实验六　工业热电偶的校验

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一．实验目的

1．了解热电偶的工作原理、构造及使用方法。了解热电势与热端温度的关系。了解对热电偶进行校正的原因及校正方法，能独立地进行校正实验和绘制校正曲线。

2．了解冷端温度对测量的影响及补偿导线的使用方法。

3．通过测量热电势掌握携带式直流电位差计的使用方法。

二．实验设备

1．铂铑－铂热电偶（标准热电偶）……………………………………….１支

２．镍铬－镍硅热电偶（被校正热电偶）…………………………………１支

3．热电偶卧式检定炉（附温度控制器）………………………………….１台

4．携带式直流电位差计 ……………………..1台

5．酒精温度计 ……………………. 1支

6．广口保温瓶 ………………….. 1个

7．热浴杯及酒精灯 ………………………. 各1个

三．实验内容与步骤

１．了解直流电位差计各旋钮、开关及检流计的作用，掌握直流电位差计的使用方法。

２．热电偶校正

（１）实验开始，给检定炉供电，炉温给定值为400ºC。当炉温稳定后，用电位差计分别测量标准热电偶和被校正热电偶的热电势，每个校正点的测量不得少于四次。数据记录于表6－１。

（２）依次校正600ºC、 800ºC、 1000ºC各点。

（３）将测量电势求取平均值并转换成温度，计算误差，根据表6－３判断被热电偶是否合格。绘制校验曲线。

表6－１热电偶校正 …….. （温度：ºC，电势mV）

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 标准热电偶(S) | | | | | 被校热电偶(K) | | | | | |
| 测量电势　　mV | | | | 温度 | 测量电势　　mV | | | | 温度 | 误差 |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |

２．热电偶冷端温度对测温的影响及补偿导线的使用方法。

（１）1000ºC校正点作完后，保持炉温不变。测量热浴杯中的水温，然后用电位差计分别测量镍铬－镍硅热电偶未加补偿导线和加补偿导线的热电势。数据记录于表6－２中。

（２）用酒精灯加热热浴杯，当水温依次为30ºC、 40ºC、 50ºC时，用电位差计分别测量镍铬－镍硅热电偶未加补偿导线和加补偿导线的热电势。数据记录于表6－２中。

（３）用铂铑－铂热电偶测量炉温，检查实验过程中炉温是否稳定，分析若炉温变化对实验的影响。

（４）将测量电势转换为温度，绘制热电偶冷端温度对测量影响曲线。

表6－２　　热电偶冷端温度对测量影响

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 水浴温度ºC | 加补偿导线 | | 未加补偿导线 | | 误差  ºC |
| 测量电势 mV | 温度 ºC | 测量电势 mV | 温度 ºC |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
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四．思考题

1 控制系统的炉温误差对热电偶的校验影响严重吗？为什么?

2 热电偶的补偿导线有无极性？交换顺序后对读数有无影响？

3 热电偶的两根补偿导线所处的温度不同，对读数有何影响？例如用手指捏住其中一根导线的中部；同时捏住两根导线的中部；捏住单根补偿导线与热偶丝的接点处；补偿导线与电位差计连接的接线柱处。各有何现象？分析原因。这里是以手指作为热干扰源，应注意绝缘以避免成为噪声干扰源。

五、实验报告内容及要求

见附录。

附一：热电偶校正实验装置介绍

热电偶在长期使用过程中，热电极和热接点容易受到氧化、污染和腐蚀。高温下热电极材料容易发生再结晶而劣化，因此热电偶的热电特性会逐渐发生变化。使用中会增加测量误差。为了保证热电偶的测量精度，必须进行定期校验。对于各种不同热电偶校正点温度及校正允许偏差都有规定，如表6－３所示。

表6－３　　工业热电偶允许误差范围

|  |  |  |  |
| --- | --- | --- | --- |
| 热电偶名称 | 分度号 | 使用温度范围 | 允许误差 |
| 铂铑－铂 | S | 0—600ºC | ±1.5ºC |
| 600—1600ºC | ±0.25%t |
| 镍铬－镍硅 | K | 0－400ºC | ±3ºC |
| 400－1300ºC | ±0.75%t |

工业和实验室用热电偶都把管状电炉作为校正的基本装置。把标准热电偶和被校正热电偶的工作端放入管状电炉的中心处，使它们处于同一温度环境中。然后比较两者的电势值，以确定被校正热电偶的误差等指标。这种方法称为比较法。实验装置如图２－１所示。主要有管状电炉、温度控制系统、直流电位差计、标准热电偶和冰点槽等。

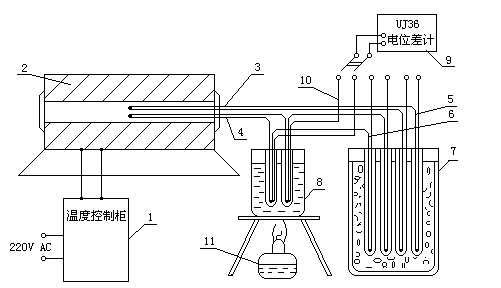


图6－１热电偶校正实验装置

１－温度调节器；２－热电偶检定炉；３－标准热电偶（Ｓ）；４－被检热电偶（Ｋ）；５－补偿导线；６－补偿导线；７－冰点槽；８－热浴杯；９－电位差计；10－铜导线；11－酒精灯

