Platinum Thermocouple Calibrations

AN INTERCOMPARISON BY EUROPEAN LABORATORIES

The importance of the accurate calibration of thermocouples needs no reiteration here. It is generally accepted that platinum-based thermocouples provide the best accuracy and reproducibility, and they are frequently used for assessing calibration laboratories.

Between 1981 and 1984 an intercomparison of calibrations of three types of platinum-rhodium thermocouples was carried out in six European standards laboratories with support from the Community Bureau of Reference of the European Economic Community, and the results have now been reported (L. Crovini, R. Perissi, J. W. Andrews, C. Brookes, W. Neubert, P. Bloembergen, J. Voyer, and I. Wessel, *High Temp.-High Pressures*, 1987, **19**, (2), 177–194).

The types of thermocouples examined were Type S (10%Rh-Pt : Pt), Type R (13%Rh-Pt : Pt) and Type B (30%Rh-Pt : 6%Rh-Pt). The manufacturing tolerances for such thermocouples are prescribed in the International Electrotechnical Commission publication 584-2, and for Types S and R are ±1°C from 600 to 1100°C and then increasing linearly to ±2.5°C at 1600°C. For Type B, the tolerance is ±1.5°C from 600 to 1100°C, and then increasing linearly to ±4.0°C at 1600°C. However, inaccuracies in calibration of metrological laboratories and calibration services should be at least 10 times better than these figures.

Calibrations of thermocouples are generally made against the freezing points of pure metals in the range 600 to 1065°C, to within ±0.2°C; and against the melting points of gold and palladium (usually in air) using the wire bridge technique in the range 1000 to 1600°C. These techniques give rise to some uncertainty, detailed in the paper, which was the reason for setting up this intercomparison study.

The measurements were made in two distinct circulations with nine thermocouples in each, consisting of three thermocouples of each type. The thermocouples were made of Class 2/IEC wires, purchased from Industrie Engelhard SpA (first circulation) and Johnson Matthey (second circulation). Before each calibration, all thermocouple wires were prepared and tested under standard conditions, and at the end of each experiment the thermocouples were dismantled, cleaned and coiled for transportation to the next laboratory. All laboratories were supplied with high purity gold and palladium from the same batch of material to eliminate the possibility of differences due to varying purity. Full details of preparation and experimental procedures are given in the paper.

The reader is also recommended to refer to the paper for a detailed analysis of the results. However, considerations of the reproducibility of the melting points show that the mean interlaboratory differences were ±0.25°C for gold and ±0.35°C for palladium, under the best conditions, both melting points being realised in air. The estimated repeatability within each laboratory was better than ±0.3°C for gold and ±0.85°C for palladium. In the second circulation, a larger drift was observed due to the longer exposures to high temperatures.

With respect to IPTS-68, the comparisons carried out in the second circulation at three laboratories gave an agreement of melting point temperatures of better than 0.7°C at the gold point and 1.5°C at the palladium point. The results indicated that the temperature assigned to the melting point of palladium in air may be too high by at least 0.5°C. All the thermocouples changed calibrations during the intercomparisons, the drift generally being due to chemical contamination.

In summary, it was concluded that the laboratories were able to calibrate new thermocouples to within ±0.4°C at the gold melting point and to within ±0.9°C at the palladium melting point with mutual agreement inside these figures.

C.W.C.