



徽宁集团
HUINING GROUP

热电偶（阻）说明书

Instructions for thermocouple and thermal resistance



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1、用途 Purpose

热电偶、热电阻通常和显示仪表、记录仪表、电子计算机等配套使用，直接测量生产过程中 - 40 ~ 1700℃ 范围内液体、蒸汽和气体介质以及固体表面温度。

It's generally used for directly measuring the surface temperature of liquid, steam and gas media and solids ranging from - 40 to 1,700 °C in the process of production, in connection with display and logging meters , and electronic computers .

2、工作原理 Working principle

2.1 热电偶的工作原理

2.1 Working principle of thermocouple

热电偶的工作原理是，两种不同成分的导体两端经焊接，形成回路，直接测温端叫工作端，接线端子叫冷端，亦称参比端。当工作和参比端存在温差时，就会在回路里产生电流，接上显示仪表，仪表上就会指示出热电偶所产生的热电动势的对应温度值。

It works by means of two junctions of different composition of conductive body forming a loop via welding. The junction for directly measuring temperature is called working junction; the connection junction is referred as cold junction, also reference junction. When there is a temperature difference between working junction and reference junction, electric current will be produced inside loop. Then, connect display meter to indicate the corresponding temperature value of thermoelectric force produced by thermocouple.

2.2 热电阻的工作原理 Working principle of thermal resistance

热电阻的测温原理是基于导体或半导体的电阻值随温度变化而变化这一特性来测量温度及与温度有关的参数。热电阻大都由纯金属材料制成，目前应用最多的是铂和铜，现在已开始采用镍、锰和铑等材料制造热电阻。热电阻通常需把电阻信号通过引线传递到计算机控制装置或者其它二次仪表上。

The principle of thermoelectric resistance is to measure temperature and temperature related parameters based on the characteristic that the resistance value of conductor or semiconductor changes with temperature. Most of the thermal resistance is made of pure metal materials, and platinum and copper are the most widely used. Now, the thermal resistance is made of nickel, manganese and rhodium. Thermal resistance usually needs to transmit the resistance signal to computer control device or other secondary instrument through lead wire.

3、主要技术参数 Main technical parameters

3.1 热电偶测温范围及允差 Measuring range and allowable error of thermocouple

热电偶名称 Name	型号 Code name	分度号 Scale mark	等级 Class	使用温度范围℃ Measuring range (°C)	允差℃ Allowable error (°C)
镍铬-镍硅	WRN	K	I	-40~1100	±1.5℃ 或 ±0.4%t
			II		±2.5℃ 或 ±0.75%t
镍铬硅-镍硅	WRM	N	I	-40~1100	±1.5℃ 或 ±0.4%t
			II		±2.5℃ 或 ±0.75%t
镍铬-铜镍	WRE	E	I	-40~800	±1.5℃ 或 ±0.4%t
			II		±2.5℃ 或 ±0.75%t
铁-铜镍	WRF	J	I	-40~750	±1.5℃ 或 ±0.4%t
			II		±2.5℃ 或 ±0.75%t
铜—铜镍	WRC 或 WRT	T	I	-40~350	±0.5 或 ±0.4%t
			II	-40~350	±1 或 ±0.75%t
			III	-200~40	±0.5 或 ±1.5%t
铂铑 ₃₀ —铂 ₆	WRR	B	II	600~1700	±0.25%t
			III		±4 或 ±0.5%t
铂铑 ₁₃ —铂	WRQ	R	I	0~1300	±1 或 ±[1+ (t-1100) × 0.003]
			II		±1.5 或 ±0.25%t
铂铑 ₁₀ —铂	WRP	S	I	0~1300	±1 或 ±[1+ (t-1100) × 0.003]
			II		±1.5 或 ±0.25%t

