

Magnetic field parameters mathematical modelling of wind-electric heater

Abstract. The paper presents the device and principle of operation of the developed and patented flow-through induction wind-electric heater. The development concerns the field of small wind-power industry. To substantiate the magnetic system's parameters of the wind-electric heater, a mockup of a gear magnetic system has been developed and the experimental studies' results of changes in electromagnetic values in the system's air gap are presented. As a consequence of solving the problems posed, a method for constructing multidimensional surfaces using the Lagrange polynomial with one variable was for the first time proposed for calculating electromagnetic quantities in an air gap of similar gear magnetic systems when constructing different powers of inductive converters of wind energy into thermal energy, as well as constructing response surfaces in multifactor experiments.

Streszczenie. W artykule omówiono urządzenie i zasadę działania opracowanego i opatentowanego przepływu indukcyjnego nagrzewnicy wiatrowo-elektrycznej. Aby uzasadnić parametry pracy systemu magnetycznego nagrzewnicy wiatrowo-elektrycznej, opracowano makietę układu magnetycznego przekładni i przedstawiono wyniki badań eksperymentalnych zmian wartości elektromagnetycznych w szczelinie powietrznej systemu. W wyniku analizy przedstawionego problemu, zaproponowano metodę konstruowania powierzchni wielowymiarowych w oparciu o wielomian Lagrange'a z jedną zmienną. Metoda ta została po raz pierwszy zaproponowana do obliczania parametrów elektromagnetycznych w szczelinie powietrznej podobnych przekładni magnetycznych. Przedstawiona metoda może być stosowana przy konstruowaniu systemów różnej mocy indukcyjnych przetworników energii wiatrowej na energię cieplną. Metoda ta może być również zastosowana do utworzenia wielowymiarowej płaszczyzny odpowiedzi. (*Modelowanie matematyczne parametrów pola magnetycznego nagrzewnicy wiatrowo-elektrycznej*).

Keywords: renewable energy sources, wind energy, wind power generation, energy conversion, inductive transducers, heating.

Słowa kluczowe: odnawialne źródła energii, energia wiatrowa, wytwarzanie energii wiatrowej, konwersja energii, przetworniki indukcyjne.

Introduction

The main purpose of the world policy when it comes to alternative energy sources is increase in production and consumption of energy produced by means of renewable energy sources, which would result with economical use of traditional fuel and energy resources [1-3].

Modern wind-power engineering is one of the most developed and promising renewable energy industries. Wind power is one of the fastest growing sources of renewable energy over the past decade, providing about 3% of global electricity consumption [4-6].

Agricultural production and small households are specific due to the relatively insignificant electricity consumption per unit of land area, this requires large scale development of small wind power engineering, wherein the used equipment, based on the technical conditions for connection to power systems, is limited to a power of 20 kW. Research of the wind power equipment market shows that small consumers are of the intention to use wind turbines to satisfy their needs (for example, as power sources for industrial and domestic equipment, in hot and cold water systems, space heating, lighting, and charging of automotive and tractor batteries, etc.).

Research in the field of small wind-power engineering shows that the global market for this renewable energy industry is at an early stage of development. And, according to the forecasts of the World Wind Energy Association, the increase in the global sector of small wind-power engineering from 2015 will be about 125 MW per year. Manufacturers of devices for small wind-power engineering are concentrated in five countries (Canada, China, Germany, the UK and the USA) and occupy more than 50% of the global market [7].

Despite the great progress in the development of wind-power engineering in the world, serial production of small wind turbines electric, mechanical, mills, etc. has not yet been established. Among the factors of such a state, the following should be noted:

- insufficient state attention to the development of small wind-power engineering;
- lack of government incentives for producers and consumers of small wind equipment;
- significant shortage of specialists in the design and manufacture of wind turbines;
- insufficient advertising of the benefits of wind power engineering.

The relevance and prospects for the use in the world of non-high capacity wind turbines has increased due to the intensification of dacha (summer cottage) construction, the development of farms and a large number of consumers who are far from sources of electrical energy [7].

