

The effect of electricity due to heat is called thermo – electric effect. In thermoelectric phenomenon heat energy is converted into electric energy and vice-versa. It may be reversible and irreversible. Current produces heat as it passes through the conductor, this effect is called Joule’s effect. Joule’s effect is irreversible, meaning even if we change the direction of current flow in the conductor heat is always produced and that heat cannot be transformed into electric energy. However, we can produce electricity in a thermocouple just by heating of its one end and cooling the other one. Three different types of thermoelectric phenomena are being discussed here.

**1. Seeback effect**

The phenomenon of generation of an electric current in a thermo - couple due to a temperature difference at its two junctions is known as thermoelectric effect or Seeback effect. A thermo couple is a pair of wires of different materials whose ends have joined to form two junctions. When one junction is kept hot and the other cold, a current begins to flow through couple. This current is called thermoelectric current and the emf (electromotive force) due to which this current flows is called thermo emf. Thermo emf is the result of temperature difference between two ends of thermos couple. Due to different electronic concentration of the materials, there exists a contact potential at each junction. Suppose a Cu - Fe thermocouple, when both junctions are at the same temperature, equal current flows from both ends of the couple in opposite directions and net current is zero, as shown in Figure 1. When one junction is heated, a contact potential at this junction is increased and hence some current starts to flow from Cu to Fe through hot junction as shown in Figure 2.

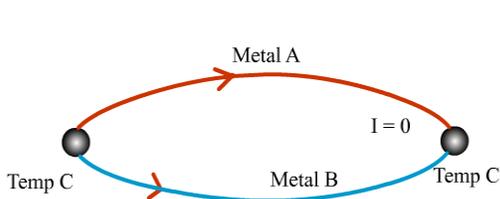
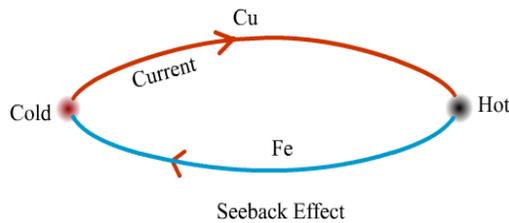


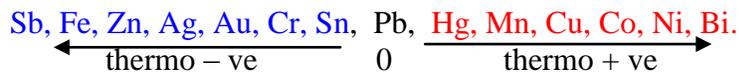
Figure 1



Seeback Effect

Figure 2

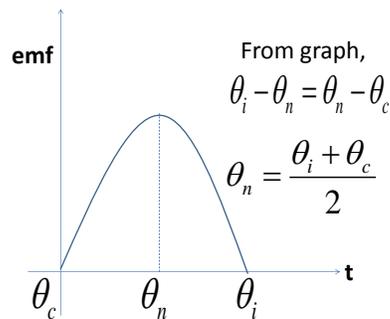
By experimenting on the different sets of thermocouple Seeback listed the thermocouple series of different elements as –



In Cu – Fe thermocouple current will flow from Cu to Fe through hot junction which can be memorized as Hot Cu fee. In Sb – Bi thermocouple, current will flow from Sb to Bi through cold junction and memories as ABC. When current is formed by the thermocouple in this series, the thermo–emf increases depending upon how far these metals are in the series, the further they are the greater the current. The direction of current, at the hot junction, is from the thermo-positive metal to the thermo-negative metal of the series.

### Variation of thermo emf with temperature.

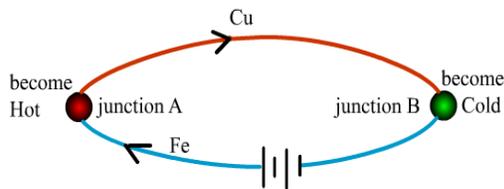
In a thermocouple when one junction A is kept cold and the other junction B is heated then thermo emf increases gradually as temperature difference increases and at a particular temperature it becomes maximum. The temperature at which thermo emf becomes maximum is called neutral temperature,  $\theta_n$ . The different thermocouple has different neutral temperature. If the temperature of B is further increased the magnitude of thermo emf keep on decreasing at the same rate as it increased previously and reaches at the point where thermo emf becomes zero. This temperature is known as temperature of inversion,  $\theta_i$ .



i.e. neutral temperature is the mean of temperature of inversion and temperature of cold junction,  $\theta_c$ . The magnitude and direction of thermo emf developed in a thermo couple depends on the nature of the two metals forming the thermocouple.

### 2. Peltier effect

The phenomenon of absorption or evolution of heat at the junctions of a thermocouple when current is passing through it is called Peltier effect. The absorption or evolution of heat depends upon the direction of flow of current, i.e. it is a reversible effect.



When two different metals are joined, contact potential is established at the junctions. This means one metal will be at higher potential than the other. In Cu – Fe thermocouple, Fe will be at higher potential than Cu. *Therefore*, when current flows from Fe to Cu at the junction A, energy has to be given out (evolved) at the junction A. Hence the junction A becomes hot. On the other hand, at the junction B, current flows from Cu to Fe, energy is to be absorbed by current and the junction B becomes cold.

*Difference between Peltier's effect and Joule's effect.*

Peltier's effect	Joule's effect
1. It is a reversible effect.	1. It is an irreversible effect.
2. Effect occurs at the junction of thermocouple.	2. Effect occurs throughout the body of conductors.
3. Heat is absorbed at one junction and evolved at the other.	3. Heat is not absorbed but evolved throughout the conductor.
4. Evolution or absorption of heat at junction depends upon the direction of current.	4. Heat produced in conductor does not depend upon the direction of current.

**3. Thomson effect**

The phenomenon of evolution or absorption of heat along the length of a conductor on passing a current through it, when different portions of the conductor are kept at different temperatures is known as Thomson's effect. It is observed that in copper, silver, zinc etc. when current is passed from its hotter end to the colder end, the heat is evolved and the wire will become hot. On the other hand, if current is passed from colder end to its hotter end, heat will be absorbed and the wire will become cold. It is because the hotter end of such metal is at higher potential. This effect is known as +ve Thomson effect. In case of Iron, cobalt, nickel etc. when current is passed from hotter end to the colder end, heat is absorbed. It is because hotter end of iron is at lower potential. This effect is known as -ve Thomson effect.

