Thomson effect

Created: Monday, 29 August 2011 07:25 | Published: Monday, 29 August 2011 07:25 | Written by Super User | Print

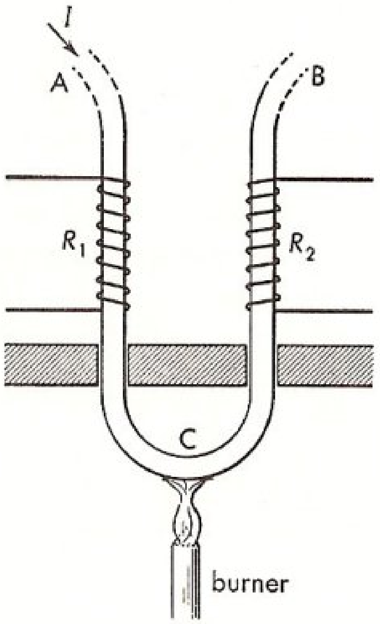
Introduction to the Thomson effect

The Thomson effect is a phenomenon in which a temperature gradient along a metallic (or semiconductor) wire or strip causes an electric potential gradient to form along its length. It describes the heating or cooling of a current-carrying conductor with a temperature gradient. Any current-carrying conductor (except for a superconductor) with a temperature difference between two points, will either absorb or emit heat, depending on the material.

Positive Thomson effect

The **positive Thomson effect** occurs in metals such as zinc and copper that have a hotter end at a higher potential and a cooler end at a lower potential. When current moves from the hotter end to the colder end, it moves from a high to a low potential, and there is an evolution of heat. This is called the positive Thomson effect.

Negative Thomson effect



The **negative Thomson effect** occurs in metals such as cobalt, nickel, and iron that have a cooler end at a higher potential and a hotter end at a lower potential. When current moves from the hotter end to the colder end, it moves from a low to a high potential, and there is an absorption of heat. This is called the negative Thomson effect.

In the experiment depicted above, a current passes through an iron rod which is bent into a U-shape. Resistance coils, R_1 and R_2, are wound about the two sides of the U, as shown. These form two arms of a balancedWheatstone bridge. The bottom of the U is then heated, which establishes two temperature gradients -- a positive one extending from A to C, and a negative one extending from C to B. As a result of this operation, the bridge moves to indicate that the resistance of R_1 has increased more than that of R_2. Evidently, heat has been liberated from R_1 and absorbed at R_2.

Absorption of heat is evidence that an electromotive force (EMF) is acting in the same direction as that of the current; that is to say, electrical energy is being supplied to the circuit at the expense of the heat energy of the environment. Such is the case in the section.

Likewise, in the section AC, the current is opposed by an EMF, with consequent transformation of electrical energy into heat energy. Thus, in iron, the Thomson EMF would give rise to a current in the iron from hot to cold regions. many metals, including bismuth, cobalt, nickel, and platinum, in addition to iron, exhibit this same property, which is referred to as the **negative Thomson effect**. Another group of metals, including antimony, cadmium, copper, and silver, display a **positive Thomson effect**; in these, the direction of the Thomson EMF is such as to support a current within the metal from cold to hot regions. In one metal, lead, the Thomson effect is zero. In certain metals, the effect reverses sign as the temperature is raised or as the crystal structure is altered.

Thomson Coeffiecient

The magnitude of the Thomson EMF for a given material, a, is expressed in terms of the **Thomson coefficient**, $?_a$, which has dimensions of emf/degree. Thus $?_a$ dt is the EMF that exists between two points whose temperatures differ by dt ^{8}C. Hence, the heat absorbed per second between two points at temperature t_1 and t_2, respectively, when a current of I amperes passes through the material, is given by
Heat absorbed/sec = $I_{t1}?^{t2}?_a$ dt - I^2R

The Thomson coefficient, $?_a$, is positive (or negative) for materials exhibiting the positive (or negative) Thomson effect. It appears that the total Thomson EMF along aconductor depends only on the temperatures of the two ends, and not in any way upon the particular manner in which the temperature gradient varies.

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

About eAge Tutoring:

eAgeTutor.com is the premium online tutoring provider. Using materials developed by highly qualified educators and leading content developers, a team of top-notch software experts, and a group of passionate educators, eAgeTutor works to ensure the success and satisfaction of all of its students.

Contact us today to learn more about our guaranteed results and discuss how we can help make the dreams of the student in your life come true!

Reference links:

- http://www.daviddarling.info/encyclopedia/W/Wheatstone_bridge.html
- http://www.splung.com/content/sid/3/page/emf
- http://en.wikipedia.org/wiki/Superconductor

Category:ROOT