Name	Code name	Scale mark	Measuring range (°C)	Class	Allowable error (°C)
Nickel chromium — Nickel silicon	WRN	K	-40~1100	I	$\pm 1.5^{\circ}\text{C}$ or $\pm 0.4\%t$
				II	$\pm 2.5^{\circ}\text{C}$ or $\pm 0.75\%t$
Nickel chromium silicon — Nickel silicon	WRM	N	-40~1100	I	$\pm 1.5^{\circ}\text{C}$ or $\pm 0.4\%t$
				II	$\pm 2.5^{\circ}\text{C}$ or $\pm 0.75\%t$
Nickel chromium — Copper nickel	WRE	E	-40~800	I	$\pm 1.5^{\circ}\text{C}$ or $\pm 0.4\%t$
				II	$\pm 2.5^{\circ}\text{C}$ or $\pm 0.75\%t$
Ferrite — Copper nickel	WRF	J	-40~750	I	$\pm 1.5^{\circ}\text{C}$ or $\pm 0.4\%t$
				II	$\pm 2.5^{\circ}\text{C}$ or $\pm 0.75\%t$
Copper — Copper nickel	WRC	T	-40~350	I	$\pm 0.5^{\circ}\text{C}$ or $\pm 0.4\%t$
			-40~350	II	$\pm 1^{\circ}\text{C}$ or $\pm 0.75\%t$
			-200~40	III	$\pm 1^{\circ}\text{C}$ or $\pm 1.5\%t$
Platinum rhodium ₃₀ — Platinum rhodium ₆	WRR	B	600—1700	II	$\pm 0.25\%t$
				III	$\pm 4^{\circ}\text{C}$ or $\pm 0.5\%t$
Platinum rhodium ₁₃ — Platinum	WRQ	R	0—1300	I	$\pm 1^{\circ}\text{C}$ or $\pm [1+(t-1100)X0.003]$
				II	$\pm 1.5^{\circ}\text{C}$ or $\pm 0.25\%t$
Platinum rhodium ₁₀ — Platinum	WRP	S	0—1300	I	$\pm 1^{\circ}\text{C}$ or $\pm [1+(t-1100)X0.003]$
				II	$\pm 1.5^{\circ}\text{C}$ or $\pm 0.25\%t$

3.2 热电阻测温范围及允差 Measuring range and allowable error of thermal resistance

名称	分度号	精度	测温温度范围℃	允许偏差℃
铂热电阻	Pt100	A	-200~500	$\pm (0.15+0.002 t)$
		B		$\pm (0.3+0.005 t)$

Name	Code name	Scale mark	Accuracy	Allowable error	Scale °C
Platinum thermal resistance	WZP	Pt100	A	$\pm(0.15+0.002 t)$	-200 - +500
			B	$\pm(0.3+0.005 t)$	

3.3 公称压力 Nominal pressure

一般是指在工作温度下保护管所能承受的静态外压而不破裂。工作压力不仅与保护管材料、直径、壁厚有关，还与其结构形式、安装方法、置入深度以及被测介质的流速和种类等有关。

Generally refers to such static exterior pressure as can be borne by protecting tubes without any cracking. Working pressure is not only associated with materials, diameters and wall thickness of protecting tubes, but also with their structure forms, mounting methods, posting depth as well as flow speed and types of measured media.

3.4 最小置入深度 Minimal posting depth

3.5.1 热电偶最小置入深度应不小于其保护管外径的 8~10 倍。

The minimal posting depth of thermocouple shall be no less than 8-10 times of its protecting tube outside diameter.

3.5.2 热电阻最小置入深度 $l_{\min}=l_{\pi}+15D$ ，其中 l_{π} 为感温元件长度，D 为保护管直径。

The minimal posting depth of thermocouple is formularized as $l_{\min} = l_{\pi} + 15D$, wherein l_{π} is the length of temperature sensitive element, and D is the diameter of protecting tube.

3.6 热电阻自热影响

Self-heating influence of thermal resistance

通过热电阻中的测量电流为 5mA 时，测得的电阻增量换算成温度值应不大于 0.3℃。

When the measuring current of thermal resistance is 5mA, the resistance increment as measured shall not exceed 0.3℃ after being converted to temperature value.