温度控制系统由SR90系列PID温度调节器、测温热电偶等组成。它为校正热电偶提供一个比较稳定的温度。温度调节器的使用说明如下。

附二：热电偶分度表

铂铑10－铂热电偶分度表

分度号：S …...（参考端温度为０℃）

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 温度 | | 0 | | | | 1 | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | 7 | | | | 8 | | | | 9 | | | |
| ℃ | | 热　 　电　 　动　　势　　mV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| -50 | | -0.236 | | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| -40 | | -0.194 | | | | -0.199 | | | -0.203 | | | | -0.207 | | | | -0.211 | | | | -0.215 | | | | -0.220 | | | | -0.224 | | | | -0.228 | | | | -0.232 | | | |
| -30 | | -0.150 | | | | -0.155 | | | -0.159 | | | | -0.164 | | | | -0.168 | | | | -0.173 | | | | -0.177 | | | | -0.181 | | | | -0.186 | | | | -0.190 | | | |
| -20 | | -0.103 | | | | -0.108 | | | -0.112 | | | | -0.117 | | | | -0.122 | | | | -0.127 | | | | -0.132 | | | | -0.136 | | | | -0.141 | | | | -0.145 | | | |
| -10 | | -0.053 | | | | -0.058 | | | -0.063 | | | | -0.068 | | | | -0.073 | | | | -0.078 | | | | -0.083 | | | | -0.088 | | | | -0.093 | | | | -0.098 | | | |
| 0 | | -0.000 | | | | -0.005 | | | -0.011 | | | | -0.016 | | | | -0.021 | | | | -0.027 | | | | -0.032 | | | | -0.037 | | | | -0.042 | | | | -0.048 | | | |
|  | |  | | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 0 | | 0.000 | | | | 0.005 | | | 0.011 | | | | 0.016 | | | | 0.022 | | | | 0.027 | | | | 0.033 | | | | 0.038 | | | | 0.044 | | | | 0.050 | | | |
| 10 | | 0.055 | | | | 0.061 | | | 0.067 | | | | 0.072 | | | | 0.078 | | | | 0.084 | | | | 0.090 | | | | 0.095 | | | | 0.101 | | | | 0.107 | | | |
| 20 | | 0.113 | | | | 0.119 | | | 0.125 | | | | 0.131 | | | | 0.137 | | | | 0.142 | | | | 0.148 | | | | 0.154 | | | | 0.161 | | | | 0.167 | | | |
| 30 | | 0.173 | | | | 0.179 | | | 0.185 | | | | 0.191 | | | | 0.197 | | | | 0.203 | | | | 0.210 | | | | 0.216 | | | | 0.222 | | | | 0.228 | | | |
| 40 | | 0.235 | | | | 0.241 | | | 0.247 | | | | 0.254 | | | | 0.260 | | | | 0.266 | | | | 0.273 | | | | 0.279 | | | | 0.286 | | | | 0.292 | | | |
|  | |  | | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 50 | | 0.299 | | | | 0.305 | | | 0.312 | | | | 0.318 | | | | 0.325 | | | | 0.331 | | | | 0.338 | | | | 0.345 | | | | 0.351 | | | | 0.358 | | | |
| 60 | | 0.365 | | | | 0.371 | | | 0.378 | | | | 0.385 | | | | 0.391 | | | | 0.398 | | | | 0.405 | | | | 0.412 | | | | 0.419 | | | | 0.425 | | | |
| 70 | | 0.432 | | | | 0.439 | | | 0.446 | | | | 0.453 | | | | 0.460 | | | | 0.467 | | | | 0.474 | | | | 0.481 | | | | 0.488 | | | | 0.495 | | | |
| 80 | | 0.502 | | | | 0.509 | | | 0.516 | | | | 0.523 | | | | 0.530 | | | | 0.537 | | | | 0.544 | | | | 0.551 | | | | 0.558 | | | | 0.566 | | | |
| 90 | | 0.573 | | | | 0.580 | | | 0.587 | | | | 0.594 | | | | 0.602 | | | | 0.609 | | | | 0.616 | | | | 0.623 | | | | 0.631 | | | | 0.638 | | | |
|  | |  | | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 100 | | 0.645 | | | | 0.653 | | | 0.660 | | | | 0.667 | | | | 0.675 | | | | 0.682 | | | | 0.690 | | | | 0.697 | | | | 0.704 | | | | 0.712 | | | |
| 110 | | 0.719 | | | | 0.727 | | | 0.734 | | | | 0.742 | | | | 0.749 | | | | 0.757 | | | | 0.764 | | | | 0.772 | | | | 0.780 | | | | 0.787 | | | |
| 120 | | 0.795 | | | | 0.802 | | | 0.810 | | | | 0.818 | | | | 0.825 | | | | 0.833 | | | | 0.841 | | | | 0.848 | | | | 0.856 | | | | 0.864 | | | |
| 130 | | 0.872 | | | | 0.879 | | | 0.887 | | | | 0.895 | | | | 0.903 | | | | 0.910 | | | | 0.918 | | | | 0.926 | | | | 0.934 | | | | 09.42 | | | |
| 140 | | 0.950 | | | | 0.957 | | | 0.965 | | | | 0.973 | | | | 0.981 | | | | 0.989 | | | | 0.997 | | | | 1.005 | | | | 1.013 | | | | 1.021 | | | |
|  | |  | | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 150 | | 1.029 | | | | 1.037 | | | 1.045 | | | | 1.053 | | | | 1.061 | | | | 1.069 | | | | 1.077 | | | | 1.085 | | | | 1.093 | | | | 1.101 | | | |
| 160 | | 1.109 | | | | 1.117 | | | 1.125 | | | | 1.133 | | | | 1.141 | | | | 1.158 | | | | 1.168 | | | | 1.166 | | | | 1.174 | | | | 1.182 | | | |
| 170 | | 1.190 | | | | 1.198 | | | 1.207 | | | | 1.215 | | | | 1.223 | | | | 1.231 | | | | 1.240 | | | | 1.248 | | | | 1.256 | | | | 1.264 | | | |
| 180 | | 1.273 | | | | 1.281 | | | 1.289 | | | | 1.297 | | | | 1.306 | | | | 1.314 | | | | 1.322 | | | | 1.331 | | | | 1.339 | | | | 1.347 | | | |
| 190 | | 1.356 | | | | 1.364 | | | 1.373 | | | | 1.381 | | | | 1.389 | | | | 1.398 | | | | 1.406 | | | | 1.415 | | | | 1.423 | | | | 1.432 | | | |
|  | |  | | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 温度  ℃ | | | | | 0 | | | 1 | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | | 7 | | | | 8 | | | | 9 | | |
| 热　 　电　 　动　　势　　mV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 200 | | | | | 1.440 | | | 1.448 | | | 1.457 | | | | 1.465 | | | | 1.474 | | | | 1.482 | | | | 1.491 | | | | | 1.499 | | | | 1.508 | | | | 1.516 | | |
| 210 | | | | | 1.525 | | | 1.534 | | | 1.542 | | | | 1.551 | | | | 1.559 | | | | 1.568 | | | | 1.576 | | | | | 1.585 | | | | 1.594 | | | | 1.602 | | |
| 220 | | | | | 1.611 | | | 1.620 | | | 1.628 | | | | 1.637 | | | | 1.645 | | | | 1.654 | | | | 1.663 | | | | | 1.671 | | | | 1.680 | | | | 1.689 | | |
| 230 | | | | | 1.698 | | | 1.706 | | | 1.715 | | | | 1.724 | | | | 1.732 | | | | 1.741 | | | | 1.750 | | | | | 1.759 | | | | 1.767 | | | | 1.776 | | |
| 240 | | | | | 1.785 | | | 1.794 | | | 1.802 | | | | 1.811 | | | | 1.820 | | | | 1.829 | | | | 1.838 | | | | | 1.846 | | | | 1.855 | | | | 1.864 | | |
|  | | | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | | |  | | | |  | | | |  | | |
| 250 | | | | | 1.873 | | | 1.882 | | | 1.891 | | | | 1.899 | | | | 1.908 | | | | 1.917 | | | | 1.926 | | | | | 1.935 | | | | 1.944 | | | | 1.953 | | |
| 260 | | | | | 1.962 | | | 1.971 | | | 1.979 | | | | 1.988 | | | | 1.997 | | | | 2.006 | | | | 2.015 | | | | | 2.024 | | | | 2.033 | | | | 2.042 | | |
| 270 | | | | | 2.051 | | | 2.060 | | | 2.069 | | | | 2.078 | | | | 2.087 | | | | 2.096 | | | | 2.105 | | | | | 2.114 | | | | 2.123 | | | | 2.132 | | |
| 280 | | | | | 2.141 | | | 2.150 | | | 2.159 | | | | 2.168 | | | | 2.177 | | | | 2.186 | | | | 2.195 | | | | | 2.204 | | | | 2.213 | | | | 2.222 | | |
| 290 | | | | | 2.232 | | | 2.241 | | | 2.250 | | | | 2.259 | | | | 2.268 | | | | 2.277 | | | | 2.286 | | | | | 2.295 | | | | 2.304 | | | | 2.314 | | |
|  | | | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | | |  | | | |  | | | |  | | |
| 300 | | | | | 2.323 | | | 2.332 | | | 2.341 | | | | 2.350 | | | | 2.359 | | | | 2.368 | | | | 2.378 | | | | | 2.387 | | | | 2.396 | | | | 2.405 | | |
| 310 | | | | | 2.414 | | | 2.424 | | | 2.433 | | | | 2.442 | | | | 2.451 | | | | 2.460 | | | | 2.470 | | | | | 2.479 | | | | 2.488 | | | | 2.497 | | |
| 320 | | | | | 2.506 | | | 2.516 | | | 2.525 | | | | 2.534 | | | | 2.543 | | | | 2.553 | | | | 2.562 | | | | | 2.571 | | | | 2.581 | | | | 2.590 | | |
| 330 | | | | | 2.599 | | | 2.608 | | | 2.618 | | | | 2.627 | | | | 2.636 | | | | 2.646 | | | | 2.655 | | | | | 2.664 | | | | 2.674 | | | | 2.683 | | |
| 340 | | | | | 2.692 | | | 2.702 | | | 2.711 | | | | 2.720 | | | | 2.730 | | | | 2.739 | | | | 2.748 | | | | | 2.758 | | | | 2.767 | | | | 2.776 | | |
|  | | | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | | |  | | | |  | | | |  | | |
| 350 | | | | | 2.786 | | | 2.795 | | | 2.805 | | | | 2.814 | | | | 2.823 | | | | 2.833 | | | | 2.842 | | | | | 2.852 | | | | 2.861 | | | | 2.870 | | |
| 360 | | | | | 2.880 | | | 2.889 | | | 2.899 | | | | 2.908 | | | | 2.917 | | | | 2.927 | | | | 2.936 | | | | | 2.946 | | | | 2.955 | | | | 2.965 | | |
| 370 | | | | | 2.974 | | | 2.984 | | | 2.993 | | | | 3.003 | | | | 3.012 | | | | 3.022 | | | | 3.031 | | | | | 3.041 | | | | 3.050 | | | | 3.059 | | |
| 380 | | | | | 3.069 | | | 3.078 | | | 3.088 | | | | 3.097 | | | | 3.107 | | | | 3.117 | | | | 3.126 | | | | | 3.136 | | | | 3.145 | | | | 3.155 | | |
| 390 | | | | | 3.164 | | | 3.174 | | | 3.183 | | | | 3.193 | | | | 3.202 | | | | 3.212 | | | | 3.221 | | | | | 3.231 | | | | 3.241 | | | | 3.250 | | |
|  | | | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | | |  | | | |  | | | |  | | |
| 400 | | | | | 3.260 | | | 3.269 | | | 3.279 | | | | 3.288 | | | | 3.298 | | | | 3.308 | | | | 3.317 | | | | | 3.327 | | | | 3.336 | | | | 3.346 | | |
| 410 | | | | | 3.356 | | | 3.365 | | | 3.375 | | | | 3.384 | | | | 3.394 | | | | 3.404 | | | | 3.413 | | | | | 3.423 | | | | 3.433 | | | | 3.442 | | |
| 420 | | | | | 3.452 | | | 3.462 | | | 3.471 | | | | 3.481 | | | | 3.491 | | | | 3.500 | | | | 3.510 | | | | | 3.520 | | | | 3.529 | | | | 3.539 | | |
| 430 | | | | | 3.549 | | | 3.558 | | | 3.568 | | | | 3.578 | | | | 3.587 | | | | 3.597 | | | | 3.607 | | | | | 3.616 | | | | 3.626 | | | | 3.636 | | |
| 440 | | | | | 3.645 | | | 3.655 | | | 3.665 | | | | 3.675 | | | | 3.684 | | | | 3.694 | | | | 3.704 | | | | | 3.714 | | | | 3.723 | | | | 3.733 | | |
|  | | | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | | |  | | | |  | | | |  | | |
| 450 | | | | | 3.743 | | | 3.752 | | | 3.762 | | | | 3.772 | | | | 3.782 | | | | 3.791 | | | | 3.801 | | | | | 3.811 | | | | 3.821 | | | | 3.831 | | |
| 460 | | | | | 3.840 | | | 3.850 | | | 3.860 | | | | 3.870 | | | | 3.879 | | | | 3.889 | | | | 3.899 | | | | | 3.909 | | | | 3.919 | | | | 3.928 | | |
| 470 | | | | | 3.938 | | | 3.948 | | | 3.958 | | | | 3.968 | | | | 3.977 | | | | 3.987 | | | | 3.997 | | | | | 4.007 | | | | 4.017 | | | | 4.027 | | |
| 480 | | | | | 4.036 | | | 4.046 | | | 4.056 | | | | 4.066 | | | | 4.076 | | | | 4.086 | | | | 4.095 | | | | | 4.105 | | | | 4.115 | | | | 4.125 | | |