This creates a national economic problem of providing small consumers with various types of energy, reducing the consumption of electricity produced by traditional methods, etc. The solution of this problem is impossible without solving the corresponding scientific and technical problem, which is to develop, study, substantiate the parameters and modes of operation of the wind electromechanical devices for converting wind energy into electrical energy or directly into thermal energy.

The solution of this scientific and technical problem includes conducting experimental studies and building a mathematical model based on their results, modeling the technological process of converting wind energy into thermal energy using a scientific model, and a production check of the developed wind electromechanical heater.

This article presents some of the studies which include experimental studies of changes of electromagnetic values in the air gap of the magnetic system of a flow-through induction wind electromechanical heater (for heating water or antifreeze), and development of software product using algorithmic languages, which provides numerical analysis of a multifactorial experiment enabling to process the experimental data.

State analysis problem

Today many methods and devices designed to convert wind energy into thermal energy are known. In [8], investigated main problems of increasing the power generation of renewable energy sources in distributed power grids. Proposed ways to decide them by taking into account the supply of power balance, reliability operating of the power grid, and electric power quality.

Also known for wind and thermal installation [9], patented in the United States, which includes an electric heater, operation of which is based on the excitation of eddy currents. The vertical rotor of the electric heater is driven from the horizontal shaft of the wind turbine through a bevel gear located on the roof of the house building. The disadvantage of the famous wind and thermal installation [9] is its low reliability and negative impact on the wellbeing of residents, due to the location of the structure with a bevel gear on the roof of the house.

An induction method has been proposed for converting wind energy into heat energy, which favorably differs from the previously known ones and the installation for its implementation [10-14]. The latter are based on the excitation of eddy currents in magnetic circuits. As the drive engine, air wind turbine with a vertical axis [15] is used. The analysis of their work, determined and identified deficiencies, and also outlined the ways to eliminate dynamic loads between the magnetic cores of the induction converter converting wind energy to heat [16].

Mathematical methods are widely used to process experimental data in various fields of science, technology and economics. Today there are a large number of textbooks and monographs, which set out the methods and principles of using mathematics in the study of various processes and objects [17-19]. Many studies study the effect of one or more factors on a certain amount [20]. In the simplest case, when studying the influence of the "x" factor on the output "y" value, the dependence $f(x)$ is constructed using polynomials or splines [20]. This method is often used for processing single factor experiments [21]. Analytical solution of a similar problem with a sufficiently large amount of data is almost impossible, which predetermines the need to create programs using algorithmic languages or refer to program shells of the Matlab type. The article discusses the possibility of creating a software product that provides a numerical analysis of a multivariate experiment using a one dimensional Lagrange polynomial for processing experimental data obtained in the study of the magnetic induction wind electromechanical heater system, which was developed for use in hot water supply systems or household heating.

Study aims

The purpose of the research is to develop a method for constructing a multidimensional surface that changes electromagnetic values in the air gap of a gear magnetic system of an inductive converter of wind energy into thermal energy using the Lagrange polynomial with one variable, followed by statistical analysis of the method obtained.

To achieve the above, the following tasks were carried out:

- electromagnetic model of magnetic system of induction converter converting wind energy to heat energy was developed for experimental studies;
- experimental studies of changes in the magnetic flux in the air gap of the magnetic system when changing its size and position of teeth relative to each other were conducted;
- a program was developed; program which using the Lagrange polynomial allows calculating the value of a

function (magnetic flux) of several variables (air gap size and tooth movement) at an arbitrary point in the factor space;

- usefulness of the developed program, for the mathematical processing of experimental data when constructing response surfaces in multifactor experiments, was established.

State analysis problem

To study the magnetic system of the heater, a program and a method have been developed.

The program included:

1. Development of an electromagnetic system of magnetic induction converter converting wind energy to heat energy.
2. Study of dependence of the total magnetic flux pole division in the gap on the movement of the core teeth in relation to the teeth of the inductor for different values of the gap.
3. Development of a method and program allowing to calculate the value of the function of several variables at an arbitrary point within the factor area. Statistical analysis of the developed program.

