1. Gulschen KERIMZADE [1]

Azerbaijan State Oil and Industry University (1)
ORCID: 1.0000-0001-7042-0324

doi:10.15199/48.2024.06.49

Method for determining the overall dimensions of an induction control support

Abstract*. Measuring instruments, force transducers, control devices and various electromechanical equipment are characterized by high accuracy based on control induction supports. As in any electrical equipment, magnetic and copper losses are an undesirable factor, since this reduces the stability of the input-output characteristic and the quality factor, and increases errors. With known dimensions of magnetic conductivity and windings of the control induction winding, as well as physical and technical characteristics for known values of temperature rises, parameters can be calculated. In the presented work, expressions for size ratios are considered.*

Streszczenie. *Measuring instruments, force transducers, control devices and various electromechanical equipment are characterized by high accuracy based on control induction supports. As in any electrical equipment, magnetic and copper losses are an undesirable factor, since this reduces the stability of the input-output characteristic and the quality factor, and increases errors. With known dimensions of magnetic conductivity and windings of the control induction winding, as well as physical and technical characteristics for known values of temperature rises, parameters can be calculated. In the presented work, expressions for size ratios are considered.* (***Metoda wyznaczania wymiarów gabarytowych wspornika sterowania indukcyjnego***)

.
Key words: overall dimensions, methodology, definition, calculation, induction support, control, winding, stability, input-output characteristic, coefficient, quality, levitation element, control.
Słowa kluczowe: wymiary gabarytowe, metodologia, definicja, obliczenia, wspomaganie indukcyjne, sterowanie, uzwojenie, stabilność, charakterystyka wejścia-wyjścia, współczynnik, jakość, element lewitacyjny, sterowanie.

Introduction

The formulation of the problem taking into account the minimization of losses is associated with difficulties in determining mathematical expressions for losses. In this case, it is necessary to take into account the relationships between the parameters of the windings, magnetic circuit and temperature. In these relationships, both active and reactive magnetic resistances of copper sections are taken into account. With a stepped design of the magnetic circuit of the control support, in mathematical expressions the coefficient of the socket where the field winding is located is $n_c=c'/c$, and the ratio of the height of the windings is $k_{12}=h_1/h_2$. The overall dimensions of the control support A, B, H depend on these ratios. To take into account the restrictions imposed on overall dimensions, it is necessary to take into account the range of changes in the coefficients n_c, k_{12}. Losses also depend on the coefficients n_c, k_{12}. Therefore, to minimize losses, it is necessary to solve the problems of determining the ratio of overall dimensions, the range of changes in magnetic conductivity and dimensions, the dependence of losses on dimensions, the dependence of copper losses in windings on winding dimensions and temperature rises [8-16].

The overall dimensions A, B, H of control supports for various purposes are subject to certain restrictions, which are determined by the size of the gaps for the placement of these devices. Overall dimensions A, B, H depend on the dimensions of the magnetic circuit, the geometric dimensions of the excitation winding and the levitation element [7-10].

The dimensions of the magnetic circuit a, b, c, H_c depend on the induction in the B_M core, the condition of uniformity of the magnetic field of the working air gap $m_a=2\div6$, $m_c=2\div6$,the dimensions of the excitation winding ($h_1 \cdot c_1$), the dimensions of the levitation element ($h_2 \cdot c_2$) and the progress of the x_p. The working stroke x_p, for windings exceeding permissible temperatures ($\tau_1 \cdot \tau_2$) are specified. The dimensions of the windings must satisfy the specified temperature exceedings, restrictions on overall dimensions and working stroke. Based on the research carried out, depending on the purpose of the devices, the ratios of overall dimensions can be in three options [2-6].

Statement and solution of the problem..

Option 1. The height of the induction levitator H is much greater than the width A, H/A>>1. In this case, A/B>1. As a result, for the dimensions of the field winding socket we have the following ratios: h/c>>1 and c′/c>1. For this reason, for the levitation element: $h_2/c_2>>1$. This ratio must correspond to maintaining a constant cross section of the levitation element $S_{02}=h_2 \cdot c_2$, since the specified temperature rise τ_2 depends on the ampere turns F_2, current density j_2 and cross section S_{02}.

Option 1. $\frac{H}{A} >> 1\ ; \frac{A}{B} > 1; \frac{h}{c'} >> 1; \frac{c'}{c} > 1; \frac{h_2}{c_2} >> 1$

Similarly for the other two options:

Option 2. $\frac{H}{A} < 1\ ; \frac{A}{B} > 1; \frac{h}{c'} << 1; \frac{c'}{c} >> 1; \frac{h_2}{c_2} >> 1$

Option 3. $\frac{H}{A} \geq 1\ ; \frac{A}{B} > 1; \frac{h}{c'} \geq 1; \frac{c'}{c} > 1; \frac{h_2}{c_2} > 1$

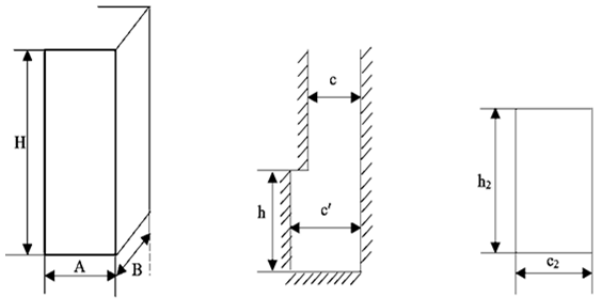

Fig. 1. Size ratio diagrams (for option 1).

