countries. A further advantage is that the new values show a much smoother progression, providing an increased accuracy of interpolation.

Further work is being carried out by an IEC Technical Committee (65B) on a set of internationally acceptable tolerances for all seven thermocouple combinations, and these should eventually be issued as Part II of the 584-1 standard.

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Tantalum Clad Rhodium-Platinum Thermocouples

LARGE DECALIBRATIONS INDUCED BY UNFAVOURABLE COMBINATION OF MATERIALS

The robustness and resistance to mechanical and thermal damage displayed by metal sheathed thermocouples have prompted their use in many arduous industrial environments, where the conventional, alumina insulated, alumina sheathed devices display limited durability. Great care must be taken, however, in the design and construction of metal sheathed thermocouple probes in order to minimise thermoelectric instability. In particular, the materials of construction must be chemically compatible at the temperature of operation, and a recent paper by T. G. Kollie, W. H. Christie and R. L. Anderson (*J. Less Common Metals*, 1978, **57**, (1), 9–27) illustrates very clearly how an incorrect choice of materials can lead to substantial reaction-induced decalibrations.

During experiments conducted at the Oak Ridge National Laboratory, platinum: 10 per cent rhodium-platinum and 6 per cent rhodium-platinum: 30 per cent rhodium-platinum thermocouples alumina insulated and encased within a pure tantalum sheath, were heated at temperatures up to 1330°C in an atmosphere of pure helium. After only a few hours at temperature, decalibrations equivalent to −152°C, and −11°C respectively were observed in the two assemblies. Subsequent metallographic examination and microprobe analyses showed that severe reactions had occurred at the interface between the alumina insulation material and the thermocouple wires, resulting in the presence of up to 27 atomic per cent aluminium in the thermocouple limbs.

It is well known (1) that platinum will react with most refractory oxides under conditions which maintain a low oxygen potential in the surrounding environment, the driving force being the extremely high affinity of platinum for the metal released upon decomposition of the oxide. In the devices described in the Oak Ridge paper, the tantalum sheath itself would be expected to act as a continuous "getter" for oxygen and thus allow the platinum-alumina reaction to proceed unhindered.

A Successful Combination

If the same thermocouples were sheathed with a material exhibiting little or no affinity for oxygen, then the oxide-platinum reaction becomes self stifling, in that the slightest tendency towards reaction raises the oxygen partial pressure in the surrounding environment to the equilibrium value. A practical embodiment of this argument is the 5 per cent rhodium-platinum sheathed 6 per cent rhodium-platinum: 30 per cent rhodium-platinum thermocouple, which, when provided with an inert gas internal atmosphere, decalibrates by only −5°C, after 500 hours at a temperature of 1450°C (2). This combination of sheath and thermocouple resulted from a detailed consideration of material compatibility, high temperature strength and mechanical durability; and in recent years it has proved to be an accurate means of sensing temperatures in many industrial processes.

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References

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