Modelling of transducers of nonsymmetrical signals of electrical nets

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***Abstract*-In the article given materials of modelling electromagnet transducers of nonsymmetrical signals of three phases electrical nets. Determined, that modellingelectromagnet transducers of nonsymmetrical signals of three phases electrical nets of power systems require a modern mathematical method, which will submit opposite of calculate optimal construction parameters and quantities. In article electromagnet transducers of nonsymmetrical signals of three phases electrical nets modeled on the base practical and computer oriented matrise methods and analytical equations of algebraical equations systems.**

Keywords: modelling, electromagnet transducers, nonsymmetrical signals, three phases electrical nets.

I. INTRODUCTION

Today, limited energy sources request controle of power supply, eletrical values an quality on the bases ofelectromagnet transducers of nonsymmetryof current and voltage of three phases electrical nets. One of the distributed kind of power supply valie are thre phases current and voltage. One of the ways of controle ofpower energy of electricity is use modern electromagnet transducers of nonsymmetrical signals of three phases electrical nets. Solar panels are created by combining multiple small panels into parallel connections and common form [1].

II. STATEMENT OF A PROBLEM

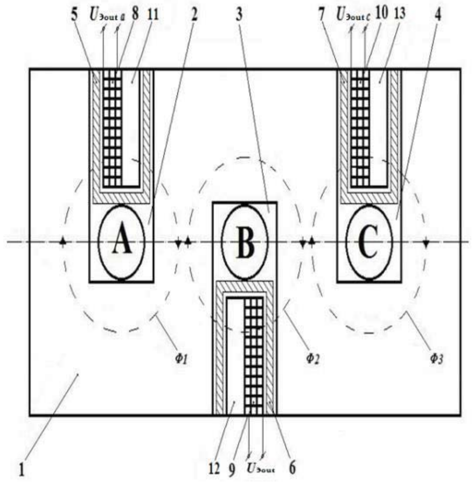
The Main factors of appearances of inaccuracies of electromagnet transdusers of three phases current and voltage are: nonsymmetry of current and voltages in value and phase, swings of frequency, change temperature surrounding ambiences, appearance of harmonicas current and voltages of electric network, vibratory loads during functioning transdusers and others.Modelimg schemes of the combined control of power supply on base of electromagnetic transdusers of three phases current to voltage with flat measure windingpractically notinertion, provide pinpoint accuracy and unification out signal universal when using in combined control system of steady-state and dynamic source of power, comsume small power, have not a rolling parts, differ high reliability.

III. MAIN PART

Prinsiple schemes of the electromagnetic transdusers of three phases primary current to secondary voltage for combined control of quantity and quality of power of energy supply system given in fig. 1 and 2 [1].

The models of electromagnetic transdusers of three phases current to voltage with flat measure windingfor multifunction control of sources of power energy system given on fig. 3 and 4.

The technical data of electromagnetic transdusers of three phases primary current to secondary voltages with flat measuring winding for power course given in tab.l.



1-base - main core, 2,3 and 4 – gaps, 5, 6 and 7 –seal holderplastins, 8,9 and 10 – flate measuring windings (FMW), 11, 12 and 13 - insulation plastins, A, B and C- primary windings – conductors of electrical three-phases nets of power supply systems

Fig.1 The Electromagnetic transdusers of the primary current to secondary voltage with a fixed magnetic circuit.

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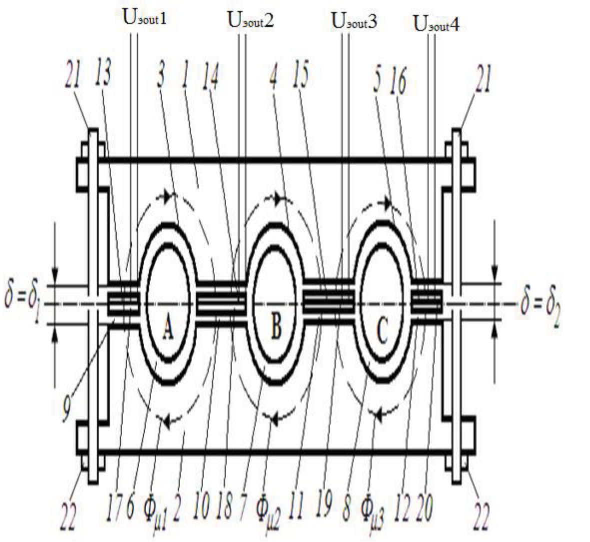


