Plastic Industry Thermocouples & Rtd's

Thermocouple & Rtd Specifications.

Thermocouples & RTDs - Description

Thermocouples & RTDs are used in a variety of applications. Thermocouples are the temperature sensor of choice primarily in plastics extrusion, injection molding, thermoforming, blow molding and blown film applications. The thermocouples favorable characteristics include good inherent accuracy, suitability over a broad temperature range, relatively fast thermal response, ruggedness, high reliability, low cost and great versatility of application. Resistance Temperature Detectors (RTDs) are commonly used in applications where accuracy and repeatability are important. Platinum RTDs have very repeatable resistance vs. temperature characteristics over time. RTDs are more expensive than thermocouples and are not suitable in high vibration and mechanical shock environments. At higher temperature conditions RTDs are more stable than thermocouples.

Plastics Industry Thermocouples-Specifications

Plastics Thermocouples are available for hot runner injection molding machines, blow molding machines and extruders.

Plastic Industry Thermocouples are made of 301 stainless and use a tube and wire construction utilizing stranded thermocouple cable through out the probe.

Plastics Thermocouples are available with various types of leads like Hi temp fiberglass, PVC, SS Braided fiberglass or with Stainless Steel flexible armour cable. Plastic thermocouples are normally rated for low temperature ranges up to a thousand degrees F, however the same construction could be used for higher temperatures.

Plastics Thermocouples are also available in metric dimensions for all designs that are required.

Industrial Thermocouples and RTD Assemblies Features:

? Mineral insulated assemblies
? High pressure rated
? Thermocouple or RTD calibrations
? High Temperature rated and thermal shock resistant
? Explosion proof, moisture and chemical resistant
? High quality control using ASTM and ANSI standard testing
? High performance sheath materials and design capabilities

Industrial Thermocouples and RTD Assemblies Specifications & Design Capabilities:

Calibration Types. . . .J, K, T, N, E, R, S, B RTD
Diameters. . . . . . . .Minimum .010" to 1.250" or more
Length. . . . . 125" minimum maximum consult NPH
Leads. . . . . .Stainless Braid, SS Armour, PVC, Fiberglass
Junctions. . . . . . . .Grounded, Ungrounded, Exposed, Dual Isolated
Multipoint common, isolated or spaced
Dual grounded or dual exposed isolated
Termination Heads. . . .Explosion Resistant, Moisture/Chemical resistant,
FDA (food), Polypropylene, Aluminum, thermosetting
Plastic Bare leads, Spade Lugs, Standard Male Plug,
Standard Female Jack, Miniature Plugs, Jacks
Right angled. . . . . . with or without protection tubes

Styles. . . . . Bare wire, Nipple Union Nipple, Leads, head
Process fittings, Twell fittings, flanged magnetic,
Spring loaded, Flexible

To order specify application, max temperature, max pressure and style along with diameter length and termination.

Technical Letter

How Thermocouples Work

These letters are intended to furnish a better understanding of the thermocouple theory of operation, and to aid in selection for a particular application.

Introduction and History

Accurate measurement of temperature is one of the most common and vital requirements in industrial instrumentation. It is also one of the most difficult objectives to achieve. Unless proper temperature measuring techniques are employed, serious inaccuracies of reading can occur, or otherwise useless data can result. The thermocouple is by far the most widely used temperature sensor for industrial instrumentation. Its favorable characteristics include good inherent accuracy, suitability over a broad temperature range, relatively fast thermal response, ruggedness, high reliability, low cost, and great versatility of application.

A discovery by T. J. Seebeck almost 150 years ago, opened the way for modern thermoelectric circuitry. In 1831, Seebeck discovered that an electric current flows in a closed circuit of two dissimilar metals when one of the two junction is heated with respect to the other.