3.7 绝缘电阻

Insulating resistance

环境温度在 15~35℃，相对湿度不大于 80%时，热电偶常温试验电压为直流 500±50V，对于长度超过 1 米的热电偶，其绝缘电阻应不小于 100MΩ · m；对于长度等于或不足 1 米的热电偶，其绝缘电阻应不小于 100MΩ。热电阻试验电压为直流 100±10V，铂热电阻绝缘电阻应不小于 100MΩ；铜热电阻绝缘电阻应不小于 50MΩ。

Where the environmental temperature is at 15-35℃ and the relative temperature is no more than 80%, the test voltage at normal temperature of thermocouple is DC500 ± 50V. Therefore, for thermocouple of over 1m length, its insulating resistance shall be no less than 100MΩ · m; for thermocouple of 1m length or below 1m length, its insulating resistance shall be no less than 100MΩ. When the test voltage of thermal resistance is DC100 ± 10V, the insulating resistance of platinum thermal resistance shall be no less than 100MΩ, and that of copper thermal resistance no less than 50MΩ.

3.8 热电偶上限温度 绝缘电阻

Insulating resistance of thermocouple at upper limit temperature

热电偶的上限温度绝缘电阻应不小于下表的规定：

Insulating resistance of thermocouple at upper limit temperature shall be no less than those as specified in the following table:

上限温度 $t_m(^{\circ}\text{C})$ Upper limit temperature $t_m(^{\circ}\text{C})$	试验温度 $t(^{\circ}\text{C})$ Test temperature $t(^{\circ}\text{C})$	电阻值 (MΩ) Resistance value (MΩ)
$100 \leq t_m < 300$	$t = t_m$	10
$300 \leq t_m < 500$	$t = t_m$	2
$500 \leq t_m < 850$	$t = t_m$	0.5
$850 \leq t_m < 1000$	$t = t_m$	0.08
$1000 \leq t_m < 1300$	$t = t_m$	0.02
$t_m \geq 300$	$t = 1300$	0.02

$100 \leq t_m < 300$	$t = t_m$	10
$300 \leq t_m < 500$	$t = t_m$	2
$500 \leq t_m < 850$	$t = t_m$	0.5
$850 \leq t_m < 1000$	$t = t_m$	0.08
$1000 \leq t_m < 1300$	$t = t_m$	0.02
$t_m \geq 300$	$t = 1300$	0.02

4、 热电偶、热电阻型号表示

Model representation of thermocouple and thermal resistance

● Assemble thermocouple

热电偶

W R □ □ — □ □ □ □
① ② ③ ④ ⑤ ⑥

W: 温度仪表 R: 热电偶

①表示热电偶材料代号

denoting pair; if single, the related sign omitted Material

②表示热电偶对数的代号:

1 单支式 (省略) 2 双支式

③热电偶的安装固定形式

thermocouple Forms of fixtures

● Assemble thermal resistance

热电阻

W Z □ □ — □ □ □ □
① ② ③ ④ ⑤ ⑥

W: 温度仪表 Z: 热电阻

①表示热电阻材料代号: P 铂热电阻 C 铜热电阻

P platinum thermal resistance

C copper thermal resistance

②表示热电阻对数的代号:

1 单支式, 省略 2 双支式

③热电阻的安装固定形式

thermal resistance Forms of fixtures

- 1、无固定装置 2、固定螺纹
No fixture Fixed screw thread
- 3、活动法兰 4、固定法兰
Movable flange Fixed flange
- 5、直角活动法兰、
Right-angled movable flange
- 6、锥形固定螺纹
Conical fixed screw thread
- 7、直形管接头式
Straight tube connection
- 8、固定螺纹管接头
Fixed screw thread tube connection
- 9、活动螺纹管接头
Movable screw thread tube connection
- ④接线盒形式
Forms of connection box
- 2、防溅式
Of sprinkling-proof type
- 3、防水式或防喷式
Of waterproof type
- 4、隔爆式
Of explosion preventative type

⑤保护管直径：

Diameters of protecting tube

0: $\phi 16$ 1: $\phi 20$ 2: $\phi 25$ 3: $\phi 28$

⑥附加装置形式

Forms of additional devices

K 铠装元件 G 变截面+铠装元件

Armored element Variable section

M 端面 F 防腐

Face Anticorrosive type Wear hardness

- 1、无固定装置 2、固定螺纹
No fixture Fixed screw thread
- 3、活动法兰、 4、固定法兰、
Movable flange Fixed flange
- 5、直角活动法兰
Right-angled movable flange
- 6、锥形固定螺纹、
Conical fixed screw thread
- 7、直形管接头式
Straight tube connection
- 8、固定螺纹管接头、
Fixed screw thread tube connection
- 9、活动螺纹管接头
Movable screw thread tube connection
- ④接线盒形式
Forms of connection box
- 2、防溅式
Of sprinkling-proof type
- 3、防水式或防喷式
Of waterproof type
- 4、隔爆式
Of explosion preventative type

