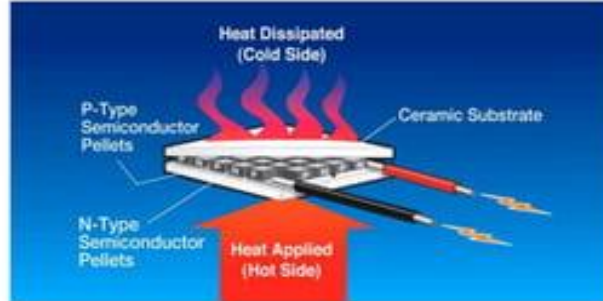
HOW THERMOELECTRIC GENERATORS WORK



Thermoelectric Generator Module



WORKING PRINCIPLE OF THERMOELECTRIC GENERATOR



- Heat is applied to one side of this thermoelectric device.
- It causes the electrons to flow in the completed circuit resulting in enough power to energize the light emitting diode.

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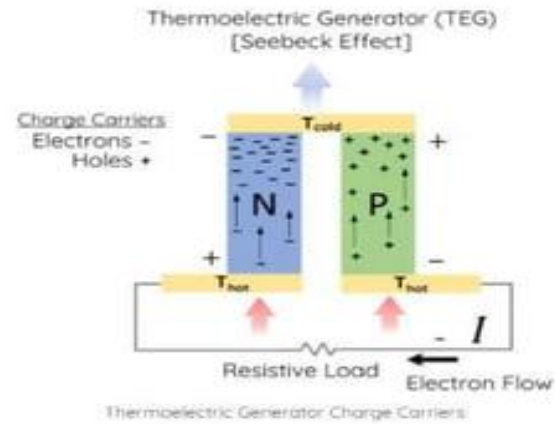
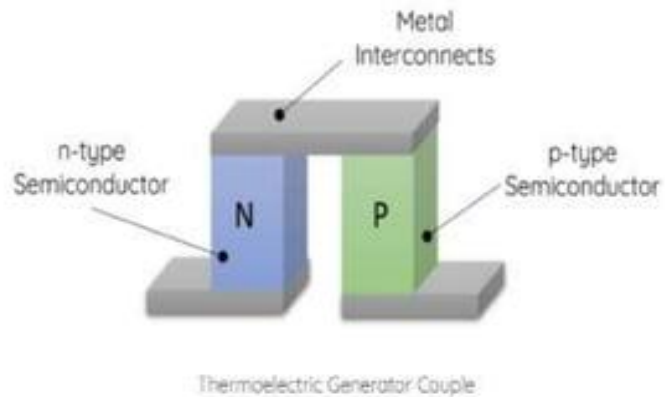


OPERATION OF THERMOELECTRIC GENERATOR

- ❖ Thermoelectric generators (TEG) are solid-state semiconductor devices that convert a temperature difference and heat flow into a useful DC power source.
- ❖ Thermoelectric generator semiconductor devices utilize the Seebeck effect to generate voltage.
- ❖ This generated voltage drives electrical current and produces useful power at a load.
- ❖ A thermoelectric generator is not the same as a thermoelectric cooler (also known as TEC, Peltier module, cooling chips, solid-state cooling).
- ❖ A thermoelectric cooler works in reverse of a thermoelectric generator.
- ❖ When a voltage is applied to thermoelectric cooler, an electrical current is produced.



HOW DOES A THERMOELECTRIC GENERATOR UTILIZE THE SEEBECK EFFECT?



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SEEBECK EFFECT

The basic building block of a thermoelectric generator is a thermocouple. A thermocouple is made up of one p-type semiconductor and one n-type semiconductor.

The semiconductors are connected by a metal strip that connects them electrically in series. The semiconductors are also known as thermoelements, dice or pellets.

The Seebeck effect is a direct energy conversion of heat into a voltage potential.

The Seebeck effect occurs due to the movement of charge carriers within the semiconductors.

In doped n-type semiconductors, charge carriers are electrons and in doped p-type semiconductors, charge carriers are holes.

Charge carriers diffuse away from the hot side of the semiconductor. This diffusion leads to a buildup of charge carriers at one end.

This buildup of charge creates a voltage potential that is directly proportional to the temperature difference across the semiconductor.

A top-down view of a white card with the words "Thank you" written in purple cursive. The card is on a light grey marble surface. To the left is a bouquet of purple flowers. To the right is a black pen with a white polka-dot grip and a gift wrapped in white paper with a red and white striped ribbon. A spool of the same ribbon is in the top right corner.

Thank
you