

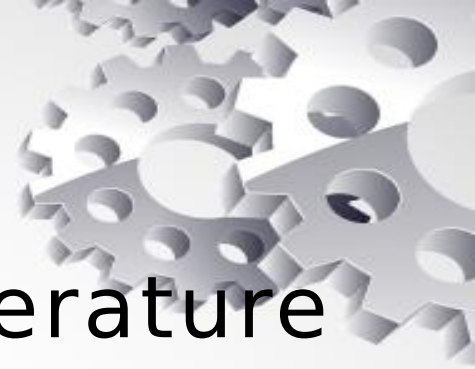
Unit 3 Thermo emf sensor:

types, thermoelectric power, general consideration, Junction semiconductor type IC and PTAT type.

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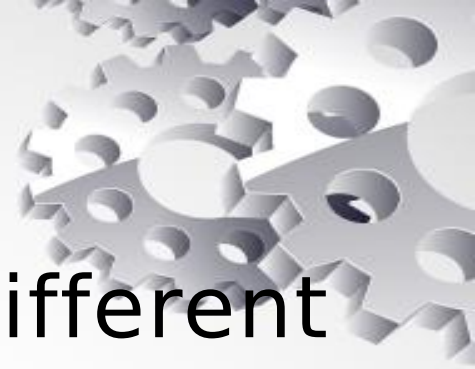
Thermocouple

- Definition: The thermocouple is a temperature measuring device. It uses for measuring the temperature at one particular point. In other words, it is a type of sensor used for measuring the temperature in the form of an electric current or the EMF.



Thermocouple

- The thermocouple consists two wires of different metals which are welded together at the ends. The welded portion was creating the junction where the temperature is used to be measured. The variation in temperature of the wire induces the voltages.