6、接插件式
Of sprinkling-proof type

⑤保护管直径：

Diameters of protecting tube

0: $\phi 16$ 1: $\phi 12$

⑥附加装置形式

Forms of additional devices

G 变截面

J 一体化温度变送器

Variable section

Elastic armored element

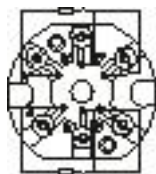
M 端面热电阻

T Elastic armored element

5.接线方式 Wiring method

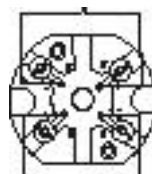
5.1 热电偶接线方式

Wiring method of thermocouple



单支接线方法

Single wiring method



双支接线方法

Pair wiring method

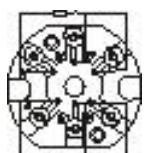
5.2.热电阻接线方式

Wiring method of thermal resistance



单支接线方法

Single wiring method



双支接线方法

Pair wiring method

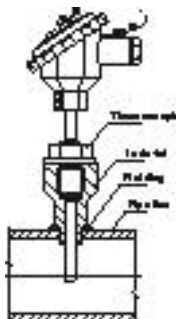
6. 安装说明 Mounting instructions

6.1 安装方法

Mounting methods

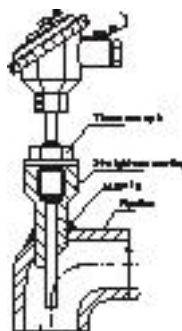
垂直安装

Vertical mounting



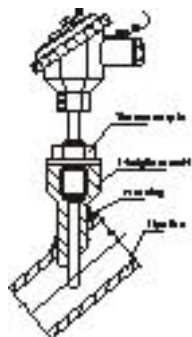
弯曲管道

Bent pipeline mounting



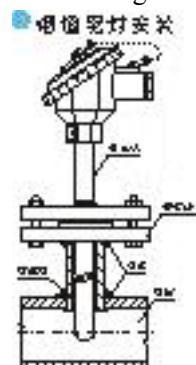
倾斜安装

Inclined mounting



烟道密封安装

Flue sealing mounting



6.2 热电偶、热电阻接线方法及注意事项

6.2 Wiring method of thermocouples and thermal resistances & precautions

连接导线应选用外径 10mm 圆形截面面积不小于 1.5mm² 的铜导线（最好是屏蔽的）。

Wires shall adopt copper wires of 10mm outside diameter with round section areas of no less than 1.5mm² (shielded wires preferred).

热电阻接线时，当测量精度要求不高且连接导线较短时，允许采用二线制（二芯电缆）；为避免因连接导线的电阻随外界温度变化而降低测温精度时，应采用三线制。

For wiring thermal resistance, double-line system (dual-core cable) is allowed when no higher measurement accuracy is required, and wires are a little short. To avoid reduction of measurement accuracy owing to variation of wire resistance following its ambient temperature change, three-line system shall be adopted.

热电偶接线时应选用相匹配的补偿导线。

In wiring thermocouples, matchable compensating conductors shall be used.

6.3 安装遵守原则

6.3 Mounting principles

● 热电偶的测量端应处于能够真正代表被测介质温度的地方。管道上安装热电偶时，应使保护管末端超过管道中心线约 5~10mm。

Measurement ends of thermocouples shall be placed where the temperature of measured media can be best shown. In mounting thermocouples on pipelines, bottoms of protecting tubes shall go beyond centerlines about 5-10mm.

● 热电偶应有足够的插入深度。一般最少不小于热电偶保护管外径的 8~10 倍。

Thermocouples shall be inserted thoroughly. Generally, the inserting depth shall be no less than 8-10 times of their respective protecting tube outside diameter.