| 490 | | | | | 4.135 | | | 4.145 | | | 4.155 | | | | 4.164 | | | | 4.174 | | | | 4.184 | | | | 4.194 | | | | | 4.204 | | | | 4.214 | | | | 4.224 | | |
| 温度 | | | 0 | | | 1 | | | 2 | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | 7 | | | 8 | | | | 9 | | | |
| ℃ | | | 热　 　电　 　动　　势　　mV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 500 | | | 4.234 | | | 4.243 | | | 4.253 | | | 4.263 | | | | 4.273 | | | | 4.283 | | | | 4.293 | | | | 4.303 | | | 4.313 | | | | 4.323 | | | |
| 510 | | | 4.333 | | | 4.343 | | | 4.352 | | | 4.362 | | | | 4.372 | | | | 4.382 | | | | 4.392 | | | | 4.402 | | | 4.412 | | | | 4.422 | | | |
| 520 | | | 4.432 | | | 4.442 | | | 4.452 | | | 4.462 | | | | 4.472 | | | | 4.482 | | | | 4.492 | | | | 4.502 | | | 4.512 | | | | 4.522 | | | |
| 530 | | | 4.532 | | | 4.542 | | | 4.552 | | | 4.562 | | | | 4.572 | | | | 4.582 | | | | 4.592 | | | | 4.602 | | | 4.612 | | | | 4.622 | | | |
| 540 | | | 4.632 | | | 40642 | | | 4.652 | | | 4.662 | | | | 4.672 | | | | 4.682 | | | | 4.692 | | | | 4.702 | | | 4.712 | | | | 4.722 | | | |
|  | | |  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | |  | | | |  | | | |
| 550 | | | 4.732 | | | 4.742 | | | 4.752 | | | 4.762 | | | | 4.772 | | | | 4.782 | | | | 4.792 | | | | 4.802 | | | 4.812 | | | | 4.822 | | | |
| 560 | | | 4.832 | | | 4.842 | | | 4.852 | | | 4.862 | | | | 4.873 | | | | 4.883 | | | | 4.893 | | | | 4.903 | | | 4.913 | | | | 4.923 | | | |
| 570 | | | 4.933 | | | 4.943 | | | 4.953 | | | 4.963 | | | | 4.973 | | | | 4.984 | | | | 4.994 | | | | 5.004 | | | 5.014 | | | | 5.024 | | | |
| 580 | | | 5.034 | | | 5.044 | | | 5.054 | | | 5.065 | | | | 5.075 | | | | 5.085 | | | | 5.095 | | | | 5.105 | | | 5.115 | | | | 5.125 | | | |
| 590 | | | 5.136 | | | 5.146 | | | 5.156 | | | 5.166 | | | | 5.176 | | | | 5.186 | | | | 5.197 | | | | 5.207 | | | 5.217 | | | | 5.227 | | | |
|  | | |  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | |  | | | |  | | | |
| 600 | | | 5.237 | | | 5.247 | | | 5.258 | | | 5.268 | | | | 5.278 | | | | 5.288 | | | | 5.298 | | | | 5.309 | | | 5.319 | | | | 5.329 | | | |
| 610 | | | 5.339 | | | 5.350 | | | 5.360 | | | 5.370 | | | | 5.380 | | | | 5.391 | | | | 5.401 | | | | 5.411 | | | 5.421 | | | | 5.431 | | | |
| 620 | | | 5.442 | | | 5.452 | | | 5.462 | | | 5.473 | | | | 5.483 | | | | 5.493 | | | | 5.503 | | | | 5.514 | | | 5.524 | | | | 5.534 | | | |
| 630 | | | 5.544 | | | 5.555 | | | 5.565 | | | 5.575 | | | | 5.586 | | | | 5.596 | | | | 5.606 | | | | 5.617 | | | 5.627 | | | | 5.637 | | | |
| 640 | | | 5.648 | | | 5.658 | | | 5.668 | | | 5.679 | | | | 5.689 | | | | 5.700 | | | | 5.710 | | | | 5.720 | | | 5.731 | | | | 5.741 | | | |
|  | | |  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | |  | | | |  | | | |
| 650 | | | 5.751 | | | 5.762 | | | 5.772 | | | 5.782 | | | | 5.793 | | | | 5.803 | | | | 5.814 | | | | 5.824 | | | 5.834 | | | | 5.845 | | | |
| 660 | | | 5.855 | | | 5.866 | | | 5.876 | | | 5.887 | | | | 5.897 | | | | 5.907 | | | | 5.918 | | | | 5.928 | | | 5.939 | | | | 5.949 | | | |
| 670 | | | 5.960 | | | 5.970 | | | 5.980 | | | 5.991 | | | | 6.001 | | | | 6.012 | | | | 6.022 | | | | 6.033 | | | 6.043 | | | | 6.054 | | | |
| 680 | | | 6.064 | | | 6.075 | | | 6.085 | | | 6.096 | | | | 6.106 | | | | 6.1117 | | | | 6.127 | | | | 6.138 | | | 6.148 | | | | 6.159 | | | |
| 690 | | | 6.169 | | | 6.180 | | | 6.190 | | | 6.201 | | | | 6.211 | | | | 6.222 | | | | 6.232 | | | | 6.243 | | | 6.253 | | | | 6.264 | | | |
|  | | |  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | |  | | | |  | | | |
| 700 | | | 6.274 | | | 6.285 | | | 6.295 | | | 6.306 | | | | 6.316 | | | | 6.327 | | | | 6.338 | | | | 6.348 | | | 6.359 | | | | 6.369 | | | |
| 710 | | | 6.380 | | | 6.390 | | | 6.401 | | | 6.412 | | | | 6.422 | | | | 6.433 | | | | 6.443 | | | | 6.454 | | | 6.465 | | | | 6.475 | | | |
| 720 | | | 6.486 | | | 6.496 | | | 6.507 | | | 6.518 | | | | 6.528 | | | | 6.539 | | | | 6.549 | | | | 6.560 | | | 6.571 | | | | 6.581 | | | |
| 730 | | | 6.592 | | | 6.603 | | | 6.613 | | | 6.624 | | | | 6.635 | | | | 6.645 | | | | 6.656 | | | | 6.667 | | | 6.677 | | | | 6.688 | | | |
| 740 | | | 6.699 | | | 6.709 | | | 6.720 | | | 6.731 | | | | 6.741 | | | | 6.752 | | | | 6.763 | | | | 6.773 | | | 6.784 | | | | 6.795 | | | |
|  | | |  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | |  | | | |  | | | |
| 750 | | | 6.805 | | | 6.816 | | | 6.827 | | | 6.838 | | | | 6.848 | | | | 6.859 | | | | 6.870 | | | | 6.880 | | | 6.891 | | | | 6.902 | | | |
| 760 | | | 6.913 | | | 6.923 | | | 6.934 | | | 6.945 | | | | 6.956 | | | | 6.966 | | | | 6.977 | | | | 6.988 | | | 6.999 | | | | 7.009 | | | |
| 770 | | | 7.020 | | | 7.031 | | | 7.042 | | | 7.053 | | | | 7.063 | | | | 7.074 | | | | 7.085 | | | | 7.096 | | | 7.107 | | | | 7.117 | | | |
| 780 | | | 7.128 | | | 7.139 | | | 7.150 | | | 7.161 | | | | 7.171 | | | | 7.182 | | | | 7.193 | | | | 7.204 | | | 7.215 | | | | 7.215 | | | |
| 790 | | | 7.236 | | | 7.247 | | | 7.258 | | | 7.269 | | | | 7.280 | | | | 7.291 | | | | 7.301 | | | | 7.312 | | | 7.323 | | | | 7.334 | | | |
| 温度 | | | 0 | | | 1 | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | 7 | | | | 8 | | | | 9 | | | |
| ℃ | | | 热　 　电　 　动　　势　　mV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 800 | | | 7.345 | | | 7.356 | | | 7.367 | | | | 7.377 | | | | 7.388 | | | | 7.399 | | | | 7.410 | | | | 7.421 | | | | 7.432 | | | | 7.443 | | | |
| 810 | | | 7.454 | | | 7.465 | | | 7.476 | | | | 7.486 | | | | 7.497 | | | | 7.508 | | | | 7.519 | | | | 7.530 | | | | 7.541 | | | | 7.552 | | | |
| 820 | | | 7.563 | | | 7.574 | | | 4.585 | | | | 7.596 | | | | 7.607 | | | | 7.618 | | | | 7.629 | | | | 7.640 | | | | 7.651 | | | | 7.661 | | | |
| 830 | | | 7.672 | | | 7.683 | | | 7.694 | | | | 7.705 | | | | 7.716 | | | | 7.727 | | | | 7.738 | | | | 7.749 | | | | 7.760 | | | | 7.771 | | | |
| 840 | | | 7.782 | | | 7.793 | | | 7.804 | | | | 7.815 | | | | 7.826 | | | | 7.837 | | | | 7.848 | | | | 7.859 | | | | 7.870 | | | | 7.881 | | | |
|  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 850 | | | 7.892 | | | 7.904 | | | 7.915 | | | | 7.926 | | | | 7.937 | | | | 7.948 | | | | 7.959 | | | | 7.970 | | | | 7.981 | | | | 7.992 | | | |
| 860 | | | 8.003 | | | 8.014 | | | 8.025 | | | | 8.036 | | | | 8.047 | | | | 8.058 | | | | 8.069 | | | | 8.081 | | | | 8.092 | | | | 8.103 | | | |
| 870 | | | 80114 | | | 8.125 | | | 8.136 | | | | 8.147 | | | | 8.158 | | | | 8.169 | | | | 8.180 | | | | 8.192 | | | | 8.203 | | | | 8.214 | | | |
| 880 | | | 8.255 | | | 8.236 | | | 8.247 | | | | 8.258 | | | | 8.270 | | | | 8.281 | | | | 8.292 | | | | 8.303 | | | | 8.314 | | | | 8.325 | | | |
| 890 | | | 8.336 | | | 8.348 | | | 8.359 | | | | 8.370 | | | | 8.381 | | | | 8.392 | | | | 8.404 | | | | 8.415 | | | | 8.426 | | | | 8.437 | | | |
|  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 900 | | | 8.448 | | | 8.460 | | | 8.471 | | | | 8.482 | | | | 8.493 | | | | 8.504 | | | | 8.516 | | | | 8.527 | | | | 8.538 | | | | 8.549 | | | |
| 910 | | | 8.560 | | | 8.572 | | | 8.583 | | | | 8.594 | | | | 8.605 | | | | 8.617 | | | | 8.628 | | | | 8.639 | | | | 8.650 | | | | 8.662 | | | |
| 920 | | | 8.673 | | | 8.684 | | | 8.695 | | | | 8.707 | | | | 8.718 | | | | 8.729 | | | | 8.741 | | | | 8.752 | | | | 8.763 | | | | 8.774 | | | |
| 930 | | | 8.786 | | | 8.797 | | | 8.808 | | | | 8.820 | | | | 8.831 | | | | 8.842 | | | | 8.854 | | | | 8.865 | | | | 8.876 | | | | 8.888 | | | |
| 940 | | | 8.899 | | | 8.910 | | | 8.922 | | | | 8.933 | | | | 8.944 | | | | 8.956 | | | | 8.967 | | | | 80978 | | | | 8.990 | | | | 9.001 | | | |
|  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 950 | | | 9.012 | | | 9.024 | | | 9.035 | | | | 9.047 | | | | 9.058 | | | | 9.069 | | | | 9.081 | | | | 9.092 | | | | 9.103 | | | | 9.115 | | | |
| 960 | | | 9.1260 | | | 9.038 | | | 9.149 | | | | 9.160 | | | | 9.172 | | | | 9.183 | | | | 9.195 | | | | 9.206 | | | | 9.217 | | | | 9.229 | | | |
| 970 | | | 9.240 | | | 9.252 | | | 9.263 | | | | 9.275 | | | | 9.282 | | | | 9.298 | | | | 9.309 | | | | 9.320 | | | | 9.332 | | | | 9.343 | | | |
| 980 | | | 9.355 | | | 9.366 | | | 9.378 | | | | 9.389 | | | | 9.401 | | | | 9.412 | | | | 9.424 | | | | 9.435 | | | | 9.447 | | | | 9.458 | | | |
| 990 | | | 9.470 | | | 9.481 | | | 9.493 | | | | 9.504 | | | | 9.516 | | | | 9.527 | | | | 9.539 | | | | 9.550 | | | | 9.562 | | | | 9.573 | | | |
|  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 1000 | | | 9.585 | | | 9.596 | | | 9.608 | | | | 9.619 | | | | 9.631 | | | | 9.642 | | | | 9.654 | | | | 9.665 | | | | 9.677 | | | | 9.689 | | | |
| 1010 | | | 9.700 | | | 9.712 | | | 9.723 | | | | 9.735 | | | | 9.746 | | | | 9.758 | | | | 9.770 | | | | 9.781 | | | | 9.793 | | | | 9.804 | | | |
| 1020 | | | 9.816 | | | 9.828 | | | 9.839 | | | | 9.851 | | | | 9.862 | | | | 9.874 | | | | 9.886 | | | | 9.897 | | | | 9.909 | | | | 9.920 | | | |
| 1030 | | | 9.932 | | | 9.944 | | | 9.955 | | | | 9.967 | | | | 9.979 | | | | 9.990 | | | | 10.002 | | | | 10.013 | | | | 10.025 | | | | 10.037 | | | |
| 1040 | | | 10.048 | | | 10.060 | | | 10.072 | | | | 10.083 | | | | 10.095 | | | | 10.107 | | | | 10.118 | | | | 10.130 | | | | 10.142 | | | | 10.154 | | | |
|  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 1050 | | | 10.165 | | | 10.177 | | | 10.189 | | | | 10.200 | | | | 10.212 | | | | 10.224 | | | | 10.235 | | | | 10.247 | | | | 10.259 | | | | 10.271 | | | |
| 1060 | | | 10.282 | | | 10.294 | | | 10.306 | | | | 10.318 | | | | 10.329 | | | | 10.341 | | | | 10.353 | | | | 10.364 | | | | 10.376 | | | | 10.388 | | | |
| 1070 | | | 10.400 | | | 10.411 | | | 10.423 | | | | 10.435 | | | | 10.447 | | | | 10.459 | | | | 10.470 | | | | 10.482 | | | | 10.494 | | | | 10.506 | | | |