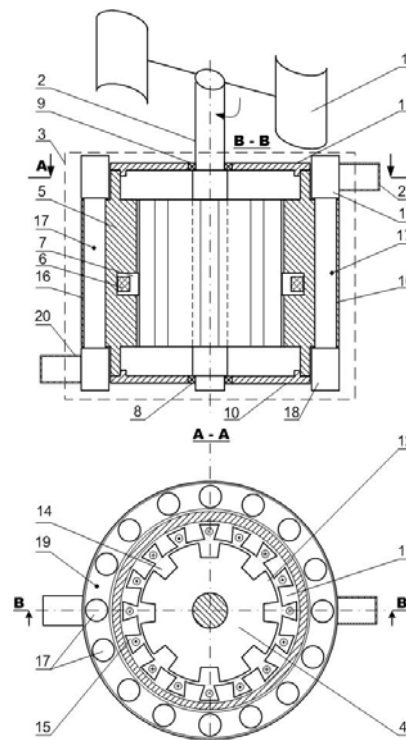


Fig.1. Flow-through coaxial wind electric heater

The device and the principle of operation of the wind electromechanical converter

In order to eliminate the dynamic loads on the magnetic cores and the foundation, it has been proposed that the fixed magnetic core should be manufactured with teeth arranged in a staggered manner, separated into equal areas [22,23] by a groove. If additional external excitation windings are installed on the external teeth of the fixed magnetic circuit, connected in parallel and connected through a rectifier to the annular excitation winding, then a wind-induced heat generator with self excitation [21], which differs significantly from a transverseflow permanent magnet disk generator generating wind energy, with simplicity of design and reliability is obtained.

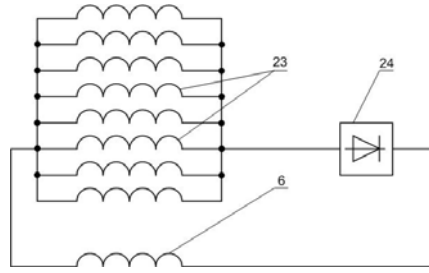


Fig. 2. Electrical circuit connection of the armature windings of the excitation induction converter (wind energy into heat)

Flow-through coaxial wind-electric heater (Fig. 1) consists of a wind turbine 1 with an output shaft 2 and an induction converter converting wind energy into thermal energy 3 in the form of a movable magnetic core 4 and a fixed magnetic core 5 of cylindrical shape [22]. Magnetic cores are located coaxially and have a jagged shape of adjacent surfaces. To create a magnetic field in the annular groove 7 of the fixed magnetic core 5, an annular excitation winding is laid 6. Bearings are mounted in bearing shields 10 and 11 of nonmagnetic material 8 and 9. On the adjacent surfaces of the magnetic cores 4 and 5 there are longitudinal teeth 12 and 13, which are created by longitudinal grooves 14 and 15. On the periphery of the fixed magnetic core 5 vertical holes 16 are made, in which cooling tubes 17, made of anticorrosion material, are placed. Tubes 17 tightly connected to the bottom 18 and top 19 tubular collectors of rectangular cross section with input 20 and outlet 21 branch pipes of cold and heated fluid (water). In grooves 15 fixed magnetic core 8 anchor coils 23 are located (Fig. 2), connected in parallel and to the field winding 6 through an adjusting rectifier 24.

The flow-through wind electromechanical heater works in the following way. Magnetic cores 4 and 5 are initially magnetized by an external power source via excitation winding 6. Further, the magnetic cores remain in a magnetized state due to residual magnetism. Due to wind power, shaft 2, wind turbine 1 and movable magnetic core 4 rotate. Teeth 12 and 13 of magnetic cores 4, 5 are magnetized by a magnetic field excitation in one direction simultaneously.