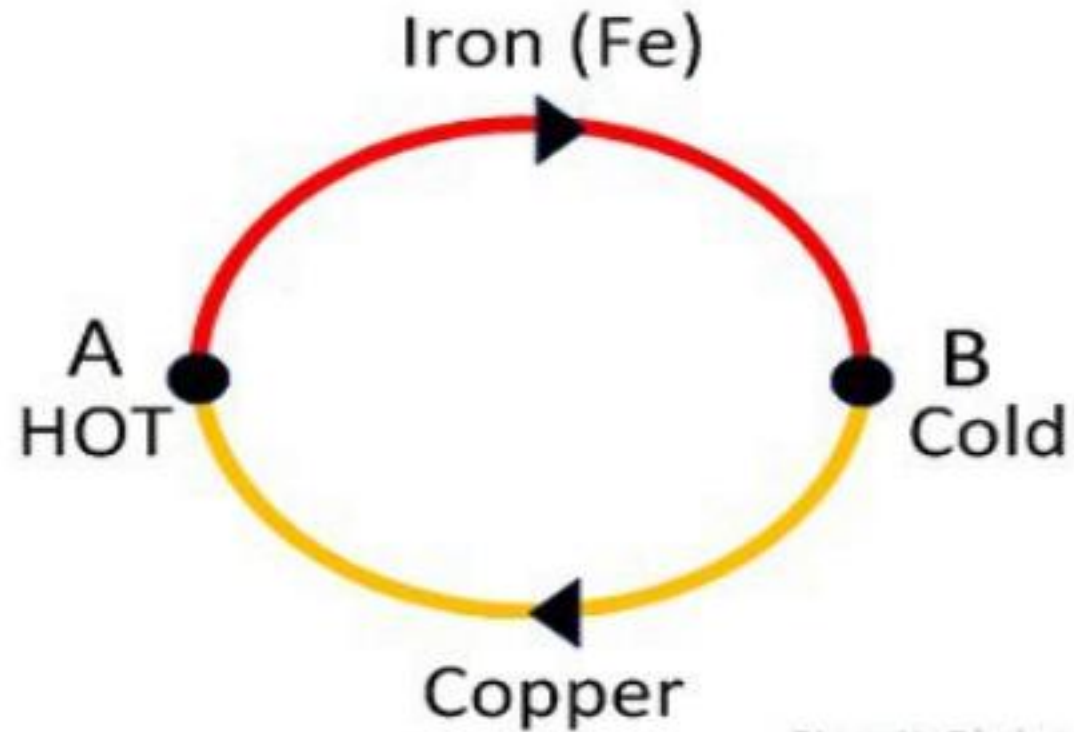


Working Principle of Thermocouple



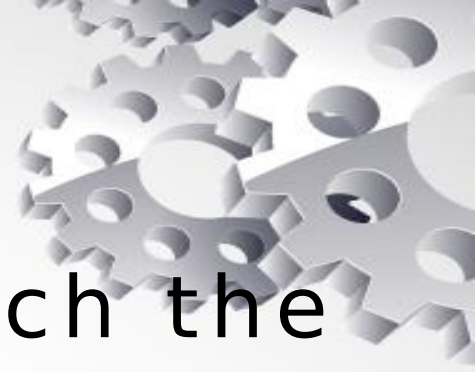
- The working principle of the thermocouple depends on the three effects.
- **See back Effect** - The See back effect occurs between two different metals. When the heat provides to any one of the metal, the electrons start flowing from hot metal to cold metal. Thus, direct current induces in the circuit.

Working Principle of Thermocouple



Working Principle of Thermocouple

- In short, it is a phenomenon in which the temperature difference between the two different metals induces the potential differences between them. The Seebeck effect produces small voltages for per Kelvin of temperature.



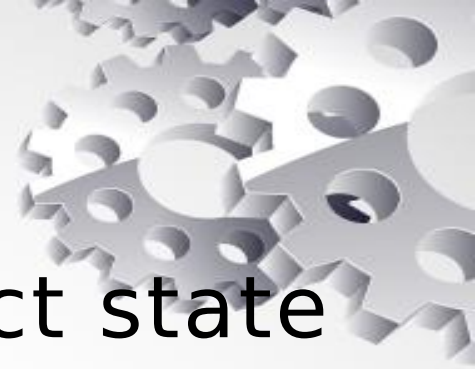
Working Principle of Thermocouple



- **Peltier Effect** – The Peltier effect is the inverse of the Seebeck effect. The Peltier effect states that the temperature difference can be created between any two different conductors by applying the potential difference between them.

Working Principle of Thermocouple

- **Thompson Effect** - The Thompson effect states that when two dissimilar metals join together and if they create two junctions then the voltage induced is proportional to the temperature gradient. The temperature gradient is a physical term which shows the direction and rate of change of temperature at a particular location.



Working Principle of Thermocouple

- This effect states that as two disparate metals fix together & if they form two joints then the voltage induces the total conductor's length due to the gradient of temperature. This is a physical word that demonstrates the change in rate and direction of temperature at an exact position.



Construction of Thermocouple

- The construction of the thermocouple is shown below. It comprises of two different metal wires and that are connected together at the junction end. The junction thinks as the measuring end. The end of the junction is classified into three type's namely ungrounded, grounded and exposed junction.