1 and 2 -base - main cores, 3,4, 5, 6, 7 and 8 –air clearence, 9,10,11 and 12 - gaps,13, 14, 15 and 16– insulation plastins, 17,18,19 and 20 - flate measuring windings (FMW), A, B and C- primary windings – conductors of electrical three-phases nets of power supply systems

Fig.2. TheElectromagnetic transdusers of the primary current to secondary with movablemagnetic circuit

Table 1

The technical data of the electromagnetic transdusers of current to voltages with flat measuring winding

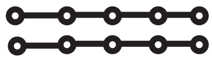
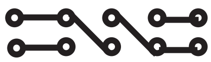
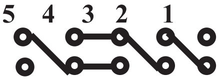
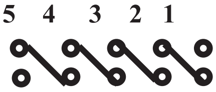
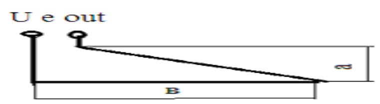
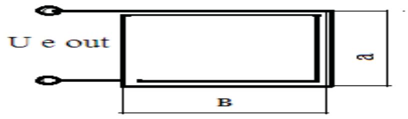
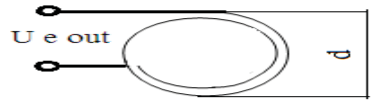
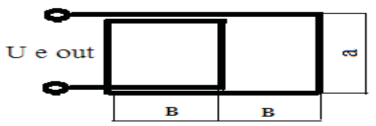
Num-ber of input point	Primary current		Output voltage U out (V)	Coeff. of trans-formation K T	Resis-tanse R (mΩ)	Inductance Lp (μH)	Construction chemasofconnections offlate measuring windings (FMW) with advisable numbers of windings
	I_p (A)	I_{max} (A)					
1	25	36	25	1/1000	0.3	0,023	**In** **5 4 3 2 1**  **Out** **6 7 8 9 10**
2	12	18	24	2/1000	1,1	0,09	**In** **5 4 3 2 1**  **Out** **6 7 8 9 10**
3	8	12	24	3/1000	2,5	0,21	**In** **5 4 3 2 1**  **Out** **6 7 8 9 10**
4	6	9	24	4/1000	4,4	0,37	**In** **5 4 3 2 1**  **Out** **6 7 8 9 10**
5	5	7	25	5/1000	6,3	0,58	**In** **5 4 3 2 1**  **Out** **6 7 8 9 10**

Table 2

Principle of design of flat measuring windings for electromagnetic transdusers ofthree phasesprimary current to secondary voltage

N	Type of flat measuring windings	Form of flat measuring windings	Area of the section
1.	**Triangulare**		$S_{\text{tr}} = ab/2$
2.	**Square-wave**		$S_{\text{sq}} = kab$
3.	**Round**		$S_{\text{r}} = k\pi\, D^2/4$
4.	**Loopy**		$S_p = 2\ ab$

The input value of electromagnetic transdusers of the current and voltages with flat measuring windings serves: primary alternating current to three-phase electric network $I_{e\ in}$ value from *1* before *1000*A and primary voltage $U_{e\ in}$ value from *0,4 - 35 sq*, but output signal $U_{e\ out}$ - a secondary output electric voltage from flat measuring windings, which in principal depends on uniformities of the sharing the magnetic flow *F* along way of the magnetic system of the transformation i.e. on length magnetic core, corner of the crossing the magnetic flow area of flat measuring windins [2]. The Portioned magnetic system of the electromagnetic transdusers of the current to voltage with flat measuring windings is presented in the manner of graph of the models. On base graph to models (fig.3) of the magnetic system of transdusers of the current and voltages with flat measuring windings are defined values, characterizing nodes (F- magnetomoiving power) and area of the transformation (P, P0, P1 - longitudal, vertical and transverse parameters).

