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THERMOELECTRIC THERMOMETERS WITH AUTOMATIC TEMPERATURE CONTROL FOR SCIENTIFIC PURPOSES

Annotation: the thermoelectric method of temperature measurement is based on the formation of EDF under the influence of heat in conductors of a special composition. Thermoelectric thermometers (thermoparas) are widely used in various areas of the technique and in scientific and research work-in the measurement of temperatures from 200 0C to +2500 0C. If, when measuring the temperature, the temperature of the ends of the thermometer is equal to 0 0C, then the temperature being measured is immediately found from the grading detail. Such a grading detail establishes a one-valued mathematical relationship between Thermo EDF and the working connection temperature. The grading detail of thermoelectric thermometers is usually determined for a case where the temperature of the free ends is 0 0C.

Keywords: temperature, measurement, thermoelectricity, conductors, thermal effect, electromotive force

Introduction

The measurement amoyil of thermoelectric thermometers is based on the thermoelectric phenomenon that Zeebec discovered in 1821. At the junction of a chain consisting of two different metal wires, the EYuK effect is formed due to the difference in temperatures. Let's consider a chain consisting of different conductors A and V [1].

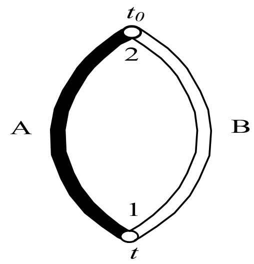

Figure 1. Dual conductor thermometric chain:
1-the soldered end of the thermoparticle(hot connection); 2-the thermoparticle
free end (cold connection)

The thermoelectric method of temperature measurement is based on the formation of EDF under the influence of heat in conductors of a special composition. Thermoelectric thermometers (thermoparas) are widely used in various areas of the technique and in scientific and research work-in the measurement of temperatures from -200 ^{0}S to +2500 ^{0}S.

Materials and methods

This includes empirical methods such as modeling, fact, experiment, description and observation, as well as theoretical methods such as logical and historical methods, abstraction, deduction, induction, synthesis and analysis. The research materials are: scientific facts, the results of previous observations, surveys, experiments and tests; means of idealization and rationalization of the scientific approach.

The tangent of the place of the thermopar in contact with the medium being measured is called the tangled end 1 (hot connection), and the position of the thermopar in the medium with a constant temperature t0 2 is called the free end (cold connection) (Figure 1). Conductors A and V are called thermoelectrodes. Such soldered conductors, on the other hand, are called termparas, the electric conducting force generated in them is called thermoelectric conducting force (EDF). The reason for the formation of EDF is the diffusion of electrons between the free electron density more metal and the free electron density less metal. At this time, the electric field that appears at the junction of the two different metals provides resistance to diffusion. When the diffusion rate of electrons is equal to their return rate under the action of an electric field, an equilibrium state is decided in motion. At this equilibrium, a subtraction of potentials occurs between metals A and V. The dynamism of electron diffusion is caused by the fact that the EDF formed on the first and second connections, also differ from each other [2].

Results and discussion:

With this in mind, it is possible to determine the size of the EDF in the chain depicted in Figure 3.16. Observing the chain in the opposite direction to the clockwise movement, the following result follows:

$E_{AV}(t_1 t_0) = E_{AV}(t) + E_{VA}(t_0)$, (1)

The tangent of the place of the thermopar in contact with the medium being measured is called the tangled end 1 (hot connection), and the position of the thermopar in the medium with a constant temperature t0 2 is called the free end (cold connection) (Figure 1). Conductors A and V are called thermoelectrodes. Such soldered conductors, on the other hand, are called termparas, the electric conducting force generated in them is called thermoelectric conducting force (EDF). The reason for the formation of EDF is the diffusion of electrons between the free electron density more metal and the free electron density less metal. At this time, the electric field that appears at the junction of the two different metals provides resistance to diffusion. When the diffusion rate of electrons is equal to their return rate under the action of an electric field, the equilibrium in motion is here: $E_{AV}(t_1 t_0)$ is the cumulative EDF affected by both factors; $E_{AV}(t)$ and $E_{AV}(t_0)$ is the EDF formed by the difference in potentials caused by the difference in temperature at the ends of conductors A and V, respectively.