Construction of Thermocouple



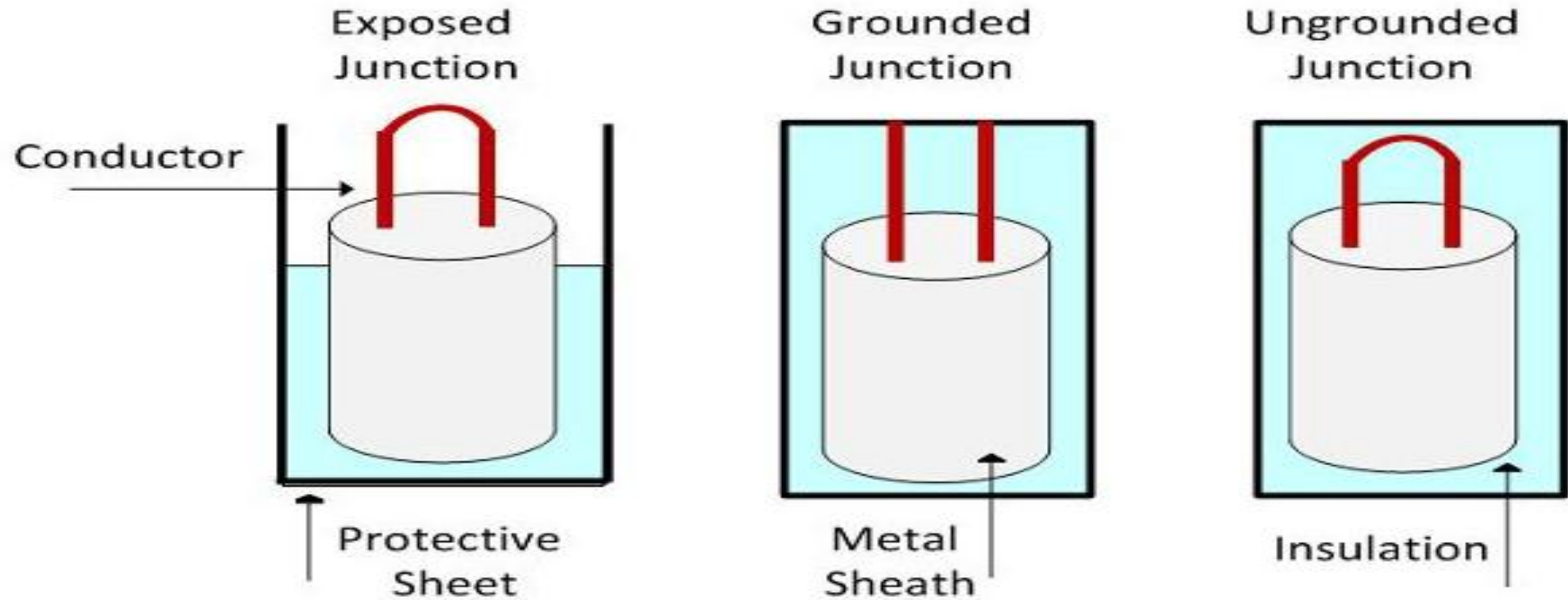
- **Ungrounded Junction** - In ungrounded junction, the conductors are entirely isolated from the protective sheath. It is used for high-pressure application works. The major advantage of using such type of junction is that it reduces the effect of the stray magnetic field.
- **Grounded Junction** - In such type of junction the metals and protective sheath are welded together. The grounded junction use for measuring the temperature in the corrosive environment. This junction provides resistance to the noise.

Construction of Thermocouple

- **Exposed Junction** - Such type of junction uses in the places where fast response requires. The exposed junction is used for measuring the temperature of the gas.