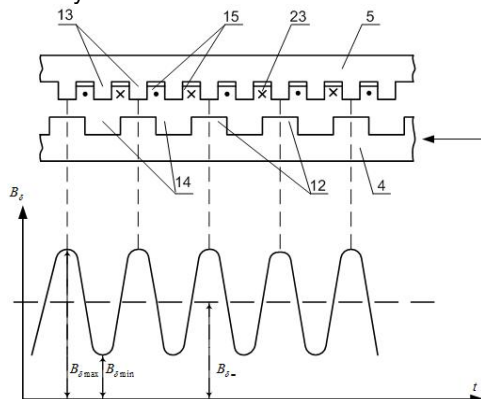


Fig. 3 Magnetic flux change Φ in the air gap of the induction transducer of wind energy to heat energy

Due to the gear structure of the adjacent surfaces of the magnetic cores 4 and 5 magnetic flux Φ , which closes through them, is distributed unevenly. Its highest value is observed in areas where tooth 12 of the magnetic circuit of magnetic core 4 is located against the tooth 13 of the stator's 5 magnetic circuit, the lowest is observed in the area where tooth 12 of magnetic circuit of magnetic core 4 is located against the groove 15 of stator's 5 magnetic circuit. In this case, between teeth 12 and 13 of the magnetic circuit air gap

size changes, which causes change of magnetic induction B . As a result, the distribution curve of the magnetic induction in the gap between the teeth 12 and 13 takes the form as shown in Fig. 3. Variable magnetic flux Φ between the teeth of the magnetic cores 4, 5 induces electromotive force in anchor windings 23. As a result, the total rectified current flowing through the adjusting rectifier 24 enters the excitation winding 6 and additionally magnetizes the magnetic cores 4, 5.

Fig. 3 shows that the maximum induction value $B_{\delta_{max}}$ is in a gap under tooth 13. With the rotation of the rolling magnetic core 4, when against tooth 12 the groove 15 of fixed magnetic core 5 is located, induction decreases to $B_{\delta_{min}}$. Thus, during the rotation of the rolling magnetic core 4, of wind turbine 1 related to shaft 2, the induction in the gap pulsates without changing its sign from $B_{\delta_{max}}$ to $B_{\delta_{min}}$. This can be presented as two components:

- variable, with amplitude

$$(1) \quad B_{\delta_{-}} = 0,5 \cdot (B_{\delta_{max}} - B_{\delta_{min}})$$

- and constant

$$(2) \quad B_{\delta_{+}} = 0,5 \cdot (B_{\delta_{max}} + B_{\delta_{min}})$$

The variable component of the magnetic field, induces, in magnetic cores 4, 5, electromotive force and eddy currents frequency $f = Z \cdot n$ (where Z and n – number of teeth and frequency of rotation of the rolling magnetic core 4), which, according to the law of Joule-Lenz, heats them. Fixed magnetic core 5 by convection transfers heat to cooling tubes 17 with flowing fluid (water), which can be used for space heating, washing dishes, for watering plants, or to fill a tank.

The constant component of the magnetic flux does not induce any electromotive force, therefore this part of the magnetic flux does not participate in the conversion of wind energy into heat. Manufacturing bearing shields 10 and 11 from a non-magnetic material turns off the possibility of shunting magnetic flux.

Experimental studies

To substantiate the parameters of the developed induction converter converting wind energy to heat energy, experimental studies have been carried out. Changes in the magnetic flux Φ and magnetic induction B in the core teeth at changing gap size were studied.

$$(3) \quad \delta_0 = \frac{\delta}{\tau}; b_{z0} = \frac{b_z}{\tau} = 0,5 \dots 1; h_{z0} = \frac{h_z}{\tau} = 0,3 \dots 1,5.$$

Where τ is a pole division.

For physical modeling, an electromagnetic model was used, removable magnetic plate sets with various teeth size were applied (Fig. 4).