If the temperature is the same at the soldered ends of the chain, the EDF will be zero, since the value of the EDF formed on both Solvers will be equal to each other, heading in the opposite direction. S_o, if $t=t_0$, we have:

$$E_{AV}(t_0) = E_{AV}(t_0) + E_{VA}(t_0) = 0 \quad (2)$$

$$E_{VA}(t_0) = - E_{AV}(t_0) \quad (3)$$

$$E_{AV}(t,t_0) = E_{AV}(t) - E_{AV}(t_0) \quad (4)$$

As can be seen from the equations, it turns out that the EDF consists of a complex function of the temperature change in the chain.

The temperature of one of the connections is constant, for example if t_0=const [3], then

$$E_{AV}(t, t_0) = f(t) \quad (5)$$

the expression indicates that it is possible to determine the relationship between EDF and temperature by grading for this thermopara, solve the question of temperature measurement from the opposite side, that is, determine the value of the temperature by measuring the EDF of the thermopara.

To connect a measuring instrument, it is necessary to master either a chain in one of the connections (Figure 2, a) or one of the thermoelectrodes (Figure 2, b).

Let's consider the EDF, which is formed according to the options for connecting a third s conductor to the thermopara chain. Figure 1, for the variant in a:

$$E_{AVS}(tt_0,t_0) = Ee_{AV}(t) + E_{VS}(t_0) + E_{SA}(t_0); \quad (5)$$

$t=t_0$, the expression refers to the interaction between EDF and temperature by grading for this thermopara, that is, if the temperature of the connections is equal,

$$E_{AVS}(t_0) = E_{AV}(t_0) + E_{VS}(t_0) + E_{VS}(t_0) + E_{AS}(t_0) = 0 \quad (6)$$

It is known from this equation:

$$E_{VS}(t_0) + E_{AS}(t_0) = - E_{AV}(t_0). \quad (7)$$

Putting the result of equation (6) in the expression (4), the equation (2) follows. 2, for the option in Figure B:

$$E_{AVS}(t,t_1,t_0) = E_{AV}(t) + E_{VS}(t_1) + t_{VS}(t_1) + E_{VA}(t_0). \quad (8)$$

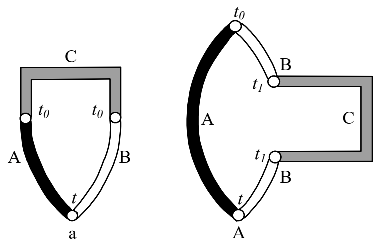

Figure 2. Third conductor connection scheme: a-chain absorption at thermopara junction; B-thermoelectrode absorpti

If we take into account Ees(T_1) = - Eesv (T_1) and Eva (t_0) = - Eab (t_0), equation (8) becomes equation (3).

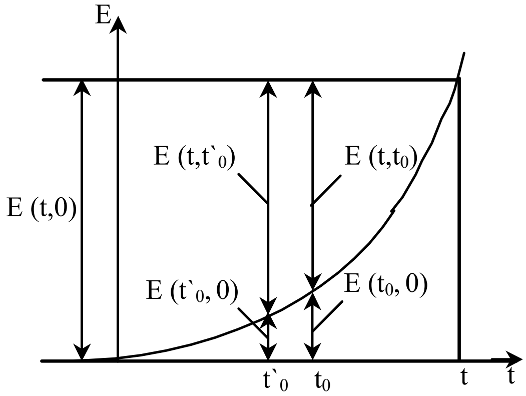

Figure 3. Correction to the temperature of the free ends of the thermoelectric thermometer

From this it is possible to draw the following important conclusion: the TEYuK does not change even when a third conductor with the same temperature at the ends is connected to the chain of the thermopar. This means that it is possible to connect attenuation wires, measuring instruments and resistors to the thermopara chain.