Construction of Thermocouple

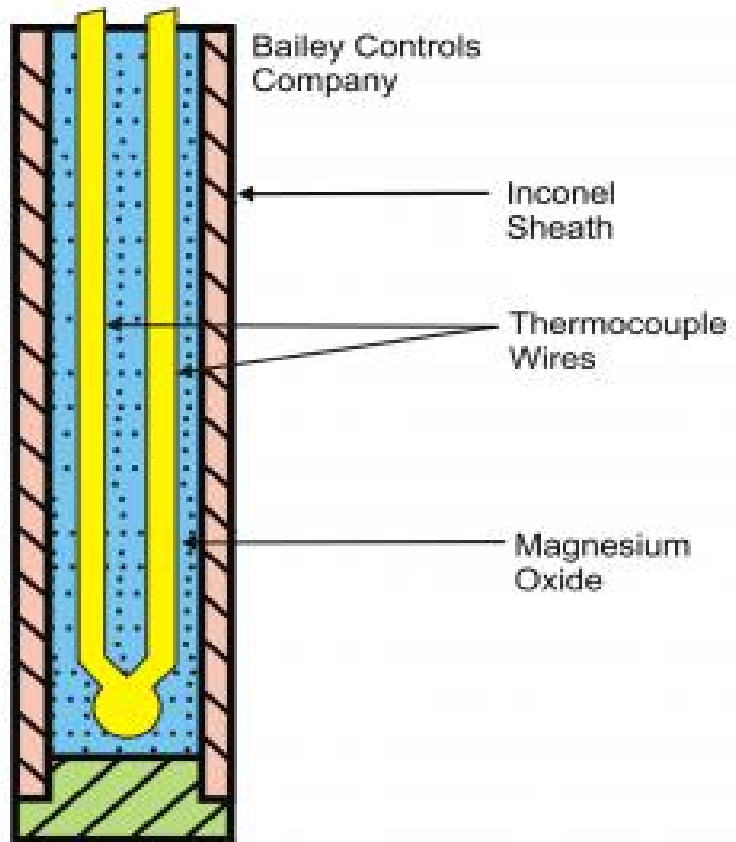


Thermocouple Junctions

Circuit Globe

The material uses for making the thermocouple depends on the measuring range of temperature.

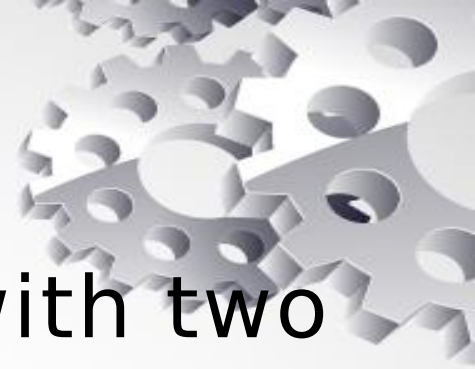
Construction of Thermocouple



Construction of Thermocouple

Construction of Thermocouple

- Generally, a thermocouple is designed with two different metal wires namely iron and constantan that makes in detecting element by connecting at one junction that is named as a hot junction. This consist of two junctions, one junction is connected by voltmeter or transmitter where the cold junction and second junction is associated in a process that is called as a hot junction.