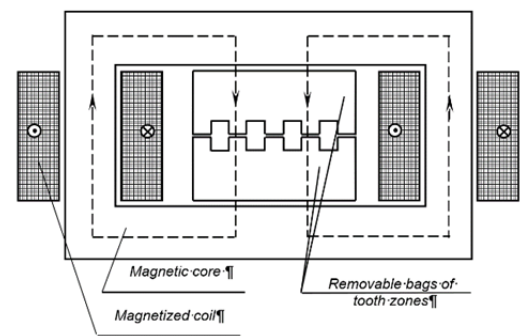


Fig. 4 Electromagnetic magnetic system layout

The air gap between the upper and lower packages can be changed from 0 to 10,5 mm, this corresponds δ_0 from 0 to 0.3. Studies were carried out for teeth of different sizes, characterized with the following ratios: $\delta_0 = \delta/\tau = 0.04...0.3$.

Magnetic flux Φ in the designated area was created by two coils through which the current flows. Induction in the air gap 2τ was determined by the ballistic method. During tests, teeth positions changed one to another changed in discrete steps. Induction measurement was performed for each position.

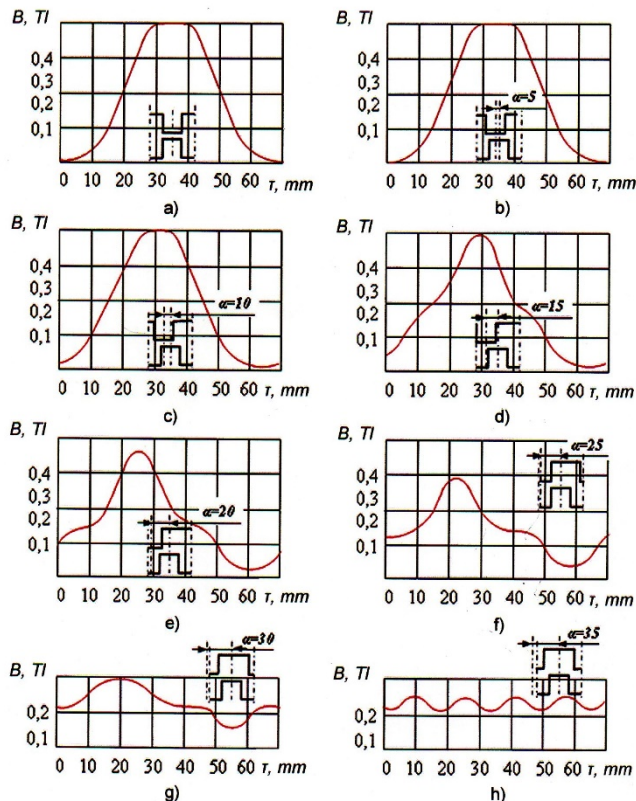


Fig. 5 Magnetic induction distribution B in the gap δ within pole division τ

Fig. 5 presents changes of magnetic induction B in the gap for eight positions of rectangular teeth of width $b_{z0} = 0,8$, height $h_{z0} = 1$, at the size of the gap $\delta_0 = 0,3$. Fig. 5 shows pulsation of the magnetic induction B in the gap from a maximum value $B_{max} = 0,5$ Tl (teeth of the magnetic cores are arranged against each other, Fig. 5, a), to a minimum value $B_{min} \approx 0,23$ Tl (teeth of the core is located against the groove of the inductor, Fig. 5, h).

Mathematical processing of the results

Mathematical analysis of the results of measurement of the magnetic flux in the gap was carried out. Direct conversion of wind energy to heat, being a result of eddy currents excitation in induction machine, was analysed.

The results of study over the influence of the size of the air gap δ in the magnetic system of an induction wind electric heater onto the change of the magnetic flux Φ , may be presented as table 1.

Table 1. Form of the experimental data for mathematical processing

Factor δ	δ_0	δ_1	δ_2	.....	δ_n
Output value Φ	Φ_0	Φ_1	Φ_2	.....	Φ_n

When it comes to more complicated case, the influence of several factors is studied, for example, the effect of the size of the air gap δ and the shift of the rotor teeth α versus

stator teeth in the magnetic system of the induction wind electric heater to the change in the magnetic flux Φ . In the first case, the regression equation, which determines the dependence of the magnetic flux Φ on the size of the gap δ , can be presented as one dimensional polynomial or splines. In the second case, these methods are absent. The development of appropriate techniques for this phenomenon analysis in order to observe processes in these magnetic circuits is indispensable. The results of the measurement of the total magnetic flux Φ in the gap δ during rotor movement in relation to stator are shown in Fig. 6 (curve 1).