| 1080 | | | 10.517 | | | 10.529 | | | 10.541 | | | | 10.553 | | | | 10.565 | | | | 10.576 | | | | 10.588 | | | | 10.600 | | | | 10.612 | | | | 10.624 | | | |
| 1090 | | | 10.635 | | | 10.647 | | | 10.659 | | | | 10.671 | | | | 10.683 | | | | 10.694 | | | | 10.706 | | | | 10.718 | | | | 10.730 | | | | 10.742 | | | |
| 温度 | | | 0 | | | 1 | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | 7 | | | | 8 | | | | 9 | | | |
| ℃ | | | 热　 　电　 　动　　势　　mV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1100 | | | 10.754 | | | 10.765 | | | 10.777 | | | | 10.789 | | | | 10.801 | | | | 10.813 | | | | 10.825 | | | | 10.836 | | | | 10.848 | | | | 10.860 | | | |
| 1110 | | | 10.872 | | | 10.884 | | | 10.896 | | | | 10.908 | | | | 10.919 | | | | 10.931 | | | | 10.943 | | | | 10.955 | | | | 10.967 | | | | 10.979 | | | |
| 1120 | | | 10.991 | | | 11.003 | | | 11.014 | | | | 11.026 | | | | 11.038 | | | | 11.050 | | | | 11.062 | | | | 11.074 | | | | 11.086 | | | | 11.098 | | | |
| 1130 | | | 11.110 | | | 11.121 | | | 11.133 | | | | 11.145 | | | | 11.157 | | | | 11.169 | | | | 11.181 | | | | 11.193 | | | | 11.205 | | | | 11217 | | | |
| 1140 | | | 11.229 | | | 11.241 | | | 11.252 | | | | 11.264 | | | | 11.276 | | | | 11.288 | | | | 11.300 | | | | 11.312 | | | | 11.324 | | | | 11.336 | | | |
|  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 1150 | | | 11.348 | | | 11.360 | | | 11.372 | | | | 11.384 | | | | 11.396 | | | | 11.408 | | | | 11.420 | | | | 11.432 | | | | 11.443 | | | | 11.455 | | | |
| 1160 | | | 11.467 | | | 11.479 | | | 11.491 | | | | 11.503 | | | | 11.515 | | | | 11.527 | | | | 11.539 | | | | 11.551 | | | | 11.563 | | | | 11.575 | | | |
| 1170 | | | 11.587 | | | 11.599 | | | 11.611 | | | | 11.623 | | | | 11.635 | | | | 11.647 | | | | 11.659 | | | | 11.671 | | | | 11.683 | | | | 11.695 | | | |
| 1180 | | | 11.707 | | | 11.719 | | | 11.731 | | | | 11.743 | | | | 11.755 | | | | 11.767 | | | | 11.779 | | | | 11.791 | | | | 11.803 | | | | 11.815 | | | |
| 1190 | | | 11.827 | | | 11.839 | | | 11.851 | | | | 11.863 | | | | 11.875 | | | | 11.887 | | | | 11.899 | | | | 11.911 | | | | 11.923 | | | | 11.935 | | | |
|  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 1200 | | | 11.947 | | | 11.956 | | | 11.971 | | | | 11.983 | | | | 11.995 | | | | 12.007 | | | | 12.019 | | | | 12.031 | | | | 12.043 | | | | 12.055 | | | |
| 1210 | | | 12.067 | | | 12.079 | | | 12.091 | | | | 12.103 | | | | 12.116 | | | | 12.128 | | | | 12.140 | | | | 12.152 | | | | 12.164 | | | | 12.176 | | | |
| 1220 | | | 12.188 | | | 12.200 | | | 12.212 | | | | 12.224 | | | | 12.236 | | | | 12.248 | | | | 12.260 | | | | 12.272 | | | | 12.284 | | | | 12.296 | | | |
| 1230 | | | 12.308 | | | 12.320 | | | 12.332 | | | | 12.345 | | | | 12.357 | | | | 12.369 | | | | 12.381 | | | | 12.393 | | | | 12.405 | | | | 12.417 | | | |
| 1240 | | | 12.429 | | | 12.441 | | | 12.453 | | | | 12.465 | | | | 12.477 | | | | 12.489 | | | | 12.501 | | | | 12.514 | | | | 12.526 | | | | 12.538 | | | |
|  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 1250 | | | 12.550 | | | 12.562 | | | 12.574 | | | | 12.586 | | | | 12.598 | | | | 12.610 | | | | 12.622 | | | | 12.634 | | | | 12.647 | | | | 12.659 | | | |
| 1260 | | | 12.671 | | | 12.683 | | | 12.695 | | | | 12.707 | | | | 12.719 | | | | 12.731 | | | | 12.743 | | | | 12.755 | | | | 12.767 | | | | 12.780 | | | |
| 1270 | | | 12.792 | | | 12.804 | | | 12.816 | | | | 12.828 | | | | 12.840 | | | | 12.852 | | | | 12.864 | | | | 12.876 | | | | 12.888 | | | | 12.901 | | | |
| 1280 | | | 12.913 | | | 12.925 | | | 12.937 | | | | 12.949 | | | | 12.961 | | | | 12.973 | | | | 12.985 | | | | 12.997 | | | | 13.010 | | | | 13.022 | | | |
| 1290 | | | 13.034 | | | 13.046 | | | 13.058 | | | | 13.070 | | | | 13.082 | | | | 13.094 | | | | 13.107 | | | | 13.119 | | | | 13.131 | | | | 13.143 | | | |
|  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 1300 | | | 13.155 | | | 13.167 | | | 13.179 | | | | 13.191 | | | | 13.203 | | | | 13.216 | | | | 13.228 | | | | 13.240 | | | | 13.252 | | | | 13.264 | | | |
| 1310 | | | 13.276 | | | 13.288 | | | 13.300 | | | | 13.313 | | | | 13.325 | | | | 13.337 | | | | 13.349 | | | | 13.361 | | | | 13.373 | | | | 13.387 | | | |
| 1320 | | | 13.397 | | | 13.410 | | | 13.422 | | | | 13.434 | | | | 13.446 | | | | 13.458 | | | | 13.470 | | | | 13.482 | | | | 13.495 | | | | 13.507 | | | |
| 1330 | | | 13.519 | | | 13.531 | | | 13.543 | | | | 13.555 | | | | 13.567 | | | | 13.579 | | | | 13.592 | | | | 13.604 | | | | 13.616 | | | | 13.628 | | | |
| 1340 | | | 13.640 | | | 13.652 | | | 13.664 | | | | 13.677 | | | | 13.689 | | | | 13.701 | | | | 13.713 | | | | 13.725 | | | | 13.737 | | | | 13.749 | | | |
|  | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |  | | | |
| 1350 | | | 13.761 | | | 13.774 | | | 13.786 | | | | 13.798 | | | | 13.810 | | | | 13.822 | | | | 13.834 | | | | 13.846 | | | | 13.859 | | | | 13.871 | | | |
| 1360 | | | 13.883 | | | 13.895 | | | 13.907 | | | | 13.919 | | | | 13.931 | | | | 13.942 | | | | 13.956 | | | | 13.968 | | | | 13.980 | | | | 13.992 | | | |
| 1370 | | | 14.004 | | | 14.016 | | | 14.028 | | | | 14.040 | | | | 14.053 | | | | 14.065 | | | | 14.077 | | | | 14.089 | | | | 14.101 | | | | 14.113 | | | |
| 1380 | | | 14.125 | | | 14.138 | | | 14.150 | | | | 14.162 | | | | 14.174 | | | | 14.186 | | | | 14.198 | | | | 14.210 | | | | 14.222 | | | | 14.235 | | | |
| 1390 | | | 14.247 | | | 14.259 | | | 14.271 | | | | 14.283 | | | | 14.295 | | | | 14.307 | | | | 14.319 | | | | 14.332 | | | | 14.344 | | | | 14.356 | | | |
| 温度  ℃ | | | | 0 | | | 1 | | | 2 | | | | 3 | | | | 4 | | | | 5 | | | | 6 | | | | | 7 | | | | 8 | | | | 9 | | |
| 热　 　电　 　动　　势　　mV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1400 | | | | 14.368 | | | 14.380 | | | 14.392 | | | | 14.404 | | | | 14.416 | | | | 14.429 | | | | 14.441 | | | | | 14.453 | | | | 14.465 | | | | 14.477 | | |
| 1410 | | | | 14.489 | | | 14.501 | | | 14.513 | | | | 14.526 | | | | 14.538 | | | | 14.550 | | | | 14.562 | | | | | 14.574 | | | | 14.586 | | | | 14.598 | | |
| 1420 | | | | 14.610 | | | 14.622 | | | 14.635 | | | | 14.647 | | | | 14.659 | | | | 14.671 | | | | 14.683 | | | | | 14.695 | | | | 14.707 | | | | 14.719 | | |
| 1430 | | | | 14.731 | | | 14.744 | | | 14.756 | | | | 14.768 | | | | 14.780 | | | | 14.792 | | | | 14.804 | | | | | 14.816 | | | | 14.828 | | | | 14.840 | | |
| 1440 | | | | 14.852 | | | 14.865 | | | 14.877 | | | | 14.889 | | | | 14.901 | | | | 14.913 | | | | 14.925 | | | | | 14.937 | | | | 14.949 | | | | 14.961 | | |
|  | | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | | |  | | | |  | | | |  | | |
| 1450 | | | | 14.973 | | | 14.985 | | | 14.998 | | | | 15.010 | | | | 15.022 | | | | 15.034 | | | | 15.046 | | | | | 15.058 | | | | 15.070 | | | | 15.082 | | |
| 1460 | | | | 15.094 | | | 15.106 | | | 15.118 | | | | 15.130 | | | | 15.143 | | | | 15.155 | | | | 15.167 | | | | | 15.179 | | | | 15.191 | | | | 15.203 | | |
| 1470 | | | | 15.215 | | | 15.227 | | | 15.239 | | | | 15.251 | | | | 15.263 | | | | 15.275 | | | | 15.287 | | | | | 15.299 | | | | 15.311 | | | | 15.324 | | |
| 1480 | | | | 15.336 | | | 15.348 | | | 15.360 | | | | 15.372 | | | | 15.384 | | | | 15.396 | | | | 15.408 | | | | | 15.420 | | | | 15.432 | | | | 15.444 | | |
| 1490 | | | | 15.456 | | | 15.468 | | | 15.480 | | | | 15.492 | | | | 15.504 | | | | 15.516 | | | | 15.528 | | | | | 15.540 | | | | 15.552 | | | | 15.564 | | |
| 1500 | | | | 15.576 | | | 15.589 | | | 15.601 | | | | 15.613 | | | | 15.625 | | | | 15.637 | | | | 15.649 | | | | | 15.661 | | | | 15.673 | | | | 15.685 | | |
|  | | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | | |  | | | |  | | | |  | | |
| 1510 | | | | 15.697 | | | 15.709 | | | 15.721 | | | | 15.733 | | | | 15.745 | | | | 15.757 | | | | 15.769 | | | | | 15.781 | | | | 15.793 | | | | 15.805 | | |
| 1520 | | | | 15.817 | | | 15.829 | | | 15.841 | | | | 15.853 | | | | 15.865 | | | | 15.877 | | | | 15.889 | | | | | 15.901 | | | | 15.913 | | | | 15.925 | | |
| 1530 | | | | 15.937 | | | 15.949 | | | 15.961 | | | | 15.973 | | | | 15.985 | | | | 15.997 | | | | 16.009 | | | | | 16.021 | | | | 16.033 | | | | 16.045 | | |
| 1540 | | | | 16.057 | | | 16.069 | | | 16.080 | | | | 16.092 | | | | 16.104 | | | | 16.116 | | | | 16.128 | | | | | 16.140 | | | | 16.152 | | | | 16.164 | | |
| 1550 | | | | 16.176 | | | 16.188 | | | 16.200 | | | | 16.212 | | | | 16.224 | | | | 16.236 | | | | 16.248 | | | | | 16.260 | | | | 16.272 | | | | 16.284 | | |
|  | | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | | |  | | | |  | | | |  | | |
| 1560 | | | | 16.296 | | | 16.308 | | | 16.319 | | | | 16.331 | | | | 16.343 | | | | 16.355 | | | | 16.367 | | | | | 16.379 | | | | 16.391 | | | | 16.403 | | |
| 1570 | | | | 16.415 | | | 16.427 | | | 16.439 | | | | 16.451 | | | | 16.462 | | | | 16.474 | | | | 16.486 | | | | | 16.498 | | | | 16.510 | | | | 16.522 | | |
| 1580 | | | | 16.534 | | | 16.546 | | | 16.558 | | | | 16.569 | | | | 16.581 | | | | 16.593 | | | | 16.605 | | | | | 16.617 | | | | 16.629 | | | | 16.641 | | |
| 1590 | | | | 16.653 | | | 16.664 | | | 16.676 | | | | 16.688 | | | | 16.700 | | | | 16.712 | | | | 16.724 | | | | | 16.736 | | | | 16.747 | | | | 16.759 | | |
| 1600 | | | | 16.771 | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | | |  | | | |  | | | |  | | |
|  | | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | | |  | | | |  | | | |  | | |
|  | | | |  | | |  | | |  | | | |  | | | |  | | | |  | | | |  | | | | |  | | | |  | | | |  | | |