If, when measuring the temperature, the temperature of the ends of the thermometer is equal to 0 ^{0}C, then the temperature being measured is immediately found from the grading detail (tables, graphs) (Figure 3). Such a grading detail establishes a one-valued mathematical relationship between Thermo Eyük and the working connection temperature. The grading detail of thermoelectric thermometers is usually determined for a case where the temperature of the free ends is 0 ^{0}C. If the temperature of the free ends is practically different from 0 ^{0}C, but constant, then to find the working connection temperature from the grading detail, it is also necessary to know the thermo EDF that forms a thermoelectric thermometer, as well as the temperature of the free ends, t0. When the temperature of the free ends is different from 0 ^{0}S, it is necessary to add to the thermo EDF E (t, t_0), which forms a thermoelectric thermometer, the EDF E $(t_0, 0)$ that occurs at the expense of the initial temperature difference:

$$E(t_0, 0)=E(t,0)-E(t,t_0). \qquad (9)$$

When the temperature of the thermoelectric thermometer working connection is t and the temperature of the free ends is 0 0S, i.e. when the grading condition is met, $E(t_0,0) = 0$ and E(t,t0) = E(t; 0) forms EDF.

If, during the measurement process, the temperature of the free ends accepts some new t0 value,then the thermo EDF $E(t, t_0)$ (figure 3.18) that produces the thermometer and the correction to the temperature of the free ends will be Ye(t0, 0), while the EDF corresponding to the grading condition will be.

$$E(t,0)=E(t,t_0) + E(t_0,0) \qquad (10)$$

The method of correcting the temperature of the free ends of a thermoelectric thermometer remains unchanged: in which way a value of E(t, 0) is obtained in the circuit,depending on the calculation or automatic correction input, this value is then added to the Thermopara EDF I. The collection Thermo EDF E(t,0) corresponds to the grading value.

Figure 4 shows a scheme for connecting a thermoelectric thermometer to a measuring instrument [2]. The thermometer kit includes a thermopara l, a connecting cable 2 and a measuring instrument 3.

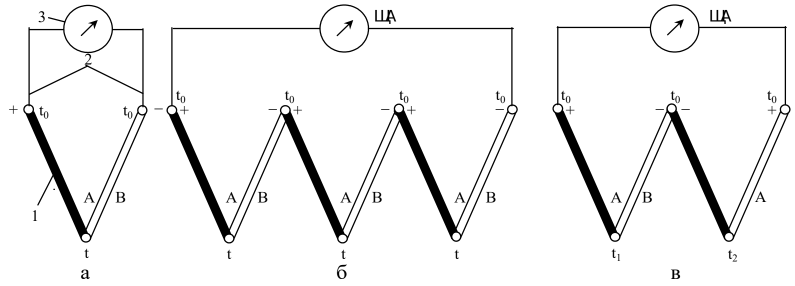

Figure 4. Thermoelectric chains: a-connecting a thermometer to a measuring instrument; B-thermobatarea; v-differential thermometer; 1-thermopara; 2-connecting cable; 3-measuring instrument

Conclusion:

A deferential thermoelectric thermometer is used to measure the temperature difference between two points. It is composed of two oppositely connected identical thermometers (Figure 4, v). If the temperature of the points being measured is equal, then the Teyuks that form a thermometer at those points are also equal. In this case, the current in the thermometer circuit will be zero, since when connected opposite, the EDF of one thermopar is balanced by the EDF of another thermopar, and the measuring instrument indicates zero [3,4]. If t1 and t2 have different temperatures, then depending on which temperature is higher, the chain electric current proportional to the difference in temperatures will correspond to the direction in question, as indicated by the measuring instrument [4].

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