УДК 621.313

**COMPARATIVE STUDY OF THEORETICAL AND EXPERIMENTAL VALUES ​​OF THE RESISTANCE OF THE CONTACT CONNECTIONS OF LOW-VOLTAGE SWITCHING DEVICES**

MUSINA A.M., KSPEU, Kazan

Scientific adviser Doctor of technical science, a professor GRACHEVA Y.I.

*Knowing the resistance of contact joints, one can increase their reliability by choosing a material that meets the specified requirements. One of the methods for determining the resistance of the contact connections of low-voltage apparatuses is to study the dependence of the resistance on the rated current through the power loss to the apparatus pole.*

*Keywords: switching devices, power loss, circuit breakers, magnetic start-up contactors, ammeter-voltmeter method, switch.*

One of the factors that determine the failure-free operation of consumers and systems of internal power supply is the reliable operation of the contacts of low-voltage switching devices [1]. Knowing the resistance of contact joints [3], one can increase their reliability by choosing a material that meets the specified requirements.

One of the methods for determining the resistance of the contact connections of low-voltage apparatuses is to study the dependence of the resistance on the rated current through the power loss to the apparatus pole. The power loss per pole ∆P can be determined from catalog data, as a result of the analysis of which we establish that the dependence of these losses on the rated current for automatic circuit breakers of the BA-57 series can be described by the expression

∆*P*pot av (*I*n) = 8,34  + 0,194*I*n, (3.5)

and for contactors of the KTI series with an approximating function of the form

∆*P*pot cont (*I*n) = 1,698 + 0,068*I*n. (3.6)

Using catalog data, we construct a graph of the resistance of the contact connections of circuit breakers of the VA series to the nominal current - curve Rpot. Av (In) (fig. 1) and for contactors of the series KTI - curve Rpot cont (In) (fig. 2).

Fig. 1. Dependencies of resistances of contact connections from rated current for circuit breakers VA

2

4

6

8

*R*rach av(*I*n)

200

100

300

0

*R*ex av(*I*n)

*R*, мОм

*I*nom, А

400

*R*pot av(*I*n)

*R*spr av(*I*n)

Fig. 2. Graphs of dependencies of the resistance of contact connections on the rated current for contactors KTI

2

4

6

8

*R*rach cont(*I*n)

200

100

300

0

*R*pot cont(*I*n)

*R*, mОм

*I*nom, А

400

*R*ex cont(*I*n)

*R*spr cont(*I*n)

Curves Rexp.av (In) in fig. 1 and Rеksp.kont (In) in Fig. 2 are experimentally found analytical dependencies of the resistances of circuit breakers and contactors on the rated current:

*I*n < 60 A, then ; *I*n ≥ 60 A, then ,

and the curve Rexp.mp (In) in fig. 3 illustrates the analytical dependence of the resistance of magnetic starters on the rated current [247]:

*I*n < 70 A, then ; *I*n ≥ 70 A, then .

Fig. 3. Plots of dependencies of the resistance of contact connections on the rated current for magnetic starters PML series

2

4

6

8

*R*rach m p(*I*n)

200

100

300

0

*R*, mОм

400

*R*ex m p(*I*n)

*I*nom, А

Next, we determine the resistance of the contact connections and the temperature of the contact pads of the devices by the calculation method [2].

 . (3.8)

. (3.9)

The results of the calculations and the types of approximating functions are presented in Table 1 and 2.

Table 1. The approximating functions of the dependences of the contact resistances on the rated current

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  |  | | --- | --- | | Apparatus |  | | Rated current *I*н, А | Approximation function |
| Circuit breakers BA series | 1 ÷ 80 | *R*rach av(*I*n) = 85,007· |
| 80 ÷ 400 | *R*rach av (*I*n) = 3,248· |
| 1 ÷ 400 | *R*pot av(*I*n) = 9,219· |
| 1 ÷ 400 | *R*spr av(*I*n) = 28,39· |
| Contactors KTI series | 1 ÷ 400 | *R*rach cont(*I*n) = 9,486· |
| 1 ÷ 400 | *R*potc ont(*I*n) = 10,628· |
| 1 ÷ 200 | *R*spr cont (*I*n) = 10,439· |
| 200 ÷ 400 | *R*spr cont(*I*n) = 1,067· |
| Magnetic starters  PML series | 1 ÷ 400 | *R*rach m p(*I*n) = 16,531· |

Table 2. The results of the calculation of the technical characteristics of the contacts of circuit breakers, contactors and magnetic starters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Apparatus | Rated current  *I*н, А | Contact sizes, мм | Pads temperature  , °С | Contact resistance,т*R*к,  mОм |
| Circuit breaker  BA-57-35 | 16 | *а* = 4,*b* = 6 | 40,3 | 39 |
| Circuit breaker | 80 | *а* = 4,*b* = 8 | 45,2 | 1,755 |
| Circuit breaker  BA-57-39 | 400 | *а*= 9,5*b* = 9 | 75,2 | 0,349 |
| Contactor  KTI 5265 | 250 | *а* = 20  *b* = 10 | 43,3 | 0,746 |
| Contactor KTI 6400 | 400 | *а* = 20  *b* = 17 | 44 | 0,414 |
| Magnetic switch  PME 211 | 25 | *r* = 4 | 40,3 | 26 |
| Magnetic switch  PA 312 | 40 | *а* = 8,1  *b* = 8,1 | 40,5 | 13 |
| Magnetic switch  PA 14 | 60 | *а* = 12  *b* = 12 | 40,3 | 11 |

To assess the accuracy of the approximating functions describing the dependences of the resistances of the contact connections of low-voltage apparatus using various methods (Table 1), we will calculate the standard deviation of the approximating functions from the experimental values by expression

.

The results of the calculations are presented in Table 3.

Table 3. Estimation of accuracy of approximating functions

|  |  |  |
| --- | --- | --- |
| Apparatus | Type of addiction | Standard Deviation S |
| Circuit breakers | Calculated Rrach (In)  Supplemental Rspr (In)  By power loss Rpot (In) | 1,997  1,215  3,323 |
| Contactors | Calculated Rrach (In)  Supplemental Rspr (In)  By power loss Rpot (In) | 1,787  2,168  5,608 |
| Magnetic starters | Calculated Rrach (In) | 0,565 |

Thus, as a result of the research, the possible accuracy and scope of some methods for estimating the resistances of contact connections of low-voltage apparatuses depending on from the available source information.

The literature

1. Elektricheskiye sistemy i seti / N.B. Buslova, V.N. Vinoslavskii, T.I. Denisenko. – Kiyev: Vishcha shkola, 1986 [Electrical systems and networks].
2. Gracheva Ye.I. Issledovaniye teplofizicheskikh protsessov v zamknutykh kontaktakh nizkovol'tnykh kommutatsionnykh apparatov / Ye.I. Gracheva, A.S. Lazarevich // Problemy energetiki. – 2004 [Investigation of thermophysical processes in closed contacts of low-voltage switching devices].
3. Shevchenko V.V. Opredeleniye poter' elektroenergii v tsekhovykh setyakh napryazheniyem do 1000 V / V.V. Shevchenko, Ye.I. Gracheva // Promyshlennaya energetika. – 2001 [Determination of electricity losses in shop networks with voltage up to 1000 V].