镍铬－镍硅热电偶分度表

分度号：K （参考端温度为０℃）

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 温度  ℃ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 热　 　电　 　动　　势　　mV | | | | | | | | | |
| -50 | -1.889 |  |  |  |  |  |  |  |  |  |
| -40 | -1.527 | -1.563 | -1.600 | -1.636 | -1.673 | -1.709 | -1.745 | -1.781 | -1.817 | -1.853 |
| -30 | -1.156 | -1.193 | -1.231 | -1.268 | -1.305 | -1.342 | -1.379 | -1.416 | -1.453 | -1.490 |
| -20 | -0.777 | -0.816 | -0.854 | -0.892 | -0.930 | -0.968 | -1.005 | -1.043 | -1.081 | -1.118 |
| -10 | -0.392 | -0.431 | -0.469 | -0.508 | -.0547 | -0.585 | -0.624 | -0.662 | -0.701 | -0.739 |
| 0 | -0.000 | -0.039 | -0.079 | -0.118 | -0.157 | -0.197 | -0.236 | -0.275 | -0.314 | -0.353 |
|  |  |  |  |  |  |  |  |  |  |  |
| 0 | 0.000 | 0.039 | 0.079 | 0.119 | 0.158 | 0.198 | 0.238 | 0.277 | 0.317 | 0.357 |
| 10 | 0.397 | 0.437 | 0.477 | 0.517 | 0.557 | 0.597 | 0.637 | 0.677 | 0.718 | 0.758 |
| 20 | 0.798 | 0.838 | 0.879 | 0.919 | 0.960 | 1.000 | 1.041 | 1.081 | 1.122 | 1.162 |
| 30 | 1.203 | 1.244 | 1.285 | 1.325 | 1.366 | 1.407 | 1.448 | 1.489 | 1.529 | 1.570 |
| 40 | 1.611 | 1.652 | 1.693 | 1.734 | 1.776 | 1.817 | 1.858 | 1.899 | 1.949 | 1.981 |
|  |  |  |  |  |  |  |  |  |  |  |
| 50 | 2.022 | 2.064 | 2.105 | 2.146 | 2.188 | 2.229 | 2.270 | 2.312 | 2.353 | 2.394 |
| 60 | 2.436 | 2.477 | 2.519 | 2.560 | 2.601 | 2.643 | 2.684 | 2.726 | 2.767 | 2.809 |
| 70 | 2.850 | 2.892 | 2.933 | 2.975 | 3.016 | 3.058 | 3.100 | 3.141 | 3.183 | 3.244 |
| 80 | 3.266 | 3.307 | 3.349 | 3.390 | 3.432 | 3.473 | 3.515 | 3.556 | 3.598 | 3.639 |
| 90 | 3.681 | 3.722 | 3.764 | 3.805 | 3.847 | 3.888 | 3.930 | 3.971 | 4.012 | 4.054 |
|  |  |  |  |  |  |  |  |  |  |  |
| 100 | 4.095 | 4.137 | 4.178 | 4.219 | 4.261 | 4.302 | 4.343 | 4.384 | 4.426 | 4.467 |
| 110 | 4.508 | 4.549 | 4.590 | 4.632 | 4.673 | 4.714 | 4.755 | 4.796 | 4.837 | 4.878 |
| 120 | 4.919 | 4.960 | 5.001 | 5.042 | 5.083 | 5.124 | 5.164 | 5.205 | 5.246 | 5.287 |
| 130 | 5.327 | 5.368 | 5.409 | 5.450 | 5.490 | 5.531 | 5.571 | 5.612 | 5.652 | 5.693 |
| 140 | 5.733 | 5.774 | 5.814 | 5.855 | 5.895 | 5.936 | 5.976 | 6.016 | 6.057 | 6.097 |
|  |  |  |  |  |  |  |  |  |  |  |
| 150 | 6.137 | 6.177 | 6.218 | 6.258 | 6.298 | 6.338 | 6.378 | 6.419 | 6.459 | 6.499 |
| 160 | 6.539 | 6.579 | 6.619 | 6.659 | 6.699 | 6.739 | 6.779 | 6.819 | 6.859 | 6.889 |
| 170 | 6.939 | 6.979 | 7.019 | 7.059 | 7.099 | 7.139 | 7.179 | 7.219 | 7.259 | 7.299 |
| 180 | 7.338 | 7.378 | 7.418 | 7.458 | 7.498 | 7.538 | 7.578 | 7.618 | 7.658 | 7.697 |
| 190 | 7.737 | 7.777 | 7.817 | 7.857 | 7.897 | 7.937 | 7.977 | 8.017 | 8.057 | 8.097 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 温度 | | | 0 | | | | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | | 9 | | |
| ℃ | | | 热　 　电　 　动　　势　　mV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 200 | | | 8.137 | | | | 8.177 | | | 8.216 | | | 8.256 | | | 8.296 | | | 8.336 | | | 8.376 | | | 8.416 | | | 8.456 | | | 8.497 | | |
| 210 | | | 8.537 | | | | 8.577 | | | 8.617 | | | 8.657 | | | 8.697 | | | 8.737 | | | 8.777 | | | 8.817 | | | 8.857 | | | 8.898 | | |
| 220 | | | 8.938 | | | | 8.978 | | | 9.018 | | | 9.058 | | | 9.099 | | | 9.139 | | | 9.179 | | | 9.220 | | | 9.260 | | | 9.300 | | |
| 230 | | | 9.341 | | | | 9.381 | | | 9.421 | | | 9.462 | | | 9.502 | | | 9.543 | | | 9.583 | | | 9.624 | | | 9.664 | | | 9.705 | | |
| 240 | | | 9.745 | | | | 9.786 | | | 9.826 | | | 9.867 | | | 9.907 | | | 9.948 | | | 9.989 | | | 10.029 | | | 10.070 | | | 10.111 | | |
|  | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 250 | | | 10.151 | | | | 10.192 | | | 10.233 | | | 10.274 | | | 10.315 | | | 10.355 | | | 10.396 | | | 10.437 | | | 10.478 | | | 10.519 | | |
| 260 | | | 10.560 | | | | 10.600 | | | 10.641 | | | 10.682 | | | 10.723 | | | 10.764 | | | 10.805 | | | 10.846 | | | 10.887 | | | 10.928 | | |
| 270 | | | 10.969 | | | | 11.010 | | | 11.051 | | | 11.093 | | | 11.134 | | | 11.175 | | | 11.216 | | | 11.257 | | | 11.298 | | | 11.339 | | |
| 280 | | | 11.381 | | | | 11.422 | | | 11.463 | | | 110504 | | | 11.546 | | | 11.587 | | | 11.628 | | | 11.669 | | | 11.711 | | | 11.752 | | |
| 290 | | | 11.793 | | | | 11.835 | | | 11.876 | | | 11.918 | | | 11.959 | | | 12.000 | | | 12.042 | | | 12.083 | | | 12.125 | | | 12.166 | | |
|  | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 300 | | | 12.207 | | | | 12.249 | | | 12.290 | | | 12.332 | | | 12.373 | | | 12.415 | | | 12.456 | | | 12.498 | | | 12.539 | | | 12.581 | | |
| 310 | | | 12.623 | | | | 12.664 | | | 12.706 | | | 12.747 | | | 12.789 | | | 12.831 | | | 12.872 | | | 12.914 | | | 12.955 | | | 12.997 | | |
| 320 | | | 13.039 | | | | 13.080 | | | 13.122 | | | 13.164 | | | 13.205 | | | 13.247 | | | 13.289 | | | 13.331 | | | 13.372 | | | 13.414 | | |
| 330 | | | 13.456 | | | | 13.497 | | | 13.539 | | | 13.581 | | | 13.623 | | | 13.665 | | | 13.706 | | | 13.748 | | | 13.790 | | | 13.832 | | |
| 340 | | | 13.874 | | | | 13.915 | | | 13.957 | | | 13.999 | | | 14.041 | | | 14.083 | | | 14.125 | | | 14.167 | | | 14.208 | | | 14.250 | | |
|  | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 350 | | | 14.292 | | | | 14.334 | | | 14.376 | | | 14.418 | | | 14.460 | | | 14.502 | | | 14.544 | | | 14.586 | | | 14.628 | | | 14.670 | | |
| 360 | | | 14.712 | | | | 14.754 | | | 14.796 | | | 14.838 | | | 14.880 | | | 14.922 | | | 14.964 | | | 15.006 | | | 15.048 | | | 15.090 | | |
| 370 | | | 15.132 | | | | 15.174 | | | 15.216 | | | 15.258 | | | 15.300 | | | 15.342 | | | 15.384 | | | 15.426 | | | 45.468 | | | 15.510 | | |
| 380 | | | 15.552 | | | | 15.594 | | | 15.636 | | | 15.679 | | | 15.721 | | | 15.763 | | | 15.805 | | | 15.847 | | | 15.889 | | | 15.931 | | |
| 390 | | | 15.974 | | | | 16.016 | | | 16.058 | | | 16.100 | | | 16.142 | | | 16.184 | | | 16.227 | | | 16.269 | | | 16.311 | | | 16.353 | | |
|  | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 400 | | | 16.359 | | | | 16.438 | | | 16.480 | | | 16.522 | | | 16.564 | | | 16.607 | | | 16.649 | | | 16.691 | | | 16.733 | | | 16.776 | | |
| 410 | | | 16.818 | | | | 16.860 | | | 16.902 | | | 16.945 | | | 16.987 | | | 17.029 | | | 17.072 | | | 17.114 | | | 17.156 | | | 17.199 | | |
| 420 | | | 17.241 | | | | 17.283 | | | 17.326 | | | 17.368 | | | 17.410 | | | 17.453 | | | 17.495 | | | 17.537 | | | 17.580 | | | 17.622 | | |
| 430 | | | 17.664 | | | | 17.707 | | | 17.749 | | | 17.792 | | | 17.834 | | | 17.876 | | | 17.919 | | | 17.961 | | | 18.004 | | | 18.046 | | |
| 440 | | | 18.088 | | | | 18.131 | | | 18.173 | | | 18.216 | | | 18.258 | | | 18.301 | | | 18.343 | | | 18.358 | | | 18.428 | | | 18.470 | | |
|  | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 450 | | | 18.513 | | | | 18.555 | | | 18.598 | | | 18.640 | | | 18.683 | | | 18.725 | | | 18.768 | | | 18.810 | | | 18.853 | | | 18.895 | | |
| 460 | | | 18.938 | | | | 18.980 | | | 19.023 | | | 19.065 | | | 19.108 | | | 19.150 | | | 19.193 | | | 19.235 | | | 19.278 | | | 19.320 | | |
| 470 | | | 19.363 | | | | 19.405 | | | 19.448 | | | 19.490 | | | 19.533 | | | 19.576 | | | 19.618 | | | 19.661 | | | 19.703 | | | 19.746 | | |
| 480 | | | 19.788 | | | | 19.831 | | | 19.873 | | | 19.916 | | | 19.959 | | | 20.001 | | | 20.044 | | | 20.086 | | | 20.129 | | | 20.172 | | |
| 490 | | | 20.214 | | | | 20.257 | | | 20.299 | | | 20.342 | | | 20.385 | | | 20.427 | | | 20.470 | | | 20.512 | | | 20.555 | | | 20.598 | | |
| 温度 | 0 | | | | 1 | | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | | 9 | | |
| ℃ | 热　 　电　 　动　　势　　mV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 500 | 20.640 | | | | 20.683 | | | | 20.725 | | | 20.768 | | | 20.811 | | | 20.853 | | | 20.896 | | | 20.938 | | | 20.981 | | | 21.024 | | |
| 510 | 21.066 | | | | 21.109 | | | | 21.152 | | | 21.194 | | | 21.237 | | | 21.280 | | | 21.322 | | | 21.365 | | | 21.407 | | | 21.450 | | |
| 520 | 21.493 | | | | 21.535 | | | | 21.578 | | | 21.621 | | | 21.663 | | | 21.706 | | | 21.749 | | | 21.791 | | | 21.834 | | | 21.876 | | |
| 530 | 21.919 | | | | 21.962 | | | | 22.004 | | | 22.047 | | | 22.090 | | | 22.132 | | | 22.175 | | | 22.218 | | | 22.260 | | | 22.303 | | |
| 540 | 22.346 | | | | 22.388 | | | | 22.431 | | | 22.473 | | | 22.516 | | | 22.559 | | | 22.601 | | | 22.644 | | | 22.687 | | | 22.729 | | |
|  |  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 550 | 22.722 | | | | 22.815 | | | | 22.857 | | | 22.900 | | | 22.942 | | | 22.985 | | | 23.028 | | | 23.070 | | | 23.113 | | | 23.156 | | |
| 560 | 23.198 | | | | 23.241 | | | | 23.284 | | | 23.326 | | | 23.369 | | | 23.411 | | | 23.454 | | | 23.497 | | | 23.539 | | | 23.582 | | |
| 570 | 23.624 | | | | 23.667 | | | | 23.710 | | | 23.752 | | | 23.795 | | | 23.837 | | | 23.880 | | | 23.923 | | | 23.965 | | | 24.008 | | |
| 580 | 24.050 | | | | 24.093 | | | | 24.136 | | | 24.178 | | | 24.221 | | | 24.263 | | | 24.306 | | | 24.348 | | | 24.391 | | | 24.434 | | |
| 590 | 24.476 | | | | 24.519 | | | | 24.561 | | | 24.604 | | | 24.646 | | | 24.689 | | | 24.731 | | | 24.774 | | | 24.817 | | | 24.859 | | |
|  |  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 600 | 24.902 | | | | 24.944 | | | | 24.987 | | | 25.029 | | | 25.072 | | | 25.114 | | | 25.157 | | | 25.199 | | | 25.242 | | | 25.284 | | |
| 610 | 25.327 | | | | 25.369 | | | | 25.412 | | | 25.454 | | | 25.497 | | | 25.539 | | | 25.582 | | | 25.624 | | | 25.666 | | | 25.709 | | |
| 620 | 25.751 | | | | 25.794 | | | | 25.836 | | | 25.879 | | | 25.921 | | | 25.964 | | | 26.006 | | | 26.048 | | | 26.091 | | | 26.133 | | |
| 630 | 26.176 | | | | 26.218 | | | | 26.260 | | | 26.303 | | | 26.345 | | | 26.387 | | | 26.430 | | | 26.472 | | | 26.515 | | | 26.557 | | |
| 640 | 26.599 | | | | 26.642 | | | | 26.684 | | | 26.726 | | | 26.769 | | | 26.811 | | | 26.853 | | | 26.896 | | | 26.938 | | | 26.980 | | |
|  |  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 650 | 27.022 | | | | 27.065 | | | | 27.107 | | | 27.149 | | | 27.192 | | | 27.234 | | | 27.276 | | | 27.318 | | | 27.361 | | | 27.403 | | |
| 660 | 27.445 | | | | 27.487 | | | | 27.529 | | | 27.572 | | | 27.614 | | | 27.656 | | | 27.698 | | | 27.740 | | | 27.783 | | | 27.825 | | |
| 670 | 27.867 | | | | 27.909 | | | | 27.951 | | | 27.993 | | | 28.035 | | | 28.078 | | | 28.120 | | | 28.162 | | | 28.204 | | | 28.246 | | |
