THERMOCOUPLE GENERAL INFORMATION

Thermocouples consist of two dissimilar metals and provide a means of sensing temperature in a variety of processes. Temperature is the most widely measured process variable and its measurement is critical in many manufacturing processes. We at JMS manufacture temperature probes of exceptional quality to assure this measurement is accurate.

Thermocouples can be constructed in a variety of ways from flexible wires smaller than a human hair to rugged sheath one half inch in diameter. They can measure temperatures from -454°F to 4200°F.

Thermocouples are low-impedance devices that work by producing electro-motive forces and these EMF's are correlated to a temperature based on a curve specified for that particular thermocouple calibration. The EMF produced occurs due to temperature gradients along the wire and not at the junction. This phenomenon can be explained in three scientific theories called the Seebeck effect, the Peltier effect, and the Thompson effect.

Three laws of thermoelectric circuits that explain thermocouple behavior are **The Law of Intermediate Metals** which explains that a circuit's EMFs are algebraically additive unless the circuit is at a uniform temperature, **The Law of Homogeneous Metals** which indicates an EMF cannot be created unless another type of metal exists in the circuit and a temperature gradient exists.

The third law is the **The Law of Intermediate Temperatures**. If two dissimilar homogeneous metals produce a thermal EMF of X; it will remain at that number if a third material is introduced into the circuit, if both ends of that third material are at the same temperature.

The millivolt signal produced by the thermocouple is a very, very, very low level signal. Thus, transmitting this signal over a long distance may be difficult if any extraneous "noise" is introduced into the system. This noise may cause errors in the EMF signal. Shielded lead wire should be used in areas with excessive "noise" to help eliminate the problem.

The lead wire that extends from the thermocouple must match the calibration of the thermocouple. This lead wire continues to transmit the signal from the thermocouple to the instrument, and as long as it is one homogeneous metal, it does not produce an EMF along that length even if it does experience temperature gradients.

The output of a thermocouple depends on the magnitude of the temperature difference between the measuring junction and the reference junction. The reference junction is the cold end to which the thermocouple is connected. While the hot measuring junction is stable at a given temperature, the output of the point at which the reference junction is made must be compensated for in the instrumentation. This is accomplished through "cold junction Compensation." The temperature of the cold junction is measured and calculated into the overall EMF signal to obtain the accurate hot junction temperature, or the temperature of the process.[2]

[2]Benedict, R.P. Fundamentals of Temperature, Pressure and flow Measurement, Second Edition, Wiley, New York (1977).

THERMOCOUPLE POINTS

1. A thermocouple produces an EMF based on the composition of the two dissimilar metals only, irregardless of the dimension or length of the conductors.

2. No voltage is produced at the thermocouple junction, only in those portions of the sensor that are in a temperature gradient.

JMS has access to several papers on noise and its effect on instruments. Call us and we will mail or fax you a copy.