Thermoelectricity

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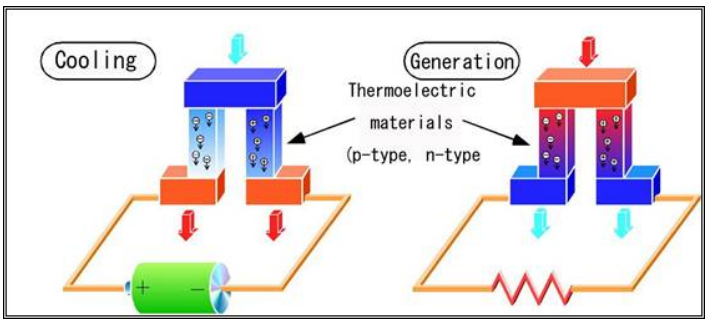
Introduction to Thermoelectricity



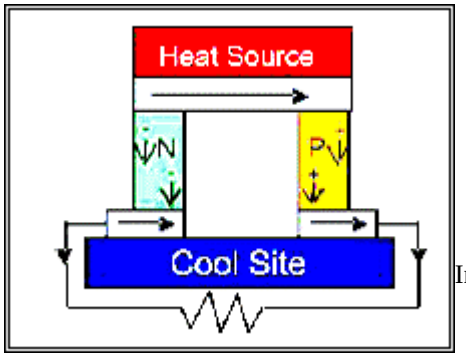
Thermoelectricity is a two-way process that may be characterized by the simultaneous effects of both electrical and thermal currents. It refers to a class of phenomena in which a temperature difference creates an electric potential or an electric potential creates a temperature difference.

Various metals and semiconductors are generally employed in these applications. One of the most commonly used materials in such applications is Bismuth telluride (Bi_2Te_3).

A thermoelectric (TE) device can capture waste heat. It produces electrical power just like conventional heat engines and steam, gas or diesel engines that are coupled to electrical generators, but it uses electrons instead of water or gases as the working fluids and makes electricity directly.

Thermoelectronics is one of the most important scientific and technological fields in energy conversion, where thermal and electrical energy can be directly converted to electrical (**thermoelectric generation**) and thermal (**thermoelectric cooling**) energies, respectively.

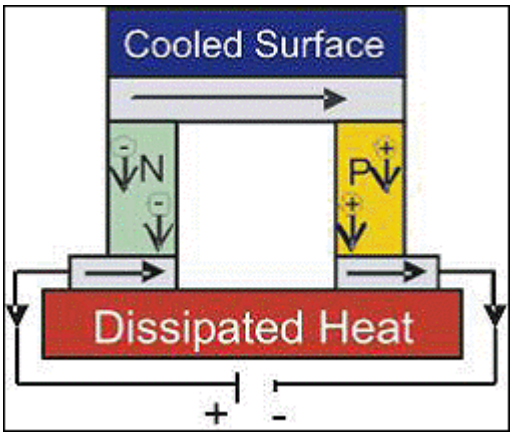
Thermoelectric Generation



In 1851, **William Thomson** (later **Lord Kelvin**) observed the cooling or heating of a homogeneous conductor resulting from the flow of an electrical current in the presence of a temperature gradient. This is known as the **Thomson effect** and is defined as the rate of heat generated or absorbed in a single current carried by a conductor that is subjected to a temperature gradient. The Thomson effect is the direct conversion of temperature differences to electric voltage and vice versa. A thermoelectric device creates voltage when there is a different temperature on each side.

Conversely when voltage is applied to it, it creates a temperature difference (known as the Peltier effect). The simplest thermoelectric generator consists of a thermocouple (thermopile) comprising a p-type and n-type semiconductor connected electrically in series and thermally in parallel. Heat is pumped into one side of the couple and rejected from the opposite side. An electrical current is produced that is proportional to the temperature gradient between the hot and cold junctions.

Thermoelectric Cooling



Thermoelectric cooling is a way to remove thermal energy from a medium, such as a device or component, by applying a voltage of constant polarity to a junction between dissimilar electrical conductors or semiconductors.
If an electric current is applied to the thermocouple as shown, heat will be pumped from the cold junction to the hot junction. The cold junction will rapidly drop below ambient temperature provided that heat is removed from the hot side. The temperature gradient will vary according to the magnitude of the generation current that is applied (Seebeck effect).

A thermoelectric cooling system typically employs a matrix of semiconductor pellets sandwiched in between two large electrodes. When a DC voltage source is connected between the electrodes, the negatively-charged side becomes cooler while the positively-charged side becomes warmer. The negative electrode is placed in contact with the component, device or medium to be cooled, while the positive electrode is connected to a heatsink that radiates or dissipates thermal energy into the external environment. Thermoelectric cooling is used in electronic systems and computers to cool sensitive components such as power amplifiers and microprocessors.

Application of Thermoelectricity

This effect can be used to generate electricity, to measure temperatures, and to cool, heat, or cook objects. Because the direction of heating and cooling is determined by the sign of the applied voltage, thermoelectric devices make very convenient temperature controllers.
Traditionally, the term thermoelectric effect or thermoelectricity encompasses three separately identified effects, the**Seebeck effect** , the**Peltier effect**, and the**Thomson effect**.

Want to know more about thermoelectricity? Click here to schedule a live session with an eAge eTutor!

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Reference links:

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- http://en.wikipedia.org/wiki/Voltage_divider
- http://en.wikipedia.org/wiki/Voltage
- http://en.wikipedia.org/wiki/Semiconductor

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