| 680 | 28.288 | | | | 28.330 | | | | 28.372 | | | 28.414 | | | 28.456 | | | 28.498 | | | 28.540 | | | 28.583 | | | 28.625 | | | 28.667 | | |
| 690 | 28.709 | | | | 28.751 | | | | 28.793 | | | 28.835 | | | 28.877 | | | 28.919 | | | 28.961 | | | 29.002 | | | 29.044 | | | 29.086 | | |
|  |  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 700 | 29.128 | | | | 29.170 | | | | 29.212 | | | 29.254 | | | 29.296 | | | 29.338 | | | 29.280 | | | 29.422 | | | 29.464 | | | 29.505 | | |
| 710 | 29.547 | | | | 29.589 | | | | 29.631 | | | 29.673 | | | 29.715 | | | 29.756 | | | 29.798 | | | 29.840 | | | 29.882 | | | 29.924 | | |
| 720 | 29.965 | | | | 30.007 | | | | 30.049 | | | 30.091 | | | 30.132 | | | 30.174 | | | 30.216 | | | 30.257 | | | 30.299 | | | 30.341 | | |
| 730 | 30.383 | | | | 30.424 | | | | 30.466 | | | 30.508 | | | 30.549 | | | 30.591 | | | 30.632 | | | 30.674 | | | 30.716 | | | 30.757 | | |
| 740 | 30.799 | | | | 30.840 | | | | 30.882 | | | 30.924 | | | 30.965 | | | 31.007 | | | 31.048 | | | 31.090 | | | 31.131 | | | 31.173 | | |
|  |  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 750 | 31.214 | | | | 31.256 | | | | 31.297 | | | 31.339 | | | 31.380 | | | 31.422 | | | 31.463 | | | 31.504 | | | 31.546 | | | 31.587 | | |
| 760 | 31.629 | | | | 31.670 | | | | 31.712 | | | 31.753 | | | 31.794 | | | 31.836 | | | 31.877 | | | 31.918 | | | 31.960 | | | 32.001 | | |
| 770 | 32.042 | | | | 32.084 | | | | 32.125 | | | 32.166 | | | 32.207 | | | 32.249 | | | 32.290 | | | 32.331 | | | 32.372 | | | 32.414 | | |
| 780 | 32.455 | | | | 32.496 | | | | 32.537 | | | 32.578 | | | 32.619 | | | 32.661 | | | 32.702 | | | 32.743 | | | 32.784 | | | 32.825 | | |
| 790 | 32.866 | | | | 32.907 | | | | 32.948 | | | 32.990 | | | 33.031 | | | 33.072 | | | 33.113 | | | 33.154 | | | 33.195 | | | 33.236 | | |
| 温度 | | | | 0 | | | | 1 | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | | 9 | | |
| ℃ | | | | 热　 　电　 　动　　势　　mV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 800 | | | | 33.277 | | | | 33.318 | | | 33.359 | | | 33.400 | | | 33.441 | | | 33.482 | | | 33.523 | | | 33.564 | | | 33.604 | | | 33.645 | | |
| 810 | | | | 33.686 | | | | 33.727 | | | 33.768 | | | 33.809 | | | 33.850 | | | 33.891 | | | 33.931 | | | 33.972 | | | 34.013 | | | 34.054 | | |
| 820 | | | | 34.095 | | | | 34.136 | | | 34.176 | | | 34.217 | | | 34.258 | | | 34.299 | | | 34.339 | | | 34.380 | | | 34.421 | | | 34.461 | | |
| 830 | | | | 34.502 | | | | 34.543 | | | 34.583 | | | 34.624 | | | 34.665 | | | 34.705 | | | 34.746 | | | 34.787 | | | 34.827 | | | 34.868 | | |
| 840 | | | | 34.909 | | | | 34.949 | | | 34.990 | | | 35.030 | | | 35.071 | | | 35.111 | | | 35.152 | | | 35.192 | | | 35.233 | | | 35.273 | | |
|  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 850 | | | | 35.314 | | | | 35.354 | | | 35.395 | | | 35.435 | | | 35.476 | | | 35.516 | | | 35.557 | | | 35.597 | | | 35.637 | | | 35.678 | | |
| 860 | | | | 35.718 | | | | 35.758 | | | 35.799 | | | 35.839 | | | 35.880 | | | 35.920 | | | 35.960 | | | 36.000 | | | 36.041 | | | 36.081 | | |
| 870 | | | | 36.121 | | | | 36.162 | | | 36.202 | | | 36.242 | | | 36.282 | | | 36.323 | | | 36.363 | | | 36.403 | | | 36.443 | | | 36.483 | | |
| 880 | | | | 36.524 | | | | 36.564 | | | 36.604 | | | 36.644 | | | 36.684 | | | 36.724 | | | 36.764 | | | 36.804 | | | 36.844 | | | 36.885 | | |
| 890 | | | | 36.925 | | | | 36.965 | | | 37.005 | | | 37.045 | | | 37.085 | | | 37.125 | | | 37.165 | | | 37.205 | | | 37.245 | | | 37.285 | | |
|  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 900 | | | | 37.325 | | | | 37.365 | | | 37.405 | | | 37.445 | | | 37.484 | | | 37.524 | | | 37.564 | | | 37.604 | | | 37.644 | | | 37.684 | | |
| 910 | | | | 37.724 | | | | 37.764 | | | 37.803 | | | 37.843 | | | 37.883 | | | 37.923 | | | 37.963 | | | 38.002 | | | 38.042 | | | 38.082 | | |
| 920 | | | | 38.122 | | | | 38.162 | | | 38.201 | | | 38.241 | | | 38.281 | | | 38.320 | | | 38.360 | | | 38.400 | | | 38.439 | | | 38.479 | | |
| 930 | | | | 38.519 | | | | 38.558 | | | 38.598 | | | 38.638 | | | 38.667 | | | 38.717 | | | 38.756 | | | 38.796 | | | 38.836 | | | 38.875 | | |
| 940 | | | | 38.925 | | | | 38.954 | | | 38.994 | | | 39.033 | | | 39.073 | | | 39.112 | | | 39.152 | | | 39.191 | | | 39.231 | | | 39.270 | | |
|  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 950 | | | | 39.310 | | | | 39.349 | | | 39.388 | | | 39.428 | | | 39.467 | | | 39.507 | | | 39.546 | | | 39.585 | | | 39.625 | | | 39.664 | | |
| 960 | | | | 39.703 | | | | 39.743 | | | 39.782 | | | 39.821 | | | 39.861 | | | 39.900 | | | 39.939 | | | 39.979 | | | 40.018 | | | 40.057 | | |
| 970 | | | | 40.096 | | | | 40.136 | | | 40.175 | | | 40.214 | | | 40.253 | | | 40.292 | | | 40.332 | | | 40.371 | | | 40.410 | | | 40.449 | | |
| 980 | | | | 40.488 | | | | 40.527 | | | 40.566 | | | 40.605 | | | 40.645 | | | 40.684 | | | 40.723 | | | 40.762 | | | 40.801 | | | 40.840 | | |
| 990 | | | | 40.897 | | | | 40.918 | | | 40.957 | | | 40.996 | | | 41.035 | | | 41.074 | | | 41.113 | | | 41.152 | | | 41.191 | | | 41.230 | | |
|  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 1000 | | | | 41.264 | | | | 41.308 | | | 41.347 | | | 41.385 | | | 41.424 | | | 41.463 | | | 41.502 | | | 41.541 | | | 41.580 | | | 41.619 | | |
| 1010 | | | | 41.657 | | | | 41.696 | | | 41.753 | | | 41.774 | | | 41.813 | | | 41.851 | | | 41.890 | | | 41.929 | | | 41.968 | | | 42.006 | | |
| 1020 | | | | 42.045 | | | | 42.084 | | | 42.123 | | | 42.161 | | | 42.200 | | | 42.239 | | | 42.277 | | | 42.316 | | | 42.355 | | | 42.393 | | |
| 1030 | | | | 42.432 | | | | 42.470 | | | 42.509 | | | 42.548 | | | 42.586 | | | 42.625 | | | 42.663 | | | 42.702 | | | 42.740 | | | 42.779 | | |
| 1040 | | | | 42.817 | | | | 42.856 | | | 42.894 | | | 42.933 | | | 42.971 | | | 43.010 | | | 43.048 | | | 43.087 | | | 43.125 | | | 43.164 | | |
|  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |
| 1050 | | | | 43.202 | | | | 43.240 | | | 43.279 | | | 43.317 | | | 43.356 | | | 43.394 | | | 43.432 | | | 43.471 | | | 43.509 | | | 43.547 | | |
| 1060 | | | | 43.585 | | | | 43.624 | | | 43.662 | | | 43.700 | | | 43.739 | | | 43.777 | | | 43.815 | | | 43.853 | | | 43.891 | | | 43.930 | | |
| 1070 | | | | 43.968 | | | | 44.006 | | | 44.044 | | | 44.082 | | | 44.121 | | | 44.159 | | | 44.197 | | | 44.235 | | | 44.273 | | | 44.311 | | |
| 1080 | | | | 44.349 | | | | 44.387 | | | 44.425 | | | 44.463 | | | 44.501 | | | 44.539 | | | 44.577 | | | 44.615 | | | 44.653 | | | 44.691 | | |
| 1090 | | | | 44.729 | | | | 44.767 | | | 44.805 | | | 44.843 | | | 44.881 | | | 44.919 | | | 44.957 | | | 44.995 | | | 45.033 | | | 45.070 | | |
| 温度  ℃ | | 0 | | | | 1 | | | | 2 | | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | | 8 | | | 9 | | | |
| 热　 　电　 　动　　势　　mV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1100 | | 45.108 | | | | 45.146 | | | | 45.184 | | | 45.222 | | | 45.260 | | | 45.297 | | | 45.335 | | | 45.373 | | | 45.411 | | | 45.448 | | | |
| 1110 | | 45.486 | | | | 45.524 | | | | 45.561 | | | 45.599 | | | 45.637 | | | 45.675 | | | 45.712 | | | 45.750 | | | 45.787 | | | 45.825 | | | |
| 1120 | | 45.863 | | | | 45.900 | | | | 45.938 | | | 45.975 | | | 46.013 | | | 46.051 | | | 46.088 | | | 46.126 | | | 46.163 | | | 46.201 | | | |
| 1130 | | 46.238 | | | | 46.275 | | | | 46.313 | | | 46.350 | | | 46.388 | | | 46.425 | | | 46.463 | | | 46.500 | | | 46.573 | | | 46.575 | | | |
| 1140 | | 46.612 | | | | 46.649 | | | | 46.687 | | | 46.724 | | | 46.761 | | | 46.799 | | | 46.836 | | | 46.873 | | | 46.910 | | | 46.948 | | | |
|  | |  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | | |
| 1150 | | 46.985 | | | | 47.022 | | | | 47.059 | | | 47.096 | | | 47.134 | | | 47.171 | | | 47.208 | | | 47.245 | | | 47.282 | | | 47.319 | | | |
| 1160 | | 47.356 | | | | 47.393 | | | | 47.430 | | | 47.468 | | | 47.505 | | | 47.542 | | | 47.579 | | | 47.616 | | | 47.653 | | | 47.689 | | | |
| 1170 | | 47.726 | | | | 47.763 | | | | 47.800 | | | 47.837 | | | 47.874 | | | 47.911 | | | 47.948 | | | 47.985 | | | 48.021 | | | 48.058 | | | |
| 1180 | | 48.095 | | | | 48.132 | | | | 48.169 | | | 48.205 | | | 48.242 | | | 48.279 | | | 48.316 | | | 48.352 | | | 48.389 | | | 48.426 | | | |
| 1190 | | 48.462 | | | | 48.499 | | | | 48.536 | | | 48.572 | | | 48.609 | | | 48.645 | | | 48.682 | | | 48.718 | | | 48.755 | | | 48.792 | | | |
|  | |  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | | |
| 1200 | | 48.828 | | | | 48.865 | | | | 48.901 | | | 48.937 | | | 48.974 | | | 49.010 | | | 49.047 | | | 49.083 | | | 49.120 | | | 49.156 | | | |
| 1210 | | 49.192 | | | | 49.229 | | | | 49.265 | | | 49.301 | | | 49.338 | | | 49.374 | | | 49.410 | | | 49.446 | | | 49.483 | | | 49.519 | | | |
| 1220 | | 49.555 | | | | 49.591 | | | | 49.627 | | | 49.663 | | | 49.700 | | | 49.736 | | | 49.772 | | | 49.808 | | | 49.844 | | | 49.880 | | | |
| 1230 | | 49.916 | | | | 49.952 | | | | 49.988 | | | 50.024 | | | 50.060 | | | 50.096 | | | 50.132 | | | 50.168 | | | 50.204 | | | 50.240 | | | |
| 1240 | | 50.276 | | | | 50.311 | | | | 50.347 | | | 50.383 | | | 50.419 | | | 50.455 | | | 50.491 | | | 50.526 | | | 50.562 | | | 50.598 | | | |
|  | |  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | | |
| 1250 | | 50.633 | | | | 50.669 | | | | 50.705 | | | 50.741 | | | 50.776 | | | 50.812 | | | 50.847 | | | 50.883 | | | 50.919 | | | 50.954 | | | |
| 1260 | | 50.990 | | | | 51.025 | | | | 51.061 | | | 51.096 | | | 51.132 | | | 51.167 | | | 51.203 | | | 51.238 | | | 51.274 | | | 51.309 | | | |
| 1270 | | 51.344 | | | | 51.380 | | | | 51.415 | | | 51.450 | | | 51.486 | | | 51.521 | | | 51.556 | | | 51.592 | | | 51.627 | | | 51.662 | | | |
| 1280 | | 51.697 | | | | 51.733 | | | | 51.768 | | | 51.803 | | | 51.838 | | | 51.873 | | | 51.908 | | | 51.943 | | | 51.979 | | | 52.014 | | | |
| 1290 | | 52.049 | | | | 52.084 | | | | 52.119 | | | 52.154 | | | 52.189 | | | 52.224 | | | 52.259 | | | 52.294 | | | 52.329 | | | 52.364 | | | |
|  | |  | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | | |
| 1300 | | 52.398 | | | |  | | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | |  | | | |
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实验七 光学高温计

