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Thermocouple Stability

Understanding Drift

Drift

Base-metal thermocouples, ANSI standard Types J, K, T, E, have innate thermoelectric instability related to time or temperature-dependent instabilities in many of their chemical, physical, and electronic properties.

When a thermocouple is used to measure the temperature of a particular environment, it can be expected that the measured voltage does not change if the temperature of that environment remains constant. Actually, the voltage can change over time, even though the temperature of the environment remains constant: this phenomenon is called **DRIFT**. Drift is a source of error in thermocouple measurement.

Drift occurs because of metallurgical changes in the conductors during the operation of the thermocouple. Because these changes are time dependent, the voltage change from the expected value, called drift, is also time dependent. An example of drift is shown below, in Figure 10, for a 1.5mm bare wire Type 'K' thermocouple exposed at 500°C. The change in voltage is reported as a function of the exposure time.

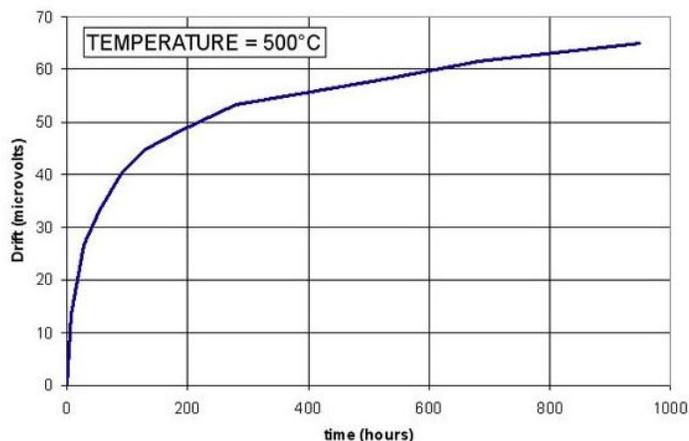


Figure10: Drift for a 1.5mm diameter bare wires type K thermocouple exposed at 500°C (adapted from [1]).

Metallurgically, drift can be distinguished in the following:

- ◆ **Surface modifications**, which are related to changes in the conductors because of interactions between the conductors and the environment around the them.
- ◆ **Bulk modifications**, which are related to changes in the volume of the conductors.

Some examples of **surface modifications** can be identified below:

- ◆ Oxidation (bare wire configurations)
- ◆ Depletion of elements from the conductors [bare wire/mineral insulated metal sheathed(MIMS)]
- ◆ Contamination from the environment (bare wire/MIMS configuration)
- ◆ Interaction with the insulator (MIMS configuration)
- ◆ Interaction with the sheath (MIMS configuration)

In relation to bulk modifications, the following phenomena can occur:

- ◆ Phase transformations
- ◆ Short/long range ordering transformations
- ◆ Grain growth
- ◆ Residual strain and dislocations annihilation
- ◆ Recrystallization

References

{1} R.E. Bentley, "Long-term drift in mineral-insulated Nicrosil-sheath type K thermocouple". *Sensor and Actuators A*, 24(1990) 21-26

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