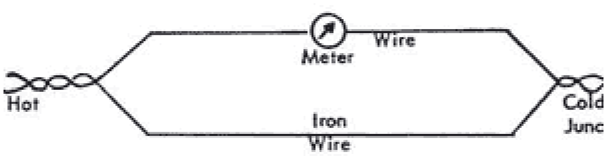
In such a thermocouple circuit the current continues to flow as long as two junction are at different temperatures. The magnitude and direction of the current is a function of the temperature difference between the junctions and of the thermal properties of the metals used in the circuit. This phenomenon, is known as the Seebeck Affect.

The conductors can be of any two dissimilar metals, and when the hot junction is heated the current flow can be observed on a milliamp meter. If the position of the hot and cold junction is reversed, current will flow in the opposite direction.

In fact, a thermocouple circuit will actually generate a measurable, low voltage output that is almost directly proportional to the temperature difference between the hot junction and the cold junction. A unit change in this temperature difference produces some net change in the voltage.

Despite its popularity the thermocouple is unfortunately surrounded by an aura of mystique. It is not unusual for a plant engineer to be somewhat vague in a discussion involving the "cold reference junction". The standard cold or reference junction is zero degrees C (32°F). Confusion sometimes results when an application requires the use of thermocouple tables based on cold or reference junction temperatures that the plant engineer views to be other than the standard. And, in some cases plant engineers or technicians with thermocouples installed in their plants are not aware that "EMF versus temperature" tables exist.

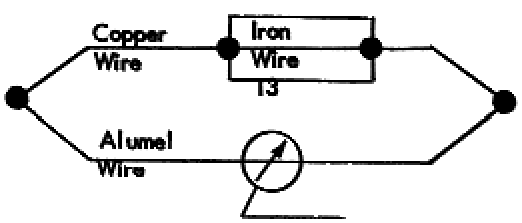
Because the thermocouple is poorly understood, it is often passed over in deference to another temperature measuring device that might be more expensive and less suited to the application. This is a situation that can be remedied by better understanding of the thermocouple and its associated circuitry.



Thermo Electric Laws

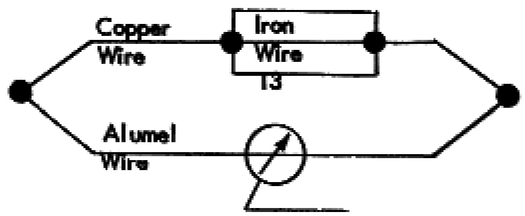
Much experimentation with thermocouple circuits has led to the formulation of three empirical "laws" which are fundamental to the accurate measurement of temperature by thermo electric means. Each law will be stated in this technical letter and its significance given in terms of actual thermo electric temperature measuring installation.

1. The law of homogeneous circuits states that an electric current cannot be sustained in a circuit of a single homogeneous metal, however varying in section, by the application of heat alone. Any current detected when the wire is heated is taken as evidence that the wire is in homogeneous.



A consequence of this law is that if one junction of two dissimilar metals is maintained at a temperature T1 and the other junction is at T2, the thermal EMF developed at the junction will not be affected by the temperature of the lead wires even though a temperature distribution exists along the lead wires. Meaning the EMF is not affected by temperatures T3 and T4.

2. The law of intermediate metals states that the algebraic sum of the thermo electromotive forces (EMF) in a circuit composed of any number of dissimilar metals is zero if the circuit is at a uniform temperature.



In a circuit as shown consisting of two dissimilar metals with their junctions at temperatures T1 and T2, a third metal is introduced by cutting and forming two junctions as shown. If the temperature of the third metal introduced is uniform over its entire length, the total electromotive force will be unaffected. As a consequence of this law any measuring device or lead wire can be added to the circuit without affecting the accuracy as long as the new junctions are at the same temperature. This law also permits soldering or brazing of thermocouple junctions.

