The Care and Maintenance of Thermocouples

PRACTICAL PROBLEMS OF INSTRUMENTATION AND INSPECTION

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The thermocouple has for many years been the most practical choice as a means of measuring high temperatures. It is accurate, consistent, robust, reasonably inexpensive, and gives a quick response to changes in temperature. At the same time, proper precautions must be taken in its instrumentation and use to ensure that these advantages are retained, and that the care given to its manufacture by the metallurgist is not vitiated by unnecessary contamination or ill treatment during its service life. In many industrial operations such as melting, casting and heat treatment the quality of the final product may depend a great deal on maintaining the accuracy of temperature measurement.

The realisation of the importance of this aspect of engineering metallurgy has presumably provided the impetus for the Institution of Engineering Inspection to publish a thirty-page monograph on "Thermocouples: Their Instrumentation, Selection and Use", compiled by B. F. Billing, of the Royal Aircraft Establishment.

This is a good practical manual, providing sufficient theory to enable works engineers, inspectors and laboratory technicians to understand the fundamentals of thermocouple thermometry. The principles of current-sensitive and potentiometric measuring instruments are well described in concise language, without omitting essential details. Although the sensitivity of the different types of instrument is indicated, there is no recommendation to enable the user to choose equipment most suitable for his purpose. There is also no mention of recorders, quick-response instruments or large-scale indicators so useful in a foundry or heat-treatment shop.

The whole field of base metal and rare metal thermocouples is surveyed accurately, the facts being well documented and up to date. The scope of the platinum metal thermocouples is well covered objectively, with information on insulation and the risks of contamination. There is a review of high temperature thermocouples – of increasing importance nowadays – including the Feussner couple and the iridium : tungsten couple, but there is no warning of the embrittlement of iridium through recrystallisation after use at high temperatures. One omission is the 0.1 per cent molybdenum-platinum : 5 per cent molybdenum-platinum thermocouple for the measurement of temperature under conditions of neutron radiation.

While there is a place in the literature for reference to such methods as burying the reference junction 10 feet in the ground, which no one is likely to employ, it scarcely has a place in a practical monograph. Moreover, the subject is unnecessarily complicated by reference to thermocouples in series or parallel, and details about the more complex instruments and methods of calibration.

The appendices give some useful tables comparing the calibrations, working ranges and physical properties of a wide variety of thermocouples suitable for use down to near absolute zero.

In a monograph offered to engineering inspectors, it might have been thought desirable to give a more practical emphasis to the faults and failings of thermocouple installations, as it is often the simple and almost obvious faults that are overlooked. Over and over again failures and rejections occur in industrial processes owing to faulty temperature measurement.

The positioning of a thermocouple in a heat-treatment furnace is of first importance. Most furnaces have temperature gradients and all too often a thermocouple is placed in a position of safety, perhaps in the roof of the furnace, where the temperature may bear little resemblance to the temperature of the work. Occasions have been known when billets have started to melt at one end of a furnace, while those at the other end were at the required temperature. The temperature variations within the chamber of a furnace should always be explored, and if necessary allowances made for the difference between the temperature at the control couple and that of the work. In critical circumstances a thermocouple should always be placed on or very near the work. The time required to attain the desired temperature, depending upon the size of the part and the thermal capacity of the furnace, should also be considered.

There is need for a constant awareness of the possibility of contaminating a platinum metal thermocouple. It is extremely unlikely that a new thermocouple will be faulty, but often, when a thermocouple breaks in service due to contamination, it is replaced by a new one *in the old sheath*, which itself must have become contaminated. Platinum thermocouples will give long and reliable service at high temperatures, often under apparently adverse conditions, provided that they are adequately protected against the few substances that can contaminate them.

Thermocouple installations should be regularly inspected and tested. A temperature indicator or recorder should be checked, either with a potential divider or a standard thermocouple at least once a month, whether it is used much or little. Terminals must be kept clean, insulation must be checked, and thermocouples themselves must be recalibrated.

Where many couples are in constant use, the simplest and quickest reliable means of calibration should always be kept in readiness for a thermocouple check by a competent technician.

So the inspector must make himself aware of the sources of error in thermocouple installations: the thermocouple must be properly located to give the true temperature of the work, its correct positioning inside the sheath must be assured, it must be free from stresses liable to cause fracture, and insulation must be effective, especially on bends.

Electrochemical Hydrogen Purification

THE USE OF A MODIFIED FUEL CELL TECHNIQUE

Arising from research in the field of fuel cell technology, a novel electrochemical method for purifying hydrogen has been reported by J. E. McEvoy, R. A. Hess, C. A. Mills and H. Shalit, of Houdry Process and Chemical Co (*Ind. and Eng. Chem. Process Design and Development*, 1965, **4**, (1) 1). In a hydrogen-consuming fuel cell the gas is oxidised electrochemically at the anode, using oxygen supplied to the cathode and a suitable electrolyte separating the two electrodes. This system may be modified by the use of two highly reversible hydrogen electrodes operating in an electrolyte of 30 per cent H_2SO_4 to form a purification cell in which hydrogen containing impurities is consumed at the anode and quantitatively generated at the cathode. A small e.m.f. applied across the two electrodes provides the driving force. Both the anode and the cathode are prepared by incorporating a platinum-impregnated charcoal catalyst in a suitable carbon matrix.