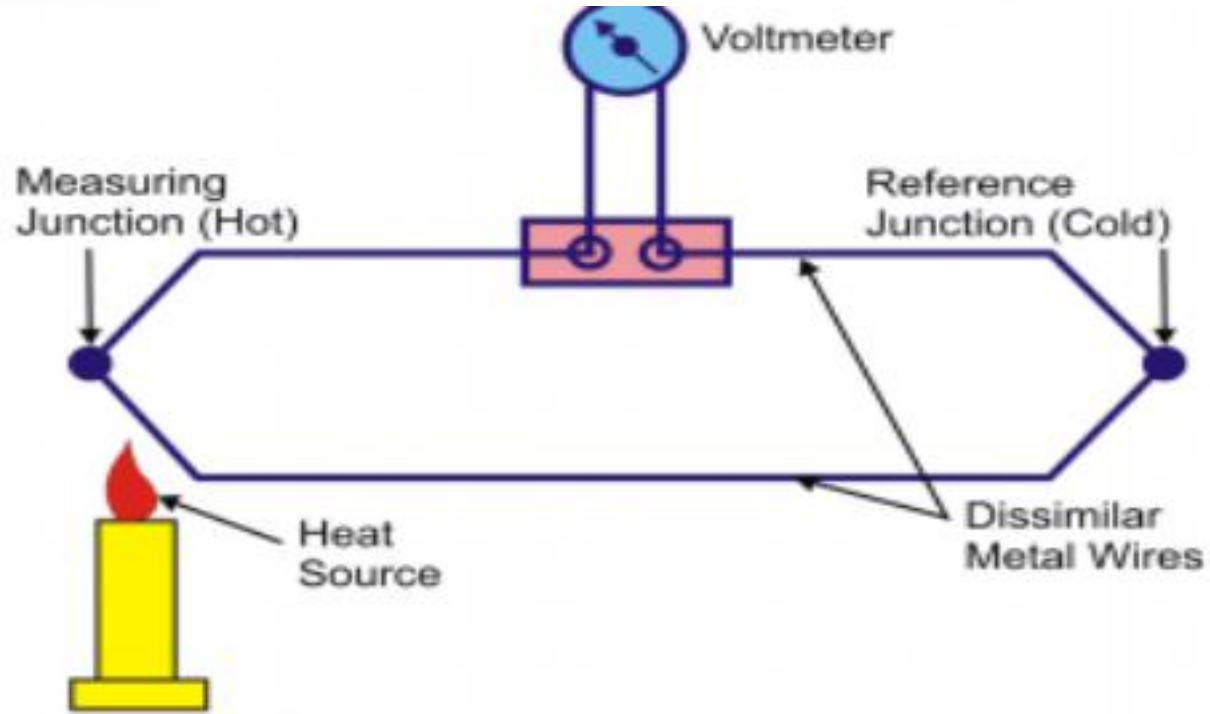


Working of Thermocouple



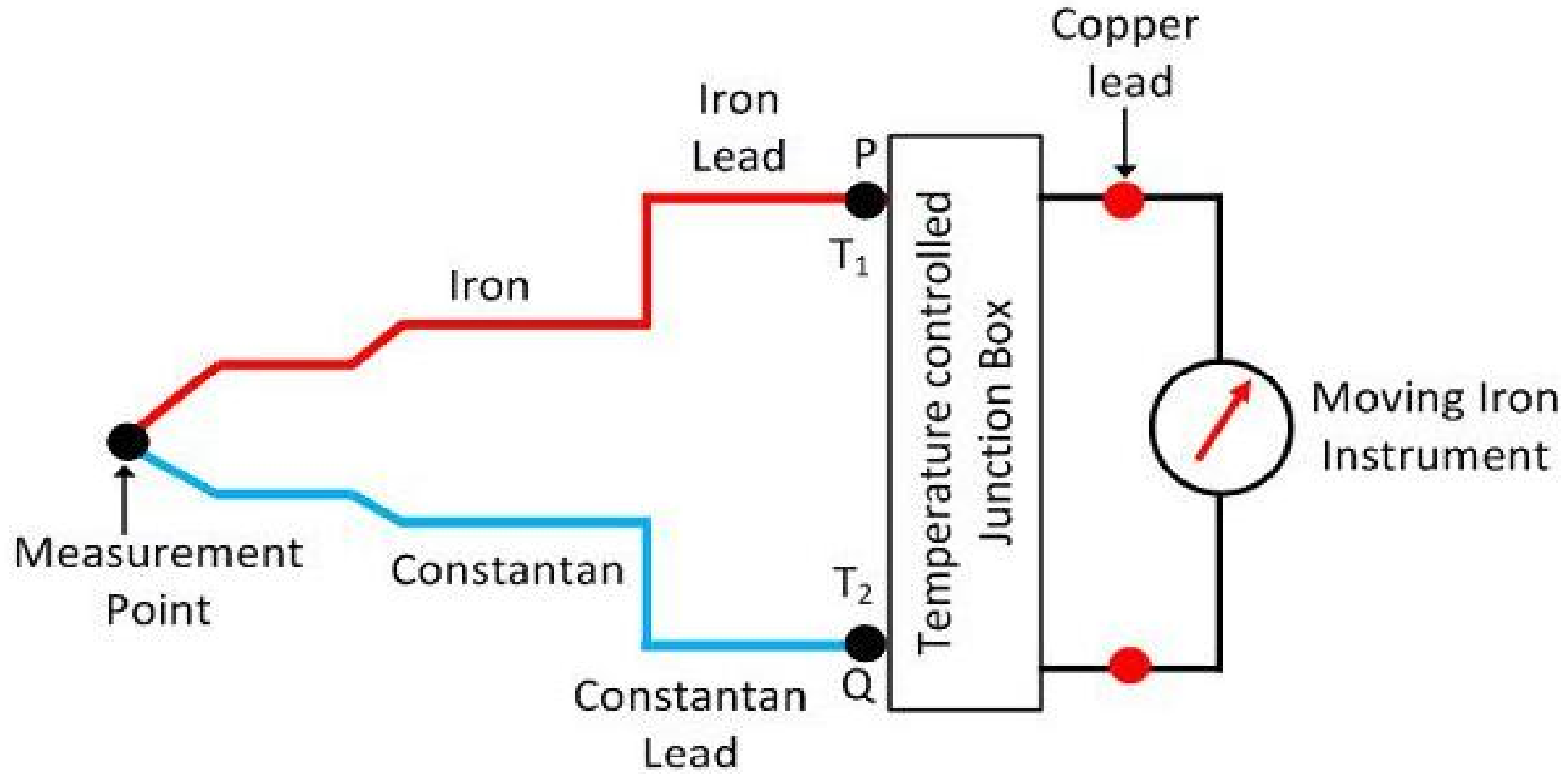
- The thermocouple schematic diagram is shown in the figure. This circuit can be built with two different metals, and that are coupled together by generating two junctions. The two metals are surrounded by the connection through welding.
- In the diagram, the junctions are denoted by P & Q, and the temperatures are denoted by T_1 , & T_2 . When the temperature of the junction is dissimilar from each other, then the electromagnetic force generates in the circuit.