3. The law of successive or intermediate temperatures states that if two dissimilar homogeneous metals produce a thermal EMF of E1 when the junctions are at temperatures T1 and T2, and a thermal EMF of E2 when the junctions are at temperatures T2 and T3, then the thermal EMF generated when the junctions are temperatures T1 and T3 will be E1 plus E2. This law permits the determination of an unknown temperature based on a certain reference junction temperature when the reference junction is at a different, but known, temperature from the unknown. It also makes feasible the use of oven controlled and electrically simulated reference junctions described in Thermocouple #3 Technical Letter.

Summary

By combining these three basic thermo electric laws, it is seen that; (1) the algebraic sum of the thermo electric EMF's generated in any given circuit containing any number of dissimilar homogeneous metals is a function only of the temperatures of the junctions and, (2) if all but one of the junctions in such a circuit is maintained at some reference temperature, the EMF generated depends only upon the temperature of that junction and can be used as a measure of its temperature.

Reference Junctions

Since the EMF generated by thermocouple circuits is a function of the difference in temperatures between the measuring junction and the reference junction, it is important that the reference junction be maintained at a constant, known temperature. This can be accomplished by (1) a temperature controlled oven, (2) an ice bath, or (3) an electrical means of simulating a known temperature.

Ice Bath

The ice bath reference consists of a container of cracked, melting ice with the reference junction completely immersed in the iced liquid. This arrangement can be maintained at the reference temperature of 32°F (0°C) within ± 1°F.

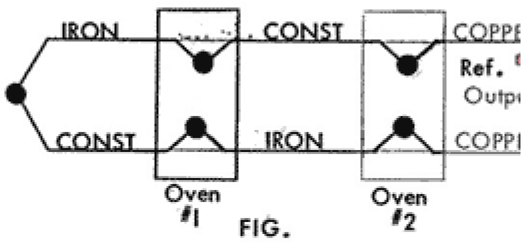
A well made ice bath kept in an insulated container will maintain an extremely stable temperature for a period of time. This easily repeatable standard gives the reliable reference temperature as long as the ice and water are in physical equilibrium. As melting occurs, the ice may rise in the container, giving the appearance of an acceptable bath, whereas the thermocouple junction at the bottom of the container is in water which is

several degrees above 32°F (0°C). Thus the common ice bath, while inexpensive and readily made, has its limitations.

Temperature Controlled Ovens

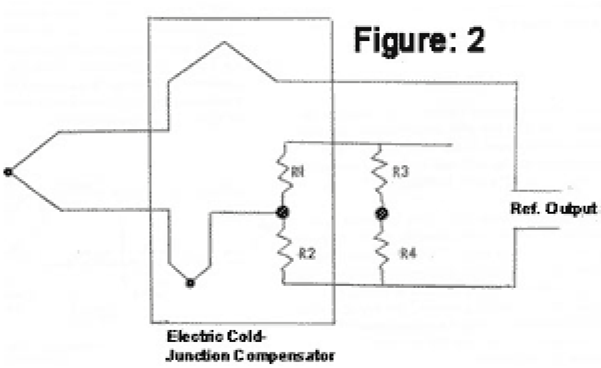
With a single temperature controlled oven, the reference junction is usually held at 150°F (65.6°C). Allowance must be made, naturally, for the fact that the reference junction is at this temperature, not 32°F (0°C); however for each type of thermocouple, the correction is readily determined. The accuracy of this type of reference is dependent upon the temperature control of the oven and is normally ±1° to ±5°F.

A double oven reference, Figure 1, uses dual temperature controlled ovens to automatically simulate an ice point reference temperature of 32°F (0°C). The two ovens are maintained at different temperatures, and the thermocouples in each oven are oppositely polarized to cancel the EMF's they generate. With the proper combination of oven temperatures and reference thermocouples, it is possible to simulate 32°F (0°C) at the reference point.



Electrical Temperature Simulation

This is by far the most convenient and popular means of cold junction reference. The most common type of electrical reference is the basic bridge circuit as shown in Figure 2.



