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Abstract: *In the world, the demand for electricity and its quality is increasing, in order to further increase the share of renewable energy sources, the reactive power that generates the magnetic field and current in asynchronous motors, which consumes more than 60% of the electricity generated from them and provided by them The research of electromagnetic current transformers, which allows controlling the consumption, evaluating the asymmetry and nonsinusoidal indicators of reactive power and energy, remotely sensing and measuring these quantities with appropriate devices, and converting them into a standard signal, is considered an urgent issue* [1]. *The research results of the construction principles of a new series of electromagnetic current converters and the algorithm of forming their cumulative and distributed parameter modals for controlling and evaluating the non-symmetric and non-sinusoidal indicators of the reactive power consumed by widely used asynchronous motors are presented. Changing the quality indicators of electric energy into signal form when connecting one and three-phase asynchronous motors to renewable energy sources in the form of an off-line and on-line system, in which the consumed electric energy is transferred to the physical and technical processes taking place in the primary generator. The results of the studies conducted based on the modeling of the effects of signal change magnitude and parameters, based on the structure of the change device are presented.*

Key words: *An Asynchronous motor, graph model, magnetic process, output voltage, asymmetrical quantities, reactive power, magnetic flux.*

Annotatsiya. *Dunyoda qayta tiklanadigan energiya manbalari ulushini, magnit maydonni va asinxron motorlarda tok hosil qiluvchi reaktiv quvvatni yanada oshirish maqsadida elektr energiyasiga talab va uning sifati ortib bormoqda. Ulardan ishlab chiqarilgan va ular tomonidan ta'minlangan elektr energiyasi iste'molini nazorat qilish, reaktiv quvvat va energiyaning assimetriya va nosinusoidal ko'rsatkichlarini baholash, ushbu kattaliklarni masofadan turib aniqlash va tegishli asboblar bilan o'lchash va ularni standart signalga aylantirish imkonini beruvchi elektr-magnit tok transformatorlarini tadqiq qilish dolzarb masala hisoblanadi [1]. Keng qo'llaniladigan asinxron motorlar tomonidan iste'mol qilinadigan reaktiv quvvatning nosimmetrik va sinusoidal bo'lmagan ko'rsatkichlarini boshqarish va baholash uchun elektr-magnit oqim o'zgartirgichlarining yangi seriyasini qurish tamoyillari va ularning umumlashgan va taqsimlangan parametrlarini shakllantirish algoritmining tadqiqot natijalari keltirilgan. Bir va uch fazali asinxron motorlarni qayta tiklanadigan energiya manbalariga tarmoqdan tashqari va on-layn tizim ko'rinishida ulashda elektr energiyasining sifat ko'rsatkichlarini signal shakliga o'zgartirish, bunda iste'mol qilingan elektr energiyasi fizikaviy va texnik energiyaga uzatiladi. Signalning o'zgarish kattaligi va parametrlarning ta'sirini modellashtirish asosida o'zgartirgichning tuzilishi asosida olib borilgan tadqiqot natijalari keltirilgan.*

Tayanch so'zlar: *asinxron motor, grafik model, magnitli jarayon, chiqish kuchlanishi, assimetrik kattaliklar, reaktiv quvvat, magnit oqimi.*

Аннотация: *В мире растет спрос на электроэнергию и ее качество, с целью дальнейшего увеличения доли возобновляемых источников энергии, реактивной мощности, генерирующей магнитное поле и ток в асинхронных*

двигателях, потребляющих более 60% энергии. Вырабатываемой от них и подаваемой ими электроэнергии. Исследование электромагнитных трансформаторов тока, позволяющее контролировать потребление, оценивать несимметрию и несинусоидальность показателей реактивной мощности и энергии, дистанционно измерять и измерять эти величины соответствующими устройствами и преобразовывать их в стандартный сигнал, считается неотложной проблемой. Приведены результаты исследования принципов построения новой серии электромагнитных преобразователей тока и алгоритма формирования их суммарных и распределенных параметров параметров для контроля и оценки несимметричных и несинусоидальных показателей реактивной мощности, потребляемой широко используемыми асинхронными двигателями. Изучено изменение показателей качества электрической энергии в сигнальную форму при подключении одно- и трехфазных асинхронных двигателей к возобновляемым источникам энергии в виде автономной и онлайн-системы, в которой потребленная электрическая энергия передается в физическую и техническую среду, описаны процессы, происходящие в первичном генераторе. Представлены результаты исследований, проведенных на основе моделирования эффектов изменения величины и параметров сигнала, исходя из конструкции устройства.