● 为防止损失，热电偶保护管露在设备外部应尽可能短，并加保温层。

To prevent loss, exposed parts of thermocouple protecting tubes shall be short as much as possible, and be coated with heat preservation.

● 若被测介质具有负压或为有害气体时，热电偶安装必须严格密封，以免外界冷空气进入，影响测量的准确性，或有害气体溢出污染空气。

In case that measured media have negative pressure or harmful gases, thermocouples shall be mounted in a completely sealing manner so as to avoid entry of ambient cold air to influence accuracy of measurement, or overflow of harmful gases to pollute air.

● 热电偶的安装地点，应尽量避免其他热源，强磁场、电场等，防止外来干扰。

Thermocouples shall be mounted in places much away from other heat source, strong magnetic field and electric field in an effort to prevent outside interferences.

● 热电偶安装位置应尽量保持垂直，防止保护管在高温下变形。但在有流速情况下，热电偶必须斜安装，如有可能，尽量安装在管道的弯曲处。若需水平安装时，则应该有耐火砖或耐热金属支架加以支撑。

Thermocouples shall be mounted as vertically as possible so as to avoid deformation of their protecting tubes under high temperature. However, if flow speed exists, thermocouples must be mounted slantways. If possible, they shall be mounted on bends of pipelines as much as possible. If horizontal mounting is required, refractory bricks or heatproof metal brackets shall be provided for supporting thermocouples.

● 对于贵金属热电偶安装时，将热电偶放在专用支架上，支架放在带轮的小车上，使热电偶刚好对设备接管正中，再向炉中缓慢推进热电偶，约每 5 分钟推进 10mm，防止刚玉管因骤热而爆裂，避免热电偶遭受热冲击。该热电偶只能在瞬间或短时间内处于测温范围最大值，否则会降低热电偶的使用寿命，甚至可能造成偶线断路。

For mounting thermocouples made of precious metal, put thermocouples on special brackets on barrow with trundles, alligning thermocouples right with centers of connecting pipes of equipments; then kick in thermocouples into stoves slowly, i.e., 10mm every 5 minutes, so as to prevent blowout of corundum tubes owing to sudden heat, and heat impact on thermocouples. Such thermocouples can only remain at max. measurement value for a short time, or otherwise reducing the service life of thermocouples or even resulting in open circuit of even wires.

7. 常见故障及处理办法 Common failures and solutions

热电偶测量系统常见故障及处理办法

故障原因	可 能 原 因	修 复 方 法
无热电势输出	测量线路短路（热电偶或补偿导线）	将短路处重修或更换
	热电偶回路断路	找到断线处，重新连接
	接线柱松动	拧紧
热电势输出偏低	热电极腐蚀或变质	更换热电偶
	绝缘破坏，造成漏电	修复或更换绝缘材料
	补偿导线极性与热电偶相反	重新改接
	补偿导线与热电偶型号不符	更换补偿导线
	补偿导线与热电极连接的两接点温度不同	延长补偿导线使两接点温度相同
	热电偶参考端温度过高	调整参考端温度或进行修正
	热电偶安装位置不当或插入深度不够	重新安装
热电势输出偏高	热电极回路电阻过大（动圈仪表）	调整电阻使符合规定
	热电极变质	更换热电偶
	补偿导线与热电偶型号不符	更换补偿导线
	热电偶安装方法、位置或插入深度不当	按规定要求重新安装
	绝缘破坏造成外电源进入热电偶回路	修复或更换绝缘材料
	热电偶参考端温度偏高（测负温时）	调整参考端温度或进行补正
	补偿导线与热电极连接处两接点温度不同	延长补偿导线使两接点温度相同
热电势输出不稳定	有干扰信号进入	检查干扰源，进行排除
	连接部件接触不良	将连接件擦净，重新拧紧
	测量线路绝缘破坏，引起时断时续短路或接地	找出故障点，修复绝缘
	热电极要断未断	修复或更换热电偶
	外界干扰	检查干扰源，进行屏蔽或接地
	热电偶安装不牢或外部振动	紧固热电偶，采取减振措施