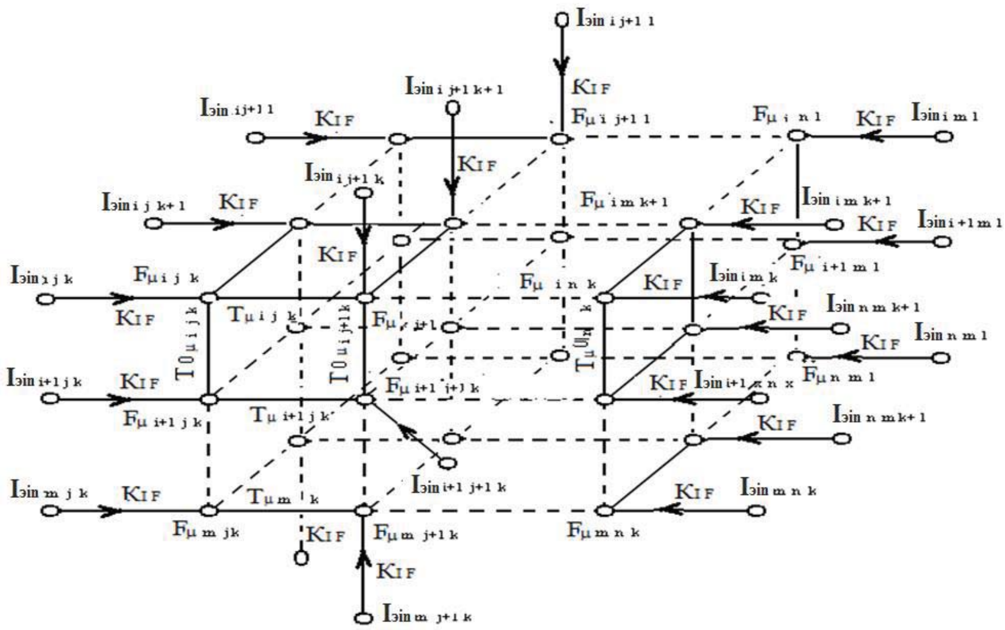


Fig.3. Ggraphs model of the magnetic system of electromagnetic transdusers of current to voltage

For a graph models of the portioned magnetic system (fig.3.) of the electromagnetic transdusers of the current and voltages with flat measuring windings, amount of nodes for calculation m.d.s. and magnetic flow has a sizes: i j k i.e. dependson conditions and accuracy of the features of the trunsduser of current to voltage, sizes of the nodes i change from 1 till n, j from 1 till m and k to from 1 till l [10-16].

For points graph models of the electromagnetic transdusers of the current to voltage with flat measuring windings (fig.3) is formed equations for determination node of magnetomoiving power:

for points i =1, j = 1 and k = 1 graph models of the electromagnetic transdusers of the current to voltage with flat measuring windings is formed equation for determination of magnetomoiving power:

$$F_{i,j,k} = \frac{K_{IF} I_{\text{эin}\ i,j,k} + \dfrac{F_{i,j+1,k}}{\Pi_{i,j+1,k}} + \dfrac{F_{i+1,j,k}}{\Pi 0_{i+1,j,k}} + \dfrac{F_{\mu i,j,k+1}}{\Pi 1_{i,j,k+1}}}{\dfrac{1}{\Pi_{i,j+1,k}} + \dfrac{1}{\Pi 0_{i+1,j,k}} + \dfrac{1}{\Pi 1_{i,j,k+1}}};$$

for points $i = m, j = 1$ and $k = 1$:

$$F_{i,j,k} = \frac{K_{IF} I_{\text{э in}\ i,j,k} + \dfrac{F_{i-1,j,k}}{\Pi 0_{i-1,j,k}} + \dfrac{F_{i,j,k+1}}{\Pi 1_{i,j,k+1}} + \dfrac{F_{i,j+1,k}}{\Pi_{i,j+1,k}}}{\dfrac{1}{\Pi 0_{i-1,j,k}} + \dfrac{1}{\Pi 1_{i,j,k+1}} + \dfrac{1}{\Pi_{i,j+1,k}}};$$

for points $i = 1, j = 1$ and $k = l$:

$$F_{i,j,k} = \frac{K_{IF} I_{\text{э in}\ i,j,k} + \dfrac{F_{i-1,j,k}}{\Pi 0_{i-1,j,k}} + \dfrac{F_{i,j,k-1}}{\Pi 1_{i,j,k-1}} + \dfrac{F_{i,j+1,k}}{\Pi_{i,j+1,k}}}{\dfrac{1}{\Pi 0_{i-1,j,k}} + \dfrac{1}{\Pi 1_{i,j,k+1}} + \dfrac{1}{\Pi_{i,j+1,k}}};$$

for points i = from 2 till m - 1, j = from 2 till n - 1 and k = from 2 till – 1:

