

Ageing of Type K Thermocouple Wire

Introduction

Ageing is the term used to describe a reversible hysteresis change which occurs mainly in the positive, Nicro, leg of a Type K thermocouple pair. In some circumstances raising the temperature of the material to between 250°C and 500°C can cause a metallurgical change within the alloy which causes the emf output to increase by up to 330µV (~8°C).

Mechanism

There is no definitive explanation but it has been variously described as due to periodic arrangement of atoms in localised areas only of the crystalline lattice^{1,2,3} or an electron spin cluster mechanism⁴.

Characteristics

It would appear that batches of Nicro alloy, containing slightly different compositions of minor elements, vary in their susceptibility to these changes. The Nicro alloy is cast to provide the emf profile of a Type K positive leg. During the casting process the initial composition is sampled and additions are made to achieve the required emf. These trace additions will vary for each batch. In addition, the lining of the furnace will absorb and release material into the 'melt' depending upon the preceding melts and the lining is completely replaced on a regular basis. All of these process variations combine to create a unique composition for each batch and potentially different ageing characteristics.

It has been suggested⁵ that once the material has 'aged' at a specific temperature subsequent use below that temperature will not incur significant further change although this would need to be tested in an application to determine the length of time required to achieve an acceptably aged condition.

Reversibility

The emf increase caused by ageing or hysteresis can be removed by re-annealing the wire at temperatures above 700°C where the localised metallurgical changes are removed⁴.

References

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