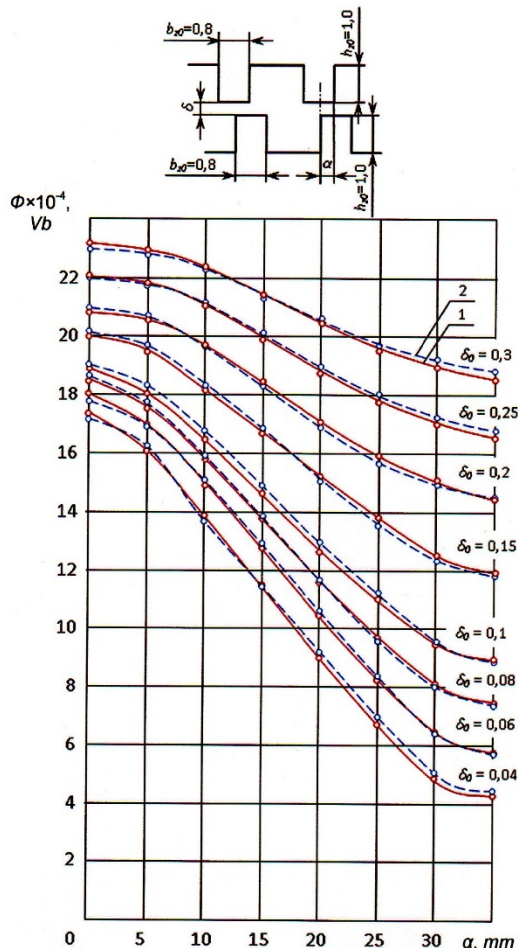


Fig. 6 The change in the magnetic flux Φ (curve 2) in the gap δ_0 , when the armature teeth move relative to the inductor teeth

One variable experiment

Let the results of the influence of some factor x on the output value y be presented in a form of table 1. The regression equation, which determines the dependence between y and x , can be obtained in the form of a polynomial of the n -th degree, for which one of the two requirements is met:

- a polynomial must accurately pass through the points with coordinates $(x_0, y_0), (x_1, y_1), \dots, (x_n, y_n)$,
- the polynomial smoothes outliers of individual points and should be as close as possible in the vicinity of points $(x_0, y_0), (x_1, y_1), \dots, (x_n, y_n)$.

The second case relates to the problems of approximation. It is used for relatively large experimental errors. The regression equation $f(x)$ is sought as a combination of elementary functions with unknown parameters $a_0, a_1, a_2, \dots, a_m$ or in the form of a m -th degree polynomial:

$$(4) \quad f(x) = a_0 + a_1x + a_2x^2 + \dots + a_mx^m$$

The sum of the squares of deviations of the experimental values of y_i from the values calculated using the regression equation can serve as a criterion of the least significant error:

$$(5) \quad s = \sum_{i=1}^n [y_i - f(x_i, a_0, a_1, a_2, \dots, a_m)]^2$$

In the first case, when experimental studies are carried out with sufficiently high accuracy, the regression equation is sought in the form of a polynomial (4), polynomials, splines, etc. Consider the possibility of representing the regression equation using the Lagrange polynomial. It is required for the coordinates of the nodes of the polynomial to be given in pairs of values from table. 1. Polynomial Lagrange takes the form [19]:

$$(6) \quad \mathcal{D}_n(x) = \sum_{k=0}^n y_k \prod_{\substack{j=0 \\ j \neq k}}^n \frac{(x - x_j)}{(x_k - x_j)}$$

$$(7) \quad \begin{aligned} \mathcal{D}_n(x) = & f(x_0) \frac{(x - x_1)(x - x_2) \dots (x - x_n)}{(x_0 - x_1)(x_0 - x_2) \dots (x_0 - x_n)} + \\ & + f(x_1) \frac{(x - x_0)(x - x_2) \dots (x - x_n)}{(x_1 - x_0)(x_1 - x_2) \dots (x_1 - x_n)} + \\ & + f(x_n) \frac{(x - x_0)(x - x_2) \dots (x - x_{n-1})}{(x_n - x_0)(x_n - x_2) \dots (x_n - x_{n-1})}. \end{aligned}$$

