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CALCULATION OF SURFACE TEMPERATURE DEFECTIVE CONTACT CONNECTIONS TO THE VALUE OF HEAT FLUX

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The summary

Calculation of electrical contact connections defects surface temperature was made taking into account glance heat flow.

Thermal imaging diagnostics provides a variety of technical state control and detection of various faults and defects of current-carrying elements including electric vehicles. This inspection of electrical contact connections under stress can detect defects at an early stage of their development.

Thermal imaging equipment, recording overheating inspected facility to 0,1 ° C reveals defects in electrical contact connections currents 2-5% of nominal. National experts recommended to perform obtained by examining the value of the normalized excess temperature, which is regulated by the current regulations[1].

Evaluation of the thermal state of bolted contact connections with load current (0.6 ... 1.0) Inom is recommended by the formula:

$$\Delta\theta_{ном} / \theta_{роб} = (I_{ном} / I_{роо})^2 \qquad (1.1)$$

where Δθnom, Δθrob- excess temperature at nominal operating current Inom and Irob load current contact connection.

When the load is within (0.3 ... 0.6) Inom to calculate the recommended value:

$$\Delta\theta_{0,5} / \Delta\theta_{роб} = (0{,}5 I_{ном} / I_{роо})^2 \qquad (1.2)$$

where Δθ0,5, Δθrob- excess temperature at a current 0,5Inom and working Irob load current [1] pin connection.

The value of the excess temperature is calculated as follow

$$\Delta\Theta = (\Theta_n - \Theta_0) \qquad (1.3)$$

where, - surface temperature compound and an arbitrary current environment. Assume that the measurements are carried out at a current I1, at ambient temperature. This power dissipation P1 can be written as a formula:

$$P_1 = I_1^2 R_1 = I_1^{\,2} \rho_1 \Gamma \qquad (1.4)$$

where - the electrical resistivity of the material connection details at measurement; D. parameter associated with the shape of the object and is independent of temperature measurement; I1- measured current.

In conditions of thermal equilibrium, the power P1 released, the object is given in the form of heat flow, thus taking into account (1.4) we can write:

$$P_1 = I_1^{\,2} R_1 = I_1^{\,2} \rho_1 \Gamma = Q_1 = \alpha_1 S \Delta\Theta_1 = \alpha_1 S (\Theta_1 - \Theta_0) \qquad (1.5)$$

where a1 - the total heat transfer coefficient; S- surface area of the object; - The surface temperature of an object at a current I1; - Ambient temperature; αt, αv, αk - coefficient of heat transfer (heat conduction, radiation, convection).

Finally:

$$P_1 = \alpha_1 S(\Theta_1 - \Theta_0) = \alpha_1 S \Delta\Theta_1 \qquad (1.6)$$

For the nominal load P2, for example 100%, with reduced temperature can be written:

$$P_2 = \alpha_2 S(\Theta_2 - \Theta_{np}) = \alpha_2 S \Delta\Theta_2 \qquad (1.7)$$

where α2 - overall heat transfer coefficient

$$\alpha_2 = \alpha_{2T} + \alpha_{2B} + \alpha_{2K} \qquad (1.8)$$

On the basis of the relations (1.4) - (1.8) can be estimated excess temperature extended object (wire) without cooling by heat conduction along the length of the metal:

$$\rho_1 I_1^2 / \rho_2 I_2^2 = \alpha_1 \Delta\Theta_1 / \alpha_2 \Delta\Theta_2 \qquad (1.9)$$

Considering that the resistivity of the metal in the study area and the heat does not depend on the temperature, you can get in the recommended regulations [1] expression:

$$I_1^2 / I_2^2 = \Delta\Theta_1 / \Delta\Theta_2 \qquad (1.10)$$

Neglecting heat transfer coefficient change, but given the dependence ρ () for defective pin connection, you can use the formula:

$$\rho_1 I_1^2 / \rho_2 I_2^2 = \Delta\Theta_1 / \Delta\Theta_2 \qquad (1.11)$$

In contrast to the simplified expression (1.10), the relation (1.11) takes into account the change in value of resistivity on temperature, which leads to an increase in the estimated value of the excess temperature.

Conclusion

The possibilities for remote estimation of heat flows allow you to develop algorithms that will be used to increase the likelihood of diagnosing by increasing the number of diagnostic parameters not previously taken into account, and that enhance the objectivity of peer review at diagnosis.

Using the value of the heat flux in the diagnosis allows you to move from empirical expert advice to develop evidence-based proposals during the energy audit.

References

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