For option 1, the dimensional relationships mainly relate to the measurement of the static force P_x, which exerts an external influence on the levitation element in the vertical direction, or to tracking systems and force transducers used for control. For option 2, the size ratios refer to actuators, control supports, and other equipment. The size ratios for option 3 belong to current stabilizers, traction regulators and other devices.

Overall dimensions depend on the socket coefficient $n_c = c'/c$, where the excitation winding is located. For a non-stepped magnetic circuit $c'=c$ and $n_c = 1$. In this case, the height of the magnetic circuit is large H. Therefore, the overall dimensions depend on the coefficients m_a, m_c, n_c, k_{12}, n_{e1}, n_{e2}. Figure 1 shows size ratio diagrams for option 1. Overall dimensions through the indicated coefficients can be expressed as [1,17-19]:

(1) $$A = 4a + 2c' = c\left(n_c + 4\frac{m_c}{m_a}\right)$$

(2) $$B = b + 2c' = c\left(m_c + 2\frac{n_c}{n_{01}}\right) + 4\Delta_k$$

(3) $$H = h_1 + h_2 + 2a + x_p = x_p + 2c\frac{m_c}{m_a} + c \cdot n_{e1}\left(1 - n_{01} + n_c + \frac{n_{e2}}{n_{e1} n_{02}}\right)$$

where

(4) $$a = c\frac{m_c}{m_a}; \frac{n_{e2}}{n_{e1}} = \frac{n_{01}}{k_{12} n_c n_{02}} \approx \frac{1}{k_{12} \cdot n_c}$$

(5) $$n_{01} = \frac{c}{c_1} = \frac{c_1 + 2\Delta_k}{c_1} \approx 0.1;$$

$$n_{02} = n_{01} = \frac{c}{c_2} = \frac{c_2 + 2\Delta_0}{c_2} \approx 0.1$$

(6) $$h_1 + h_2 = c \cdot n_{e1}\left(n_c - \frac{2\Delta_k}{c} + \frac{n_{e2}}{n_{e1} n_{02}}\right);$$

$$\frac{2\Delta_k}{c} = n_{01} - 1$$

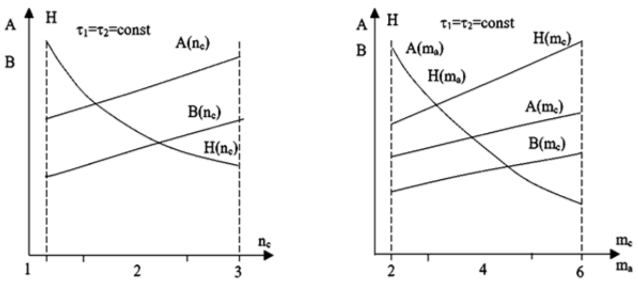

Fig. 2. Dependences of overall dimensions on coefficients n_c, m_a, m_c.

As can be seen from expressions (1) – (6), to reduce the overall dimensions A, B, H, it is necessary to reduce the working air gap c and the coefficient m_c. As the coefficient n_c increases, the overall dimensions A and B increase. With the coefficient m_a increasing, the overall dimensions A and H decrease. Therefore, to eliminate the excess height H of the levitator, it is necessary to increase the coefficient n_c and reduce the levitation constant n_{e2} (Fig.2) [1,19-22].

Conclusions

To take into account the range of changes in the coefficients n_c, k_{12}, it is necessary to take into account the restrictions on overall dimensions. Losses also depend on the specified coefficients, therefore, to minimize losses, it is necessary to solve problems such as:
- determining the ratio of overall dimensions,
- the range of changes in specific magnetic conductivity and dimensions,
- as well as the dependence of losses in windings on dimensions, magnetic conductivity and temperature rises.

