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EXPERIMENTAL DETERMINATION OF HEAT TRANSFER COEFFICIENT UNDER FREE CONVECTION IN AN UNBOUNDED SPACE

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Abstract. This article deals with the Experimental determination of heat transfer coefficient under free convection in an unbounded space. Experiments were performed with different types of resistors when changing power, the heat transfer coefficient is calculated. On the basis of the work dependences of temperature of the resistor from power, the heat transfer coefficient from power are revealed, the interpolation polynomial equation is received.

1 Introduction

The electric scheme of almost any modern device has the heat allocating elements. Thermal control components of technical equipment such as power transformers [1], electro contact connections [2], semiconductor devices [3] is a critical task in maintenance of the set level of reliability [4]. As the object of research was chosen the typical element of electronic schemes - the resistor. The characteristics of the resistor are the value of nominal resistance and power, which shows how much energy it is able to dissipate without overheating [5,6]. In addition, it's necessary to provide that the thermal effects on the fuel element located near the device absent or minimized.

The purpose of the work is the experimental determination of the heat transfer coefficient of a typical fuel element in the conditions of free convection.

2 Scheme of installation and experiment

Researches of the thermal mode were conducted with use of the modern Testo-885 thermal imager having the following characteristics:

- Temperature sensitivity – less than 30 mK;
- Infrared resolution – 320 x 240 pixels.

The scheme of experiment is submitted in fig. 1. Determination of heat transfer coefficient was carried out with the presence of the radiator (fig. 1b) and without radiator (fig. 1a). To reduce the thermal resistance between the radiator and resistors was used heat-conducting paste ALSI-3.

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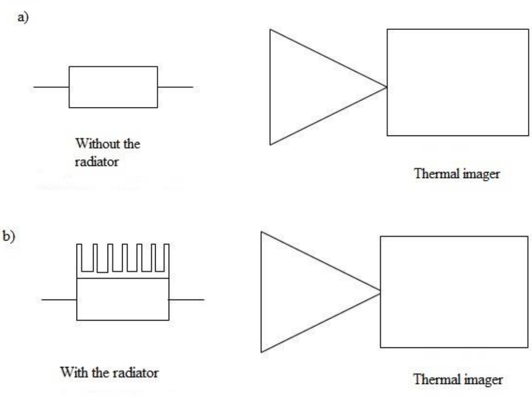

Fig. 1. Schematic image of experimental installation: a) the resistor without radiator; b) the resistor with a radiator.

Processing of thermograms it was carried out in the specialized software Testo. The essence of experiment is to determine the heat transfer coefficient of the resistor with a power limit of 10 watts. Heating of the resistor was due to increased resistance in the electrical circuit to which it was connected.

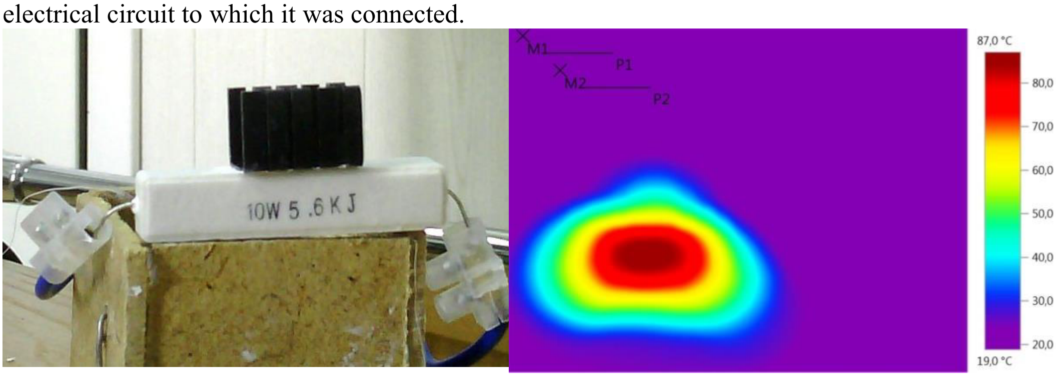

Fig. 2. The resistor with the radiator and temperature field at a power value of 8 watts.

For obtaining more exact values on the resistor by means of paste which reduces thermal resistance was placed the radiator prototype. The radiator was necessary for us for providing temperature condition.

As the main characteristic of the resistor is power, it was decided to check the values of temperature which will produce the resistor depending on the power change.

The mathematical formulation of the problem. Calculation of heat transfer coefficient was carried out according to the following expression [4]:

$$\alpha_\kappa = (1.42 - 1.4 \cdot 10^{-3} t_m) \cdot N \cdot \left(\frac{t - t_c}{L}\right)^{\frac{1}{4}} \quad (1)$$

where: N - coefficient considering orientation of a surface in space; L - defining size; tm - average temperature; t - case temperature; tc - ambient temperature;

The power in the electrical circuit was calculated as:

$$P = U \cdot I \quad (2)$$

where: I - amperage; U - voltage.

The power in the electrical circuit was measured by an ampermeter and the voltage was measured by a voltmeter connected in parallel to the resistor. Graphic temperature dependence of the resistor on the power is shown in figure 3.

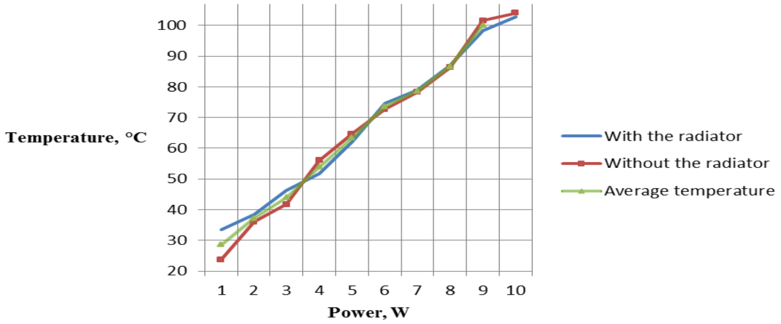

Fig. 3. Experimental dependence of temperature on power of the heat allocating element.

Value of coefficient of a thermolysis depends on the defining size, and the disseminating stream. For the average temperature values using Matlab program was obtained interpolating polynomial:

$$y = p_1 \cdot x + p_2 \tag{3}$$

Polynomial coefficients: p1=8.5439; p2=19.9443. The norm of discrepancy is 5.1644.

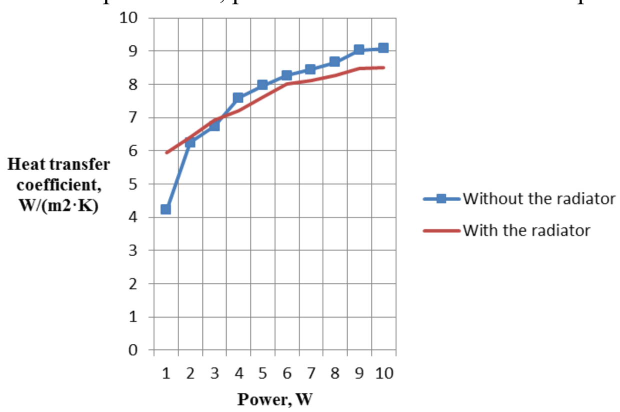

Figure 4. The dependence of the heat transfer coefficient of the resistor to the power side of the unit heatallocating element.

3 Conclusion

Experimental research has shown that the heat transfer coefficient for the resistor without the radiator is more than for the resistor with the radiator. These values can be explained by the fact that the thermal energy of the resistor without the radiator is dispersed directly in space and not wasted on heating of the radiator. On the other hand, in the conditions of free convection use of a radiator allows to lower thermal loading of an element.

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