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Methodology for determining heating mode parameters in electrotechnology of machine parts dismantling

Cylindrical steel connections of machine parts (bushings to a shaft) made with an interference fit are widely used in machine-building and mining. While repairing and testing machines it is necessary to perform dismantling. Connections dismantling realized by means of the axial loads using removers accompanied with damage surfaces as emerging surface scratches. Heating details connections permit avoiding undesirable consequences. At the same time connections heating modes that lead to interference liquidation and conditions necessary to dismantle the site are not studied enough. Lack of theoretically substantiated mode parameters results in practical use of induction heating systems with unsuccessful constructive decisions and relatively low technical and economic factors.

The choice of P_0 level significantly influences the thermal process character [1]. It is proposed to set the value of P_0 to provide the required level of ΔT_T in transient heating mode [2]. The value of P_0 is received from the formula

$$P_0 = \alpha_в \cdot \Delta T_T \cdot \frac{R_2}{R_1}, \qquad (1)$$

where R_1 and R_2 are external and internal bushing radii.

Contact thermal conductivity between the bushing and shaft $\alpha_в$ is defined experimentally identifying its value directly on the object to be dismantled. During low-temperature stationary heating measurements are made on the lateral surface of internal $T_н$ and external $T_в$ temperatures of its surfaces (Figure 1).

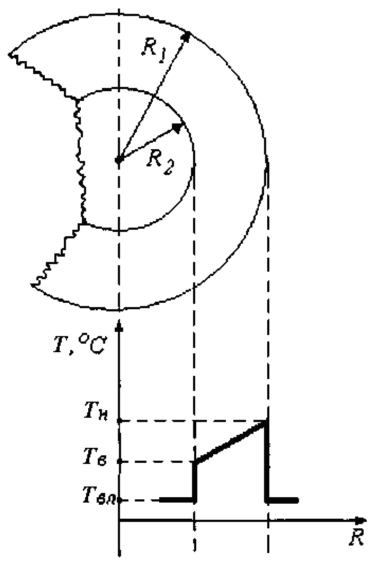

Figure 1. The Characteristic of Temperature in a Stationary Connection Heating Mode

The value of $\alpha_в$ is received from the formula

$$\alpha_в = \frac{(T_н - T_в)\lambda_{ст}}{(T_в - T_{вл})(R_1 - R_2)}, \qquad (2)$$

where λ_{cm} is the factor of thermal conductivity of steel.

When choosing the current frequency of induction installation it is offered to use inequalities

$$X_n \le \Delta_в;\ \Delta_e \le \Delta_в / 1.68, \qquad (3)$$

where $\Delta_в$ is bushing thickness; Δ_e is the depth of penetration of electromagnetic waves, calculated on the basis of the value of μ on the bushing surface (μ_e).To limit mode $\Delta_e = \Delta_в / 1.68$ “deep” bushing heating is typical. This mode corresponds to the lower recommended value of inductor current frequency $f_н$. Figure 2 shows the dependence $f_н(P_0)$.

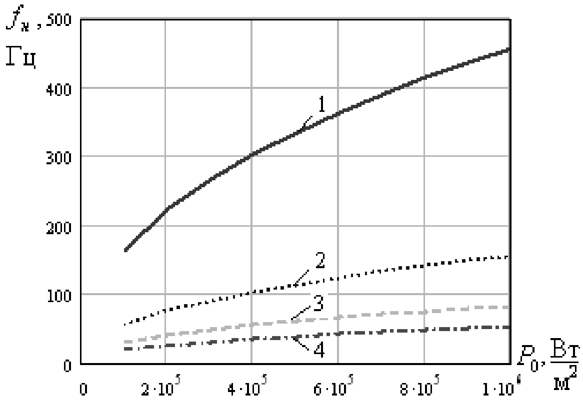

Figure 2. $f_н(P_0)$ Dependencies: 1 – $\Delta_в$ = 0,005 m; 2 – $\Delta_в$ = 0,01 m; 3 – $\Delta_в$ = 0,015 m; 4 – $\Delta_в$ = 0,02 m.

Figure 2 shows that at the bushing thickness being less than 2 cm it is possible to carry out heating with the industrial current frequency of 50 Hz. Under lower thickness values and also under size restrictions in design it is reasonable to use high frequencies (kHz).

The developed mathematical model focuses on determining the mode parameters that guarantee temperature conditions for connection dismantling and improve technical and economic factors of induction installations (reducing mass, size, and cost). If the method is available the savings for one installation purchasing is several thousand dollars.

References

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2. Dreshpak, N.S. 2009. *Induction heating modes of cylindrical details connected with interference fit*. Technical Electrodynamics. Kyiv: National Academy of Sciences of Ukraine.Edition 6: 61–66.