一、实验目的

1．光学高温计的测温原理。

2．熟悉光学高温计的构造及使用方法。

二、实验设备…

1．WGG-2型光学高温计 1台

2．辐射光源 1个

3．自耦变压器 1台

三．实验内容与步骤

1．观察光学高温计各部分的构造。

2．掌握光学高温计测量温度的方法。

（1）装好光学高温计的工作电池，按下电源开关，试验滑线电阻改变时灯丝亮度是否变化，显示温度的指针是否偏转。

（2）接通辐射光源的电源，缓慢旋转自耦变压器的手柄，将电压分别调整至40V、60V、80V、100V，这时光源发亮，即可使用光学高温计测量温度。并记录测量结果。

表1－4光学高温计测温

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 自耦变压器电压值 | 40V | 60V | 80V | 100V |
| 光学高温计测量值 |  |  |  |  |
|  |  |  |  |
|  |  |  |  |

四、思考题

１．在高温计与被测温物体之间放置一块玻璃板、透明塑料板甚至水蒸气（哈气），对测量读数有无影响？高温计与灯丝之间的距离变化对测量有无影响？为什么？

２．将眼睛对灯丝亮度的识别过程改为CCD结合信号处理和电阻反馈的自动过程，就可以得到一台能够自动在线测量的仪器。试设想并画出这种自动测量仪器的构成框图。

五、实验报告内容及要求

见附录。

附：光学高温计的结构及使用方法

WGG-2型光学高温计的外形如图图7－1所示。光学高温计具有结构简单、测量温度高、不与被测物接触等特点。可用于测量700℃以上物体的温度。它主要由光学系统和电测系统两部分组成。WGG-2型隐丝式光学高温计的结构如图7－2所示。使用时调节目镜的位置可清晰地看到灯丝。调节物镜的位置能使被测目标清晰地成像在灯丝平面上。以比较两者的亮度。红色滤光片在测温时移入视场，在一定波长（0.66微米）上比较灯丝和被测目标的温度，通过调节灯丝电流，用肉眼分辨亮度是否均衡。当两者亮度相等时，则灯丝顶端的轮廓隐灭于被测目标的影像中。在物镜和灯泡之间设置吸收玻璃，如需使用第二量程（高于1400℃）时，转动吸收玻璃的把手，使之移入视场。