In this configuration, R2 is a temperature-sensitive component that is thermally bonded to the cold junction thermocouple. The resistance-temperature curve of R2 matches the EMF-temperature characteristics of the thermocouple material. The voltage change across R2 is equal and opposite to the cold junction thermal voltage over a wide ambient temperature range, resulting virtually error-free compensation.. The circuit also produces an off-set voltage equivalent to the required reference temperature. This results in the simulation of a reference temperature at the cold junction and of the thermocouple circuit. This type of reference temperature simulation is well adapted to zero suppression of a large temperature. By calibrating the instrument for reference temperature at or near the temperature to be recorded, small temperature changes can be measured. The accuracy of this type of reference junction is about ± 0.5°F. It can be made very small and requires little power.

Measuring Junctions

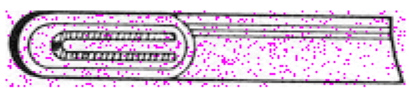
As discussed in the first three thermocouple technical letters, each thermocouple must utilize a measuring junction and a reference junction at two different temperatures. The measuring junction is generally at the higher of the two temperatures and the reference junction is at ambient. The measuring junction is place into or on whatever is to be measured and the referenced junction is connected either to a controller or a temperature indicator. This technical letter will attempt to explain the measuring junctions most commonly used in industrial applications, and will attempt to explain why each junction is important.

The Grounded Junction

The grounded measuring junction is the most common junction used in industry. This style is available on assemblies having electrically conductive metallic sheaths, and this means the thermocouple measuring junction is in electrical contact with the sheath. This junction provides a fast response time and gives long service life in corrosive conditions. It can replace larger diameter exposed junction thermocouples for equal response time plus the protection of the sheath.

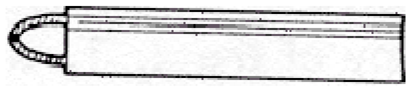
The Ungrounded Junction

In the ungrounded junction, steps are taken in manufacturing processes to electrically isolate the measuring junction from an electrically conductive sheath. This junction style is required when the thermocouple is used with instrumentation which is not itself internally electrically isolated. The ungrounded style junction is slower to respond then the grounded style for a given mass, but it can be the most reliable and rugged style junction. This junction is excellent in conductive solutions and can give long life under conditions of vibration shock and corrosion.



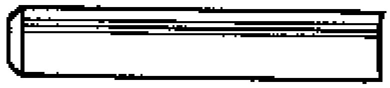
The Exposed Junction

The exposed junction is where the measuring junction of the thermocouple is not protected by any sheath material. This is the fastest responding junction, but is also most susceptible to corrosive failure. It is generally recommended for measurement of gas or solid surfaces in a non-corrosive environment. A small diameter metallic sheath with an exposed thermocouple junction has very little mass to thermally conduct the temperature, therefore giving very fast response time.



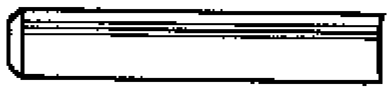
The Reduces End Junction

The basic purpose of the reduced end thermocouple junction is to offer a combination of the physical strength of a large diameter sheathed thermocouple and the response time of a small diameter thermocouple. This reduced end can be either ungrounded or grounded. The small mass at the measuring tip will give fairly fast response, but will have the strength characteristics of the larger diameter thermocouple.



The Flat End Junction

This junction is ground flat to reduce the mass for faster response time. It can be utilized in measuring surfaces of heated objects and can be combined with the grounded or ungrounded construction.



The junctions shown above may be formed by welding, brazing, soldering or by mechanical joining. considerations in selecting the joining technique include joint strength, contact resistance, environmental conditions (including operating temperature) and compatibility of the joining method with the thermocouple materials.

As can be seen the major criteria involved with selecting a junction is response time, medium to be measured, and electrical isolation. The junctions discussed in this technical letter can be utilized with any of the J, T, K, E thermocouples to obtain the best temperature control and measurement available.

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