Dr. Shiva Kant Mishra
Dept. of Physics
H D J C, Ara
V K S U. Ara

B. Sc. Part II
Current Electricity

Seeback Effect

(113) Para 8

In 1826 Thomas Johan Seebeck (1770-1831) discovered that when two dissimilar metals are joined so as to form a closed circuit and a difference of temp. is established between their junctions, an e.m.f. is developed and hence electric current flows through the circuit. The e.m.f. so produced is called thermo-electric e.m.f. and the phenomenon known as Seeback effect. Such an arrangement of connecting two dissimilar metals is called Thermo-Couple. The magnitude of thermo-electric e.m.f. depends upon the nature of the two metals and on the temperature difference of their junctions.

(113) Para

Seeback investigated the thermo-electric properties of a large numbers of metals and arranged them in a series known as the thermo-electric series. When a circuit is formed of the two metals of the series, the thermo-e.m.f. is greater, the farther the metals are apart in the series. Also the direction of the current, at the hot junction, is from the metal occurring earlier in series to the metal occurring later in it. The following is a selection from Seeback's series Bi, Ni, Co, Pt, Cu, Mn, Hg, Sn, Au, Ag, Zn, Cd, Fe, As, Sb, Te.

The position of a metal in this series,

as Seebeck himself observed, is somewhat dependent on its purity. The thermocouple of Cu and Fe is shown in fig-1.

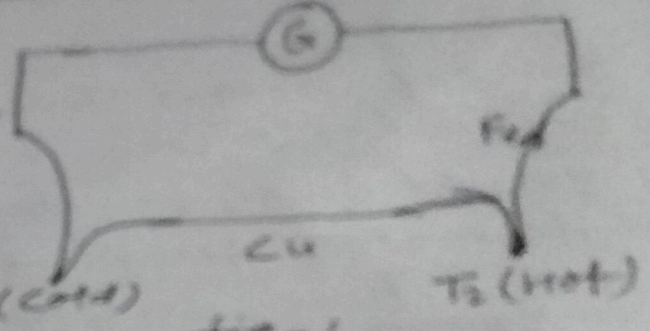

fig-1

The current in this couple flows from Cu to Fe through the hot junction. The thermo-e.m.f. for this couple is only 1.22 millivolts for a temperature difference $(T_2 - T_1)$ of 100°c between the hot and cold junctions.

Variation of Thermo-e.m.f with temperature

Let there be a thermo-couple of two dissimilar metals A and B. Let one junction (cold junction) be at 0°c and the temp. of the other junction (hot junction) be raised gradually. The thermo-emf in the circuit varies with the temp. of the hot junction and if thermo e.m.f E in the circuit be plotted against the temp. of the hot junction, the graph is parabola as shown in fig-2

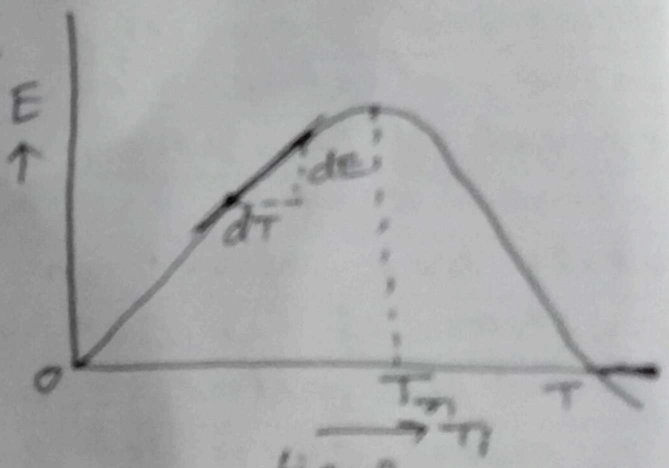

fig-2

The thermo e.m.f. is 0 when both the junctions are at the same temp. 0°c and gradually increases as the temp. of the hot junction increases.

(11) At a Particular temp. of the hot Junction the Thermo-e.m.f becomes Maximum. This temp. of the junction (at which the e.m.f in the Thermo-Couple is Maximum) is called the neutral temp. T_n for the Thermo-Couple. The neutral temp. is constant for a given Pair of metals forming the Thermo-Couple. If the temp. of the hot junction be further raised, the Thermo e.m.f. decreases and becomes zero at a Particular temp., called the temp. of inversion T_i. Beyond the inversion temp. T_i, the Thermo e.m.f. again increases, but in inverse direction. The temp. of inversion is as much above the neutral temp. as the temp. of the Cold junction is below it. Therefore the inversion temp. is not constant for a given Thermo-couple, but depends on the temp. of the cold junction. The temp. of inversion on the neutral temp. is obtained only when the metals of the Thermo-Couple can remain without damage at ~~hence~~ these temp.s

Mathematically Thermo-e.m.f. is given by

$$E = at + bt^2$$

When t is temp. of hot junction cold junction being at 0°C and a, b are constants for a given Thermocouple.