$$F_{i,j,k} = \frac{K_{IF} I_{\text{э in}\ i,j,k} + \dfrac{F_{i,j-1,k}}{\Pi_{i,j-1,k}} + \dfrac{F_{i,j+1,k}}{\Pi_{i,j+1,k}} + \dfrac{F_{i,j,k-1}}{\Pi 1_{i,j,k-1}} + \dfrac{F_{i,j,k+1}}{\Pi 1_{i,j,k+1}} + \dfrac{F_{i-1,j,k}}{\Pi 0_{i-1,j,k}} + \dfrac{F_{i+1,j,k}}{\Pi 0_{i+1,j,k}}}{\dfrac{1}{\Pi_{i,j-1,k}} + \dfrac{1}{\Pi_{i,j+1,k}} + \dfrac{1}{\Pi 1_{i,j,k-1}} + \dfrac{1}{\Pi 1_{i,j,k+1}} + \dfrac{1}{\Pi 0_{i-1,j,k}} + \dfrac{1}{\Pi 0_{i+1,j,k}}};$$

where: $I_{\text{э}\ i,j}$ - an current in conductor of the three-phase electric network of energy system, being value - an influences on area of the transformation of the electromagnetic transdusers of the current to voltage; K_{IF} - a factor relationship between electric and magnetic circuit; Π - a portioned parameters magnetic circuit.

The graphs of the steady-state features of the electromagnetic transdusers of the current to voltage, got according to formulas(1-3) are presented on fig.3 - 6:

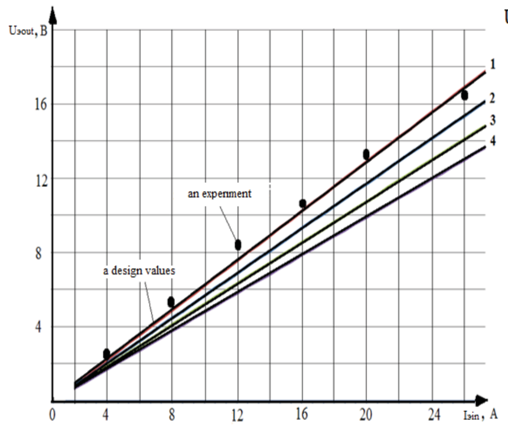
$$U_{eout} = 4{,}44 fW \left(F_{pio\max A}\, e^{-\frac{R_1 t}{L_1}} \pm F_{rem\ A}\, e^{-\frac{R_1 t}{L_1}}\right) \qquad (1)$$

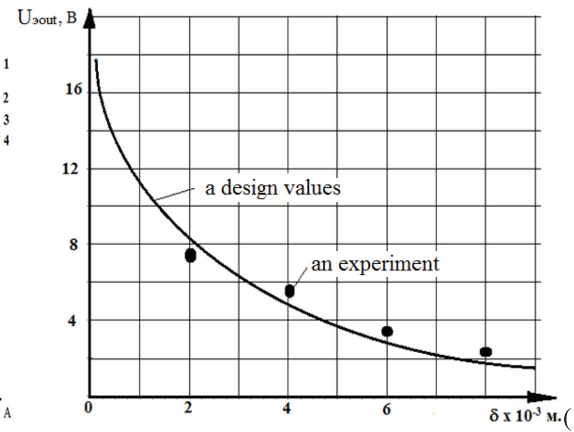
Similar formulas for building of the steady-state features for secondary voltages of the phases B and C three-phase electric nets:

$$U_{eout} = 4{,}44 fW (F_{\max B} \; e^{-\frac{R_{II}t}{L_{II}}} \pm F_{rem\,B} \; e^{-\frac{R_{II}t}{L_{II}}}), \qquad (2)$$

$$U_{eout} = 4{,}44 fW (F_{\max C} \; e^{-\frac{R_{III}t}{L_{III}}} \pm F_{rem\,C} \; e^{-\frac{R_{III}t}{L_{III}}}) \qquad (3)$$

As can be seen from fig.4 and 5, when increase air gaps-clearance, strongly decreases the value of the output voltage U_{eout}. The Best values of output voltage are provided at value of the air clearance equal *0,002 - 0,003 m.* and count whorl W_{FMW}equal *3 - 4* (fig.6). Increase the number whorl of the electromagnetic transdusers of the cujrrent to voltage (fig.6) promotes more fluent change the value of the output voltage, change area sections of flat measure winding provides linear change the output value of the voltage (fig.7).