Working of Thermocouple



Working of Thermocouple

Working of Thermocouple



Working of Thermocouple

- If the temperature at the junction end turns into equivalent, then the equivalent, as well as reverse electromotive force, produces in the circuit, and there is no flow of current through it. Similarly, the temperature at the junction end becomes imbalanced, then the potential variation induces in this circuit.



Working of Thermocouple

- The magnitude of the electromotive force induced in the circuit relies on the sorts of material utilized for thermocouple making. The entire flow of current throughout the circuit is calculated by the measuring tools.
- The electromotive force induced in the circuit is calculated by the following equation
- $E = a (\Delta\theta) + b (\Delta\theta)^2$
- Where $\Delta\theta$ is the temperature difference among the hot thermocouple junction end as well as the reference thermocouple junction end, a & b are constants

Advantages & Disadvantages of Thermocouple



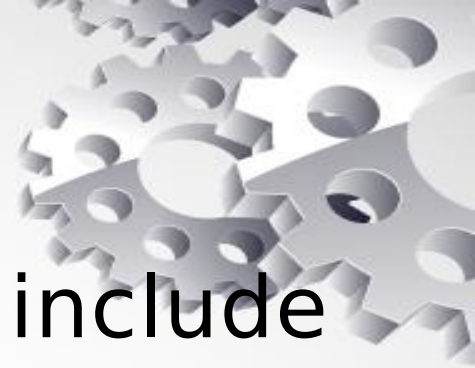
- The advantages include the following.
- Accuracy is high
- It is Robust and can be used in environments
- The thermal reaction is fast
- The operating range of the temperature is wide.
- Wide operating temperature range
- Cost is low and extremely consistent

Advantages & Disadvantages of Thermocouple



- The disadvantages include the following.
 - Nonlinearity
 - Least stability
 - Low voltage
 - Reference is required
 - least sensitivity
 - The thermocouple recalibration is hard

Thermocouple Applications



- Some of the applications of thermocouple include the following.
- These are used as the temperature sensors in thermostats in offices, homes, offices & businesses.
- These are used in industries for monitoring temperatures of metals in iron, aluminum, and metal.

Thermocouple Applications

- These are used in the food industry for cryogenic and Low-temperature applications. Thermocouples are used as a heat pump for performing thermoelectric cooling.
- These are used to test temperature in the chemical plants, petroleum plants.
- These are used in gas machines for detecting the pilot flame.