Authors. *Kerimzade Gulschen Sanan. Associate Professor of the Department of Electromechanics of the Azerbaijan State University of Oil and Industry. Baku city, Azadlyg avenue 34,*
E-mail: gulschen98@mail.ru

REFERENCES

[1] G.S.Kerimzade, "Calculation of parameters of control induction support". Przeglad Elektrotechniczny.E**–ISSN 2449-9544. ///../2024.pp. .Warszawa.** DOI:10.15199/48.2023.06.412023
[2] Y.R. Abdullayev, N.M. Piriyeva, O.O. Kerimzade, "Calculation of excitation winding of the stepped inductional levitator", 11th International Conference on "Texnical and Phycsial Problems f Electrical Engineering". Bucharest, Romania, 10-12 September, 2015.
[3] Y.R.Abdullayev, G.S.Kerimzade, G.V.Mammadova, N.M. Piriyeva, "Design of electric devices with induction levitation elements", Russian Electrical Engineering, 2015, № 86(5), pp. 252–257.
[4] Y.R.Abdullaev, G.S.Kerimzade "Design of electric devices with LE".Moscow."Electrical engineering", № 5, pp.16-22, 2015.
[5] Y.R.Abdullayev, G.S.Kerimzade, G.V.Mammadova, N.M.Piriye va "Design issues of electromechanical converters with levitation elements", Elektromekhanika Scientific and Technical Journal, Volume 61, № 2. pp. 47-52, Moscow, Russia, 2018.
[6] G.S.Kerimzade, G.V.Mamedova, "Working modes for designing electrical apparatuses with induction levitation elements", Bulletin Buildings, Baku, volume17, № 1, pp.42-46. 2015.
[7] G.S. Kerimzade, G.V. Mamedova, "Analysis of the parameters of electric devices with levitational elements", News of universities Instrumentation, Sankt Peterburq, № 12, volume 61, pp.67-71, 2018
[8] G.S.Kerimzade "Analytical connections of the parameters and sizes of the presizion stabilizer of alternating current using the effect of inducial levitation", International Journal on technical and Physical Problems of Engineering" (IJTPE). September. 2022. Number 3. pp.175-184.
[9] G.S. Kerimzade, "Analysis of the methodology for calculation current stabilizer with induction levitation", International Journal on technical and Physical Problems of Engineering" (IJTPE) December. 2022. Number 4.pp. 170-174.
[10]G.S. Kerimzade, "Analytical expressions of the relationship to the calculation of the AC stabilizer with induction levitation", International Journal on technical and Physical Problems of Engineering"(IJTPE).March. 2023.Number1.(in print edition).
[11]G.V.Mamedova, G.S.Kerimzade, N.M.Piriyeva Electromagnetic calculation of tension devices for winding wires of small cross sections. International Journal on technical and Physical Problems of Engineering" (IJTPE). December. 2022. Number 4. pp. 80-85.
[12] G.S. Kerimzade, "Indicators of parametrs when designing elec trical apparatus with levitation elements". News of Azerbaijan High Technical Edicational Institutions. Volume 24. ISSUE 1 (135).2022. ISSN: 1609-1620. pp.39 – 43.
[13] G.S.Kerimzade " Features of calculating a precision alternating current stabilizer with induction levitation".-" Innovative scientific research"-"Vestnik nauki".Ufa. 2022.№9-1(21),pp.36- 60. URL : https://ip-journal.ru/

[14] G.S. Kerimzade, “Indicators of parametrs when designing elec trical apparatus with levitation elements”. News of Azerbaijan High Technical Edicational Institutions. Volume 24. ISSUE 1 (135).2022. ISSN: 1609-1620. pp.39 – 43.
[15] G.S.Kerimzade.”Features of methods for calculation of automa tic devices line speed and dimension control”.-International Center for Science and Education (ICSE) “Universum”- Techni cal science. Moscow, №10 (103).2022. volume 6, pp.28-32. ISSN: 2311-5122. DOI :10.32743/UniTech.2022.103.10.
[16] G.S.Kerimzade “Controlled high-precision current stabilizers with induction levitation of the moving part”.News of Azerbai jan Universities.Baku.2023.Volume 25.Number 2.pp.46-56. E-ISSN: 2674-5224, DOI:10.36962/PAHTEI
[17] N.M.Piriyeva, G.S.Kerimzade “Electromagnetic efficiency in induction levitators and ways to improve it“ Przeglad Elektro techniczny.E–ISSN 2449-9544.6 /2023.pp.204-207.Warszawa DOI:10.15199/48.2023.06.412023 .
[18] N.M.Piriyeva,G.S.Kerimzade “Methods for increasing electro magnetic efficiency in induction levitator “ Przeglad Elektrotech niczny.E–ISSN 2449-9544.10/2023.pp.192-195.Warszawa. DOI:10.15199/48.2023.06.412023 .
[19] Ya.R.Abdullaev,G.S.Kerimzade.“Electrical apparatus”.Tutorial. ASOIU.Baku. 2006.-143p.
[20] Ya.R.Abdullaev,G.S.Kerimzade.“Electrical and electronic appa ratus”.Tutorial. ASOIU.Baku.2019.-170p.
[21] G.S.Kerimzade, G.V.Mamedova. “Electromechanical devices with induction levitation”,part 1.Tutorial. Baku. ASOIU. 2023.-104p.
[22] Ya.R.Abdullaev,G.S.Kerimzade,G.V.Mamedova.“Electrical au-tomation control devices”. Tutorial. Baku. ASOIU.2012-260p.