Tungsten vs Tungsten 74 Rhenium 26 Thermocouple

HIGH TEMPERATURE TECHNOLOGY developments have advanced so rapidly in recent years that an increasing need has arisen for materials that are suitable for thermoelectric applications at high temperatures. As reported earlier,[1] a series of noble metal thermocouple wires, manufactured by Engelhard Industries, Inc., provide industry with the essential means for precise high temperature measurement. In addition, Engelhard Industries now offers a W vs W 26 Re thermocouple, made of refractory metals, that extends the range of reliable temperature measurement up to 2800°C (5072°F).* Some of the characteristics and the requirements for effective use of this W vs W 26 Re thermocouple are summarized in this paper.

Atmospheres and Temperature Limits. The W vs W 26 Re thermocouple is suitable for use in vacuum, hydrogen, and inert gases such as nitrogen, argon and helium. This thermocouple is not suitable for use under oxidizing conditions or in the presence of hydrocarbon vapors which will rapidly attack tungsten at temperatures above 1000°C (1832°F). The high melting points of the elements comprising the thermocouple [tungsten, m.p. 3380°C (6116°F); rhenium, m.p. 3167°C (5733°F)] plus a low vapor pressure make the tungsten-rhenium thermocouple attractive for use in a vacuum at intermediate and high temperature.

In the range from 2000°-2800°C (3632°-5072°F), the W vs W 26 Re thermocouple is especially recommended. However, its high output also makes it useful for the measurement of temperatures below this range.

Insulators. Double-bored insulators of high purity aluminum oxide may be used to approximately 1800°C (3272°F). Above this temperature, beryllium oxide [m.p. 2570°C (4650°F)] and thorium oxide [m.p. 3299°C (5970°F)] should be considered.

Fabrication and Standard Calibration. Hot junctions of the W vs W 26 Re thermocouple may be formed by inert gas arc welding. Since the wires may become embrittled in the vicinity of the weld, it is important that the wires are not flexed in this region after the junction is formed. To overcome this problem, a double-bored insulator may be placed in position prior to forming this junction. If this is not practical, the wires may be twisted together before inert gas arc welding. One or two complete turns are all that is necessary. The insulators can then be slipped on without breaking the weld joint.

Extension leads of plain copper are considered to be satisfactory because the output of the thermocouple at temperatures up to 100°C (212°F) is relatively low. Because of this, the errors introduced by normal fluctuations in room temperature are small in relation to the accuracy of calibration. For the most accurate work, an ice or isothermal cold junction is recommended. In normal industrial applications, no correction need be made for cold junction temperatures between 0° and 20°C (32° and 68°F); above this temperature range, the following corrections may be added to the observed output:

Cold Junction, °C	Correction, mv.
25	0.050
35	0.077
45	0.108
55	0.141
65	0.180
75	0.218
85	0.274
95	0.312
100	0.333

From the Baker Platinum Division and Instruments & Systems Division of Engelhard Industries, Inc., Newark, New Jersey.

* This thermocouple was developed in the Rugby Research Laboratories of A.E.I. Lamp & Lighting Co. Ltd., for whom Engelhard Industries, Inc. is offering this material as an exclusive agent in the U.S.A.

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Table I. Calibration Table for W vs W 26 Re

Temperature, °C Reference Junction, 0°C

E.M.F., millivolts

°C	E.M.F., mv.	°C	E.M.F., mv.
100	0.333	1500	25.130
200	1.250	1600	27.130
300	2.200	1700	29.130
400	3.130	1800	30.880
500	4.380	1900	32.500
600	5.630	2000	34.130
700	7.130	2100	35.500
800	8.888	2200	36.880
900	10.830	2300	38.130
1000	13.130	2400	39.250
1100	15.630	2500	40.250
1200	18.250	2600	41.380
1300	20.750	2700	42.250
1400	23.000	2800	43.250

A standard calibration chart — shown in Table I — has been determined and all wires are manufactured and tested to meet this calibration. The e.m.f. of these couples conforms to the standard calibration within a tolerance of $\pm 1\%$. The reproducibility of the readings obtained on a particular couple is, of course, appreciably closer than this.

Reference

1. Zysk, E. D. *Engelhard Ind. Tech. Bull. 1,* 8 (1960).