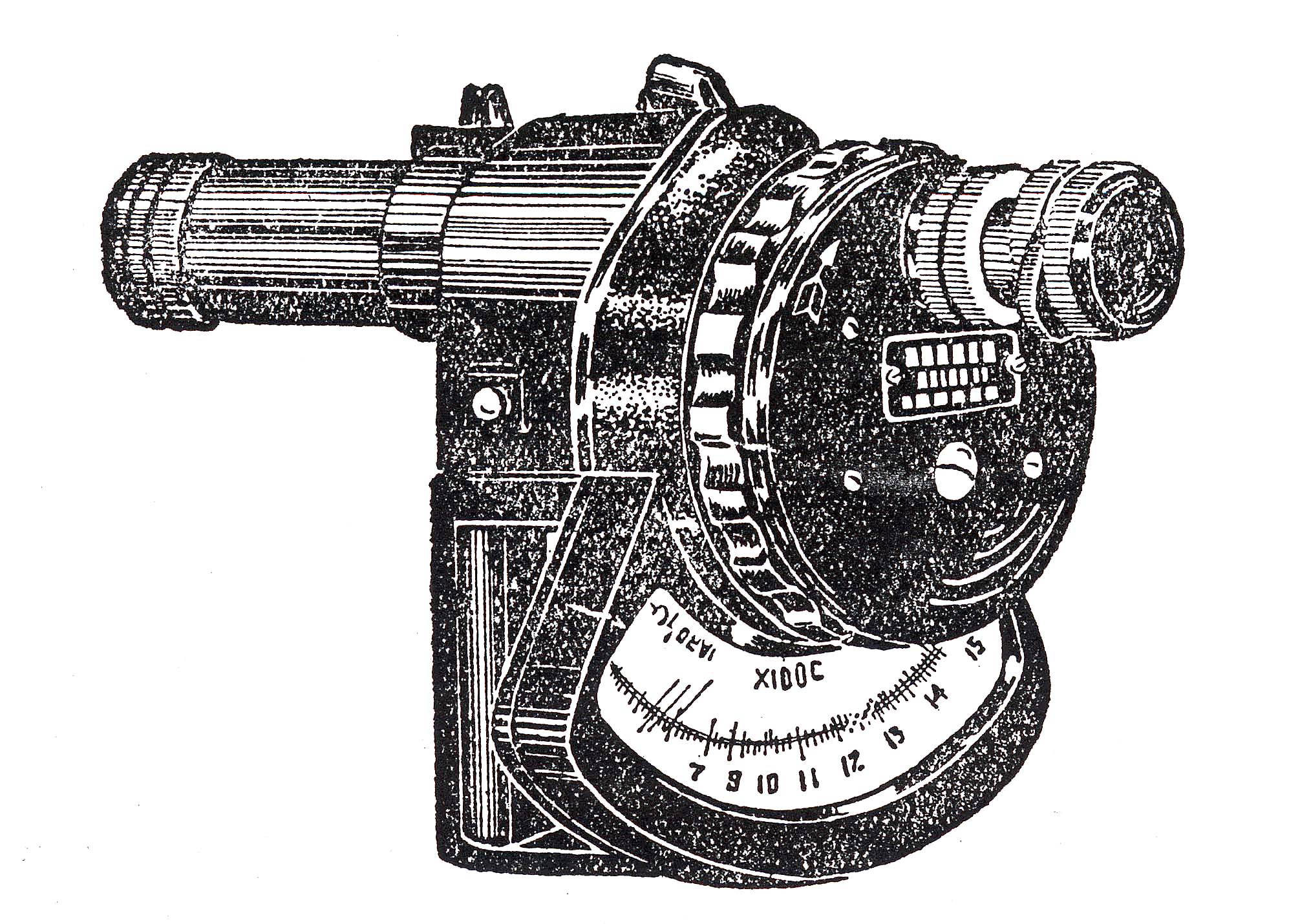


图7－1　　光学高温计外形

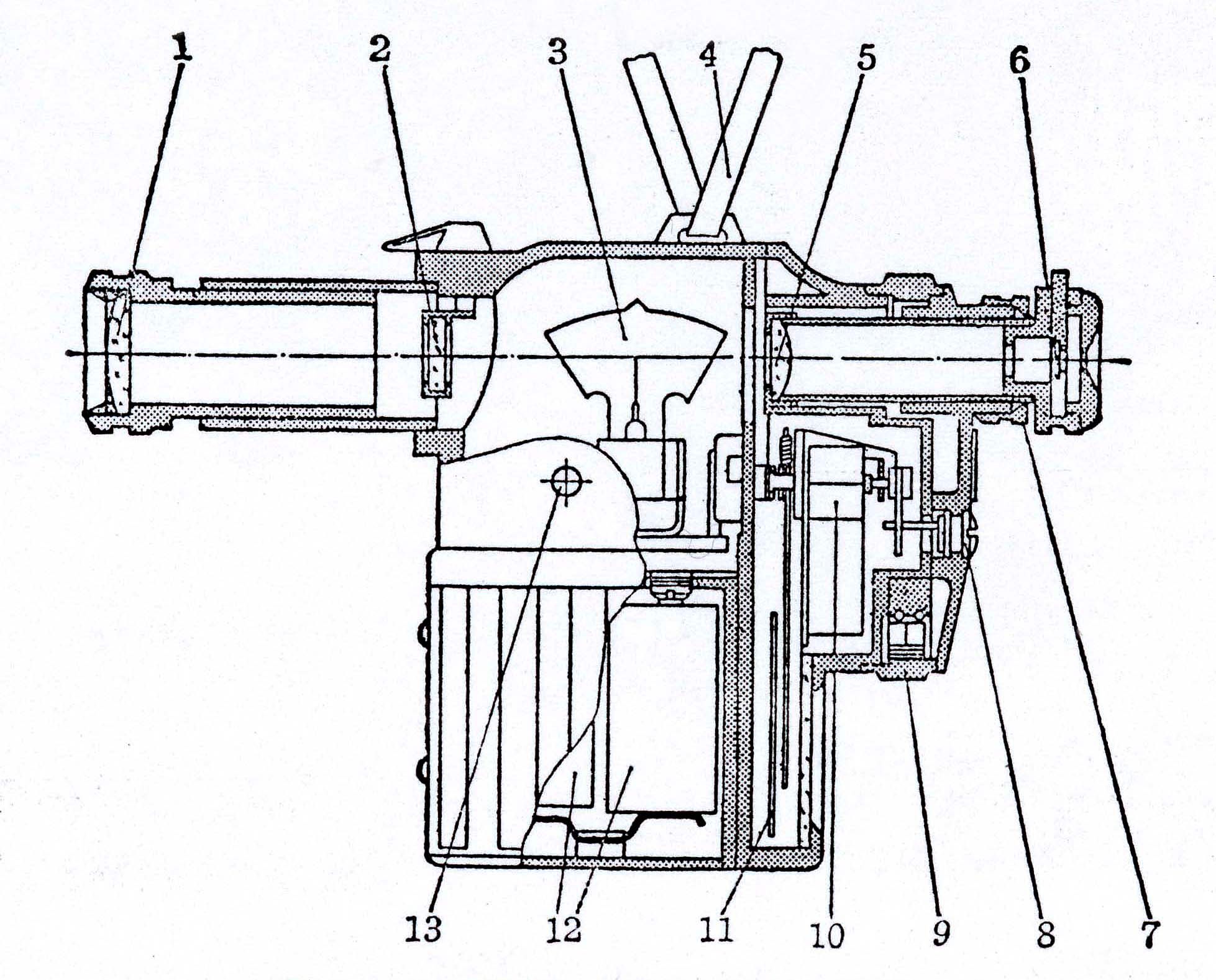


图7－2　光学高温计结构图

1物镜；2吸收玻璃；3高温计灯泡；4皮带；5目镜；6红色滤光片；7目镜定位螺母；8零位调节器；9滑线电阻盘；10测量电表；11刻度盘；12干电池；13按钮开关；

实验八 浮球式压力计

一、实验目的

1．了解浮球式压力计的结构，掌握其工作原理及使用方法。

2．掌握压力表校验的基本方法。

二、实验设备

1．Y047浮球式压力计　 1台

2．弹簧管式压力表 　　　1块

三、实验内容与步骤

校验弹簧管压力表：

1．校验前参照浮球式压力计的使用要求调整好浮球式压力计。

2．从弹簧管压力表下限开始（每隔0.025MPa作为一个校验点）将相应质量的砝码放在砝码架上（正行程）。同时将弹簧管压力表指示值记入表8-1中。

表8－1 校验弹簧管压力表

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 砝码MPa | 弹簧罐压力表示值 | | | | | | | | 引用  误差 |
| 正行程 | | 平均 |  | 反行程 | | 平均 | 误差 |
| 0 |  |  |  |  |  |  |  |  |  |
| 0.025 |  |  |  |  |  |  |  |  |  |
| 0.050 |  |  |  |  |  |  |  |  |  |
| 0.075 |  |  |  |  |  |  |  |  |  |
| 0.100 |  |  |  |  |  |  |  |  |  |
| 0.125 |  |  |  |  |  |  |  |  |  |
| 0.150 |  |  |  |  |  |  |  |  |  |
| 0.175 |  |  |  |  |  |  |  |  |  |
| 0.200 |  |  |  |  |  |  |  |  |  |
| 0.225 |  |  |  |  |  |  |  |  |  |
| 0.250 |  |  |  |  |  |  |  |  |  |

3．从弹簧管压力表上限开始，按校验点的压力逐点校验压力表（反行程）。

上述正、反行程各校验两次。

4．对所校验的仪表做出评价。

四、思考题

１．实验中为何要对仪表做正反行程的校验？

２．如何检查在最高压力校验点处的正反行程误差？

五、实验报告内容及要求

实验报告的内容包括实验目的、实验内容、主要实验设备、实验原理线路图、实验简要步骤、实验数据处理与绘制曲线、对实验结果进行分析得出结论等。实验报告字迹要工整，图表要正规，数据要准确真实。

附:实验说明

Y047浮球式压力计介绍：

浮球式压力计是一种压力基准仪器，是校验各种压力变送器、差压变送器和精密压力表的理想设备。

1．原理与结构

浮球式压力计是以压缩空气或氮气作为能源，以精密圆球作为活塞的一种气动负荷式压力计。如图3-3所是，精密圆球置于圆筒形的喷嘴内部，砝码通过砝码架作用在球体的顶端，喷嘴内的气压作用在球体下部是圆球在喷嘴内漂浮起来，当已知质量的砝码所产生的重力与气压的作用力相平衡时，压力计就能输出一个稳定而精确的压力值。

压缩空气或氮气通过流量调节器进入球体的下部，并通过球体和喷嘴之间的缝隙排入大气。在球体下部形成的压力将球体连同砝码向上托起。当排除气体流量等于来自调节器的流量时，系统处于平衡状态。这是，球体将浮起一定高度，球体下部的压力作用面积（即浮球的有效面积）也就一定。由于球体下部的压力通过压力稳定器后作为输出压力，因此输出压力将与砝码负荷成比例。

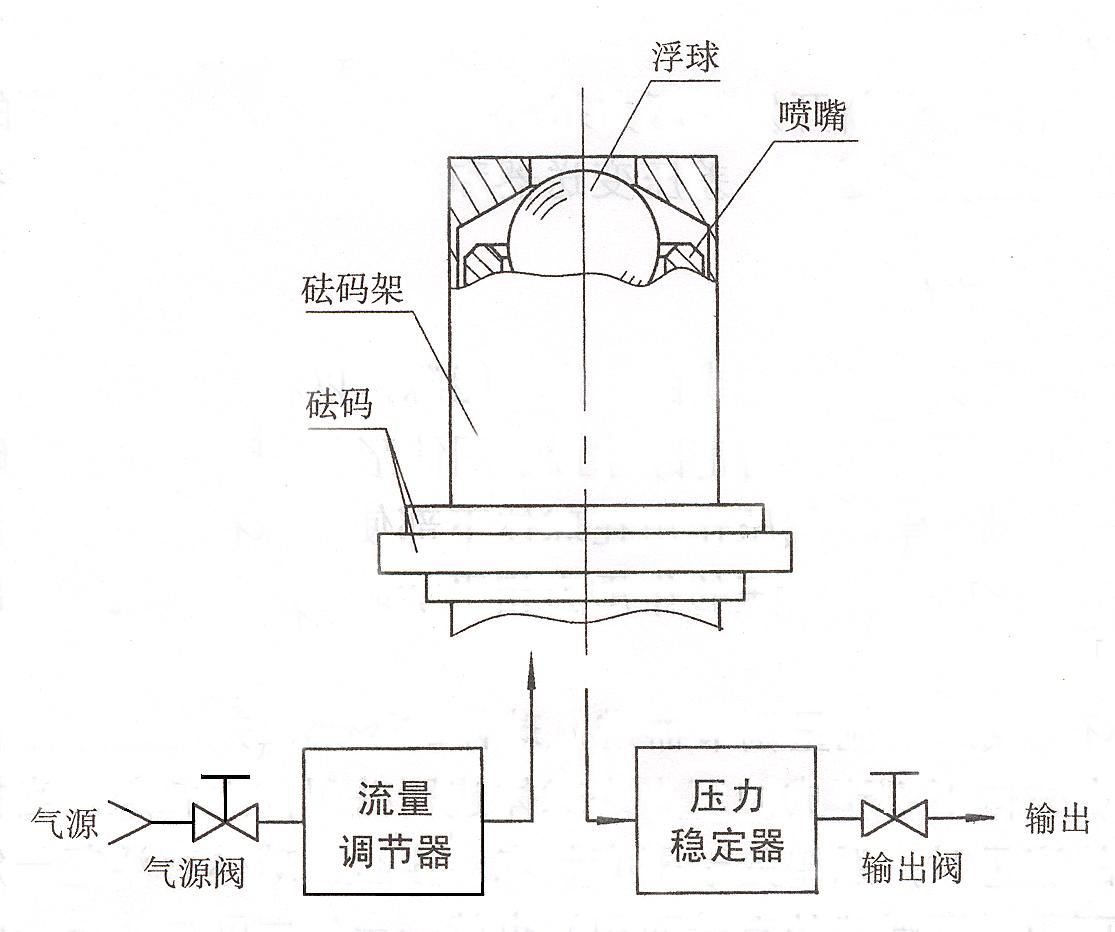


图3-3 浮球压力计原理图

在砝码架上增、减砝码时，将破坏上述的平衡状态，使浮球下降或上升。从而也改变了排入大气的气体流量，浮球下部的压力发生变化。调节器测出压力变化后，立即改变气体的流入量，使系统重新达到平衡状态，以保持浮球的有效面积不变。因而，保持了输出压力和砝码负荷之间的固定比例关系，所以浮球式压力计可达到很高的精确度。

2．浮球式压力计特点

（1）浮球压式压力计带有调节器，加减砝码后无须再作任何操作，即可得到精确的输出压力。因此使用极为方便。

（2）工作时浮球不下降，可以长期连续输出精确的压力信号。

（3）由于仪器能自行调节，其精度与操作者的技术水平无关。

（4）浮球式压力计在工作过程中气流从浮球四周排入大气，使球悬浮于喷嘴内，避免了球体与喷嘴之间的接触。因此不但具有摩擦小、重复性好、分辨能力高的特点、，而且也排除了旋转砝码的必要性。

（5）在工作过程中，气流能不断地对球体进行清洗，提高了仪器使用的可靠程度。

3．主要技术数据

|  |  |
| --- | --- |
| 输出压力范围 | 0.001-0.25MPa |
| 精确度 | ±0.05% |
| 工作温度 | 15-30℃ |
| 额定气源压力 | 0.5 MPa |
| 最高气源压力 | 0.7 MPa |
| 最低气源压力 | 输出压力的1.5倍，但不能低于0.3MPa |
| 耗气量（额定气源压力） | 不超过150 l/h |

4．浮球式压力计的操作

浮球式压力计应安放在温度尽可能接近20℃，湿度为10-75%，周围空气流动不大，且不含有腐蚀性介质和没有任何震动的环境中。使用前，通过仪器底盘两角的调平螺钉调整水平。当水平仪上的水泡居于中间位置时，压力计即处于正确的工作位置。

使用时应首先调好气源压力（额定气源压力：0.5MPa）, 并将砝码架套在浮球上，然后打开气源阀和输出阀。待浮球浮起后，压力计输出砝码架上所标志的压力值。

逐步按被校仪表的要求在砝码架上加入所需压力值的砝码，当浮球再次浮起后，压力计即能输出所需要的校验压力。

5．在操作时必须注意下列事项

（1）增、减砝码时一次不宜太多。

（2）没有必要旋转浮球压力计的砝码来克服摩擦力。过多的旋转会影响仪器的精度。

（3）校验仪表完成后应先除去砝码，关闭气源阀门，然后再取下被校仪表。不能在加压的情况下突然取下被校仪表，以免冲击浮球。

（4）压力计的输出压力值为所加砝码及砝码架上标明的压力数值的总和。输出压力值的误差不超过该值的±0.05%。当输出压力值小于压力计上限制的10%时，误差不超过上限值10%的±0.05%。

附录：实验报告格式

题目（同指导书中的实验名称）

作者（含同组者）

署名单位（专业、班级）

摘要：

关键词：

1，引言

（包括目的、意义、所用设备等）

2，内容

（描述实验过程）

3，实验结果及分析

（以表、图等形式描述实验数据，并有必要的文字说明；对数据结果详加分析和说明；思考题的解答）

4，结论

（总结实验过程和结果）

致谢（向指导老师及有关人员表示感谢）

参考文献

注意：

要求统一采用B5规格白纸或格纸。不清楚之处可咨询指导老师。