Table 2. The test results of the program Lagrange1 (x) Lagrange polynomial fifth degree for exponential function e^x

x	0,000	0,333	0,667
e^x	1,000000	1,395612	1,947734
$\mathcal{D}_5(x)$	1,000000	1,395679	1,947676
x	1,000	1,333	1,667
e^x	2,718282	3,793668	5,294490
$\mathcal{D}_5(x)$	2,718338	3,793604	5,294571

Calculations by the Lagrange formula (6) with fixed interpolation nodes are easy to program. To study the accuracy of interpolation by the Lagrange polynomial, a program Lagrange1 (x) has been developed in the algorithmic language C ++. The program was tested for the exponential function, e.g. in table 2 results are presented for the polynomial of the fifth degree within the range [0, 1.667].

Table 2 shows that the calculation inaccuracy is 10^{-5} . With an increase in the degree of the polynomial to 8, the relative error decreases to 10^{-17} .

Multifactorial experiment

The Lagrange polynomial in the case of interpolation of a function of two variables $f(x, y)$ takes the form [18]:

$$(8) \quad L(x) = \sum_{n=0}^N \sum_{m=0}^M f_{nm} l_{nm}(x, y)$$

$$l_{nm}(n, m) = 1$$

$$l_{nm}(x, y) = 0 \text{ at } x \neq n \vee y \neq m.$$

Basic polynomials are defined by the formula:

$$(9) \quad l_{nm}(x, y) = \prod_{\substack{i=0 \\ i \neq n}}^N \prod_{\substack{j=0 \\ j \neq m}}^M \frac{(x - x_i)(y - y_j)}{(x_n - x_i)(y_m - y_j)}$$

The maximum degree of the polynomial $L(x, y)$ is not greater than $n \times m$. By definition $L(x_n, y_m) = f(x_n, y_m)$. It is

assumed that the value of the function $f(x_n, y_m)$ at the nodal points x_n, y_m is known. Coordinate indexing x_n, y_m , where indices change in intervals $0 \leq m \leq M, 0 \leq n \leq N$, is presented in table. 3.

Table 3. Indexing the coordinates of nodal points in the Lagrange polynomial (8) with two variables

The left index refers to the factor x, right - to the factor y				
0, 0	0, 1	0, 2	.....	0, N
1, 0	1, 1	1, 2	.....	1, N
2, 0	2, 1	2, 2	.....	2, N
.....
M, 0	M, 1	M, 2	.....	M, N

Creating a program for constructing a polynomial (6) is not particularly difficult. However, the question of constructing a polynomial related to the number of factors greater than 2 remains open. A solution to this problem is as follows: a program has been developed, the developed program using the Lagrange polynomial with one variable (6), allows to calculate the value of the function of several variables at an arbitrary point of the factor space. The proposed method is implemented in the form of Lagrange1(x), Lagrange2(x, y) programs in C++ language.

Program Lagrange1(x) allows to calculate values of a one dimensional function by the formula (6). Lagrange1(x) test is discussed in clause 1 of this work "One variable experiment".

