Further, if the temperature of cold junction is kept at 0^0C, then mathematically, variation of thermo emf is given by, (parabolic nature)

$$E = \alpha\theta + \frac{1}{2}\beta\theta^2$$

Here, θ is the temperature of hot junction, α & β are thermoelectric constants, whose values depend upon the **nature of metal used in thermocouple** and also depend upon **temperature difference of two junctions.**

Relation between α, β, θ_i and θ_n:

Consider a thermocouple whose cold junction is kept at 0^0C, then mathematically, variation of thermo emf is given by, (parabolic nature)

$$E = \alpha\theta + \frac{1}{2}\beta\theta^2 \ldots\ldots\ldots (1)$$

Where, θ is the temperature of hot junction.

We know at temperature of inversion, the thermo-emf becomes zero.

i.e., $for\ \theta = \theta_i \quad , \quad E = 0$

$\therefore$ Eq^n (1) can be written as,

$$0 = \alpha\theta_i + \frac{1}{2}\beta\theta_i^{\,2}$$

$$\alpha + \frac{1}{2}\beta\theta_i = 0 \qquad [\theta_i \neq 0]$$

$$\boxed{\theta_i = \frac{-2\alpha}{\beta}} \quad \ldots\ldots\ldots (2)$$

Again, differentiating equation (1) w.r.to θ, we get

$$\frac{dE}{d\theta} = \alpha + \beta\theta \ldots\ldots\ldots (3)$$

At neutral temperature, the thermo-emf becomes maximum.

i.e., for $\theta = \theta_n \quad , \quad \frac{dE}{d\theta} = 0$

Therefore, equation (3) can be written as:

$$0 = \alpha + \beta\theta_n$$

$$\boxed{\theta_n = \frac{-\alpha}{\beta}}$$

Note: $For\ \theta_c = 0,$

$$\theta_i = \frac{-2\alpha}{\beta}$$

$$\theta_n = \frac{-\alpha}{\beta}$$

Then obviously, $\theta_i = 2\theta_n$

The temperature of inversion is double of neutral temperature only if the temperature of cold junction is 0^oC.

1. The thermo-emf (E) and the temperature of hot junction θ satisfies the relation $E = a\theta + b\theta^2$ where a= 4.1×10^{-5} V $(^0C)^{-1}$ and b = – 4.1×10^{-8} V $(^0C)^{-2}$. If the cold junction temperature is 0^0C, find the neutral temperature. (**Ans: 500^0C**)
2. A thermocouple has 540 ^{0}C as its temperature of inversion when its cold junction is at 0 ^{0}C. Find the temperature of inversion, if cold junction is at 30 ^{0}C. (**Ans: 510^0C**)