(1 - 20 мм., 2 - 22 мм., 3 – 24 мм., 4 – 26 м.)

Fig.4 Steady-state features of output voltage under different FMW under importances of the air clearance
(points - an experiment,
line – a design values)

Fig.5. Dependency of the U_{eout} with different importances

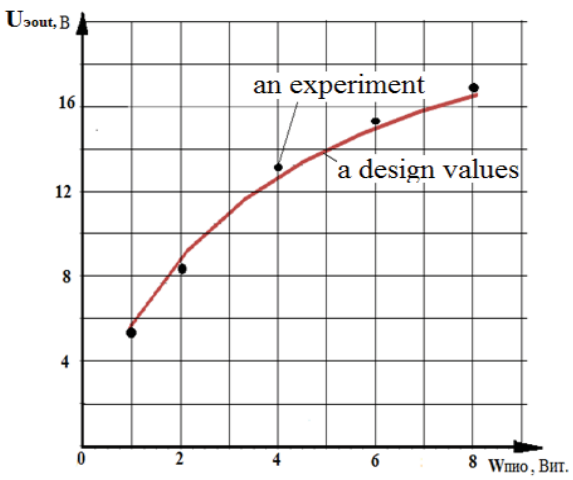


Fig.6 Dependency of the output voltage $U_{e\ out}$ under different importances of the number whorl - W_{FMW}.

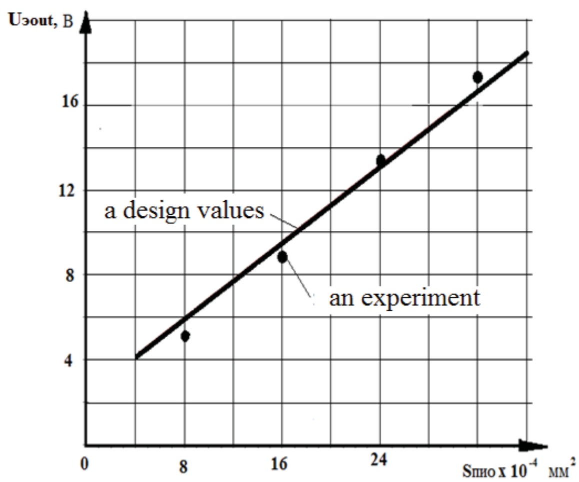


Fig.7 Dependency of the outputvoltage $U_{e\ out}$ under differentimportances area sections

In given articlefor combined control of values and parameters of three-phase current of electric nets and power supply systems,on the based on theoretical and experimental research is designed: principles of desing of electromagnetic transdusers of primary current tosecondary voltage with flat measuring winding; the corresponding to mathematical models; the algorithms of research and designing; as well as methods of the calculation that has allowed to solve a problem development and construction efficient electromagnetic transdusers one- and multiphases primary current tosecondary voltage.

VI. CONCLUSION

1. Motivated,that modeling of flat measuring windings in electromagnetic trunsduser, must provides control system the reception unified out signal with parameter: voltage - *20* V, current - *100 mA*.

2. The Best values output voltages U_{eout} are provided at value of air gaps- clearance - δequal - 0,002 - 0,003 m and numbers whorl flat measuring windings - W_{FMW} equal - *3 - 4*.

3.Determined, that electromagnetic transduseresof current to voltage in electric sets of the systems of power supply shows, that accuracy and automations of control source of power, have allowed to reduce the loss to electric powers on 11,26% under normative importance 13,29% ofaccounte due to improving of class of accuracy of elements controle system of power systems from 1,0 to 0,5.

VII. FUTURE SCOPE

Modeled this electromagnet transducer of current and voltage of three phases electrical nets and achieved the desired results. However, as the electromagnet transducers of current and voltage of three phases electrical nets is located in several electrical nets and systems, it needs to be monitoring remotely and remotely controlling if required.

Therefore, in our future work we are planning to together with organizing control in power supply systemssystems based on electromagnet transducers of current and voltage of three phases electrical nets technology (sensors, microcontrollers, activators, intelligent meters), regularly monitoring quantity and quality power supply, save energy and perform various tasks remotely, for example, disconnecting the defective device from nets and timely reporting to the relevant department in case of emergency, and transfer the equipment to the minimum power consumption when the energy source is exhausted.

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