Lagrange2(x, y) program designed to calculate values of two dimensional function $f(x, y)$ at an arbitrary point of the factor space (x_u, y_u) . The calculation algorithm is as follows. The given points are spaced one from another as $x_m \leq x_u \leq x_{m+1}, y_n \leq y_u \leq y_{n+1}$. Lagrange1(x) program for building M one dimensional Lagrange polynomials $L_0(x), L_1(x), L_2(x), \dots, L_M(x)$ is activated. $L_0(x)$ is determined for fixed value y_0 , second $L_1(x)$ – for fixed value y_1 , and so on., last $L_M(x)$ – for fixed value y_M . Next values of polynomials are calculated, $L_i(x), 0 \leq i \leq M$, in point $x = x_u$, and one dimensional polynomial is created, $L(y)$ passing through node points $y_0, y_1, y_2, \dots, y_M$, where the function $f(x_u, y_u)$ equals, respectively, $L_0(x_u), L_1(x_u), L_2(x_u), \dots, L_M(x_u)$. When building $L(y)$, Lagrange1(x) program is used. Next, the value of $L(y)$ at point y_u is calculated. The result value is the value of the function $f(x_u, y_u)$.

The algorithm of data processing for two variables is as follows. In order to calculate values of $f(x, y, z)$ at an arbitrary point, coordinates (x_u, y_u, z_u) of which are spaced one from another as $x_m \leq x_u \leq x_{m+1}, y_n \leq y_u \leq y_{n+1}, z_k \leq z_u \leq z_{k+1}$, it is assumed that k value range is $0 \leq k \leq K$, the function $f(x, y, z)$ is set at all nodal points. Lagrange2(x, y) program activation results with building of $K + 1$ surfaces for fixed values $z_0, z_1, z_2, \dots, z_K$. Next, using the Lagrange1(z) program, one dimensional polynomial $L(z)$ is created, and its value at point z_u is calculated. The result value is the value of the function. $f(x_u, y_u, z_u)$.

Similarly, programs are created with a large number of variables.

The results of the experimental data processing on the study of the wind electric heater magnetic system.

Fig. 6 (curve 1) shows the experimentally determined dependance of magnetic flux Φ in the gap on the shift of rotor teeth α versus stator teeth and clearance values δ_0 . Dependency function $f(\alpha, \delta_0)$ was created using the Lagrange2(α, δ_0) program. As nodal points, the values of shifts with a step equal to 5 mm were taken: $\alpha_0 = 0, \alpha_1 = 5$ mm, $\alpha_2 = 10$ mm, ... $\alpha_7 = 30$ mm, wherein the clearance values are: $\delta_{00} = 0,04, \delta_{01} = 0,06, \delta_{02} = 0,08, \delta_{03} = 0,1, \delta_{04} = 0,15, \delta_{05} = 0,2, \delta_{06} = 0,25, \delta_{07} = 0,3$. The function values at the nodal points (α_m, α_n) were determined on the basis of

results of the experimental study (Fig. 6). The results of the calculations are presented in Fig. 6 (curve 2).

The results of the comparison of experimental and calculated data (Fig. 6) regarding the magnetic flux change Φ versus the size of air gap δ_0 and shift of the teeth α are highly correlated. Therefore, the proposed method of constructing a multidimensional surface using the Lagrange polynomial of one variable can be used to calculate gear magnetic systems of small wind electro heaters of different power.

Conclusions and prospects for further research

The conducted research allowed to formulate the following conclusions.

For the first time, a method for constructing a multidimensional surface using the one variable Lagrange polynomial was used.

Lagrange1(x) and Lagrange2(x, y) programs were developed using C++ language, this was done in order to calculate values of one variable and two variable functions at an arbitrary point of the multidimensional space. Lagrange1(x) implements calculations, using formula (6), for one variable. Lagrange2(x, y) calculates the values of two variable function $f(x, y)$.

Mathematical analysis of experimental data was carried out, wherein the dependence of the magnetic flux Φ on the shift of teeth α and clearance values δ_0 in induction wind electromechanical heater was tested. Comparison of experimental and calculated data proves high correlation. Inaccuracy of calculations is 10^{-5} . With the increase of the polynomial degree to 8, the relative error reduces to 10^{-17} .

The developed method is recommended to be used when building response surfaces in multifactor problems with more than two factors, which simplifies the solution of such problems and improves their accuracy.

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