

# THE THERMOCOUPLE

The thermocouple is a device that measures a temperature difference. It is therefore little use on its own, requiring a separate temperature sensor to pin down the actual temperature. Thermocouples can be made smaller than other sensors and, not so relevant to us, cover a large temperature range.

The principle of operation is this: A small voltage appears between the ends of a wire that is in a temperature gradient. This voltage can be measured by connecting one end, let us say the hot end of the wire, to another wire of a different material that has a different voltage difference over the same temperature range. A voltage will now appear between the cold ends of the two wires. This voltage is quite small. If one wire is copper and the other is constantan, a copper nickel alloy, and the hot junction is 20 degrees warmer than the cold ends, the voltage will be about 800 microvolts.

This is easily measurable nowadays and thermocouple thermometers are precise to about 0.2 degrees. The reference sensor is usually a thermistor (cheap) or a platinum resistance thermometer (accurate). Temperature measurement will be discussed in detail in later episodes of this series.

There are some practical considerations in the choice and use of thermocouples. The standard low temperature thermocouple is copper-constantan, type T. This is stable and highly regarded by the experts.

The copper wire has, however, such good thermal conductivity that it is difficult to measure surface temperature, of a wall for example, because heat moves along the wire to the measuring tip. For this purpose I recommend type K: chromel-alumel. This has a similar sensitivity, reputedly worse stability, and a rather non-linear voltage below zero degrees. It seems OK at the sort of room temperatures conservators need to be wise about. There are hand-held instruments that take both types of thermocouple. A two input instrument is very useful. It can be adapted to work as a rapid action psychrometer.

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