Common failures and solutions of thermocouple measurement system

Failure phenomena	Possible reasons	Solutions
No thermoelectric force output	Short circuit of measuring circuit (thermocouple or compensating conductor)	Repair or replace circuit of short circuit
	Broken circuit of thermocouple	Find out broken wires and rewire thermocouple
	Loosening of wiring terminals	Tighten
Lower thermoelectric force output	Corrosion or deterioration of thermoelectric poles	Replace thermocouple
	Leaking of electricity resulting from damaged insulation	Repair or replace insulation materials
	Polarity of compensating conductor contrary to thermocouple	Make reconnection
	Compensating conductor in unconformity with thermocouple in model	Replace compensating conductor
	Different temperature of two contacts connecting compensating conductors and thermoelectric poles	Prolong compensating conductors to keep two contacts at the same temperature
	Overhigh temperature of thermocouple reference junction	Readjust reference junction temperature or make modification
	Unproper mounting location of thermocouple or insufficient inserting depth	Remount thermocouple
	Bigger loop resistance of thermocouple (movable coil meter)	Regulate resistance for conformity with the related specification
Higher thermoelectric force output	Deterioration of thermoelectric poles	Replace thermocouple
	Compensating conductor in unconformity with thermocouple in model	Replace compensating conductor
	Unproper mounting method and location, or inserting depth of thermocouple	Remount thermocouple in accordance with the relevant requirement
	Entry of exterior power source and resulting return circuit of thermocouple arising from damaged insulation	Repair or replace insulation materials
	Overhigh temperature of thermocouple reference junction (in measuring negative pressure)	Readjust reference junction temperature or make modification
	Different temperature of two contacts connecting compensating conductors and thermoelectric poles	Prolong compensating conductors to keep two contacts at the same temperature
	Entry of interference signals	Check and remove interference source
Unstable thermoelectric force output	Bad contact of connecting parts	Clean connecting parts and tighten them again
	Damage to measuring circuit insulation resulting in interrupted short circuit or earthing	Find out failure points and repair insulation
	Thermoelectric poles prone to break	Repair or replace thermocouple
	Outside interference	Check interference source and make shielding or earthing
	Unsteady mounting of thermocouple or outside vibration	Fasten thermocouple and adopt vibration reduction measures

热电阻测温系统常见故障及处理方法

Common failures and solutions of thermal resistance measurement system

故障现象	可能原因	处理方法
显示仪表指示值比实际值低或示值不稳	保护管内有金属屑、灰尘、接线柱间脏污及热电阻短路（水滴等）	除去金属屑，清扫灰尘、水滴等，找到短路点，加强绝缘等
显示仪表指示无穷大	热电阻或引出线断路及接线端子松开等	更换电阻体，或焊接及拧紧接线螺丝等
阻值与温度关系有变化	热电阻丝材料受腐蚀变质	更换电阻体
显示仪表指示负值	显示仪表与热电阻接线有错，或热电阻有短路现象	改正接线，或找出短路处，加强绝缘

Failure phenomena	Possible reasons	Solutions
Display meter indicating value lower than actual one, or indicating unsteadily	Metal scraps, dust inside protecting tubes, smudge among connections, and short circuit (dripping) of thermal resistance	Remove metal scraps, sweep dust and drippings, and find out short circuit points and intensify insulation and so on.
Display meter indicating infinite	Short circuit of thermal resistance or lead-in , and loosening of connection ends	Replace resistance body, or weld and tighten connection screws
Connection of resistance value and temperature having changes	Resistance wire material corroded or deteriorated	Replace resistance body
Display meter indicating negative value	Wrong connection of display meter and thermal resistance , or short circuit of thermal resistance	Adjust connection, or find out short circuit, and intensify insulation

8. 运输与贮存 Transportation and storage

8.1 运输

8.1 Transportation

热电阻、热电偶在运输中应仔细地包装好，避免碰撞、撞击等现象。

Thermocouples and thermal resistances shall be packed carefully for transportation so as to avoid collision and striking, etc..

8.2 热电阻、热电偶应贮存在周围环境温度 15~35℃，相对湿度不大于 80%，且空气中不含有使零部件腐蚀的介质中。

8.2 Thermocouples and thermal resistances shall be kept in the ambient environment of 15-35 °C with relative humidity of no more than 80%, and without any media easy to corrode parts floating in the air.



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