Ключевые слова: *Асинхронный двигатель, графовая модель, выходное напряжение, несимметричные величины, реактивная мощность, магнитный поток.*

Introduction: Today, as in the rest of the world, special attention is being paid to saving natural resources and introducing ecologically clean technologies in productive sectors. Achieving economic sustainability is also a very important factor in reducing negative impacts on the environment. In this sense, the Decree of March 1, 2013 "On Measures for the Further Development of Alternative Energy Sources" is a document of historic importance, adopted at the right time.

According to Decree of the President of the Republic of Uzbekistan, dated February 1, 2019 No. UP-5646, there are the following types of alternative energy sources in Uzbekistan: wind energy-2.2 million tons; Solar energy-50976 million tne; geothermal energy-6700 million tons; and the total amount of alternative energy is equal to 117984 million tne. Creating opportunities for practical use of this energy is the most pressing issue for energy professionals. If we could use 0.0125% of the energy coming from the Sun, this would be equal to the value of all the energy sources on earth.

Before talking about the advantages of alternative and renewable energy sources, let's briefly touch on the current situation in the world energy. According to the calculations of international organizations, due to economic development, by 2030, the demand for energy will increase by 50 percent compared to the beginning of our century, and the total need will be 23.27 billion tons of conventional fuel. Therefore, the negative impact on the environment will increase.

Currently, 10.2 percent of all energy produced in the world is accounted for by renewable energy. By 2050, its share in some species is expected to exceed 70 percent. This will allow to reduce the harmful emissions released into the environment by only 500 billion tons. After all, the goal of developing low-carbon energy is to solve the global problems arising due to the increasing emission of steam gases into the air. According to the planned plan, for example, it is planned to reduce the amount of such gases by 20-25 percent by 2020, by 40 percent in 2040, and by 50-60 percent in 2060.

It is known that Uzbekistan is a country that can fully meet its needs in terms of fuel and energy resources. Currently, natural gas accounts for 80% of this supply, oil for 7.6%, and coal for more than 5%. Our country has great potential in alternative and renewable energy sources. In particular, the amount of solar energy falling on the territory of our country and the theoretical power generated is equal to 6 billion 750 million tons of conventional fuel. This is three times more than the existing reserve of non-renewable resources.

Wide application of innovative scientific developments in various sectors of the economy is to ensure harmony of science, technology and economic development. In the development of innovative production, the development of energy saving technologies is of great importance. In the conditions of our republic, especially in this field, the large-scale introduction of energy recovery sources such as solar batteries, wind and micro-hydropower devices will undoubtedly have the expected effect.

If we take into account that our country is in the region with the most sunny days, if we switch to using solar collectors for space heating, we would achieve a great achievement in the economy and energy system.

Figure 1. ***Production of electricity from solar energy.***

In the picture, it is shown that the solar panel converts the light from the sun into electrical energy, direct current is collected in the accumulator battery, the collected direct current is converted into alternating current through the inventor, and the main consumer is transferred to the asynchronous motor.

It should be noted that the efficient use of renewable energy sources and the construction of large solar energy facilities require certain land areas. Because in order to generate 1 MW of electricity, it is necessary to install solar devices on one hectare of land, and for 100 MW of power, on 100 hectares of land. Therefore, a separate technology and technological base should be created in all areas of alternative and renewable energy in our republic.

Asynchronous motors are the main consumers of electricity consumed in industry and production, and the widely used renewable energy sources for supplying them with electricity are non-sinusoidal currents and voltages arising from the characteristics of single-phase and three-phase electricity currents and asymmetry leads to increased voltage, power and energy waste and failure of resources in electric power transmission and distribution networks [1,2].

Based on the conducted research, a current-to-voltage conversion device that allows changing the primary one- and three-phase currents of the reactive power consumed by the asynchronous motor, which is the main consumer of renewable energy sources, into signals in the form of secondary voltages - electromagnetic the structure of the current converter and the scheme of the output signal formation - the connection of the sensing elements have been developed and they are shown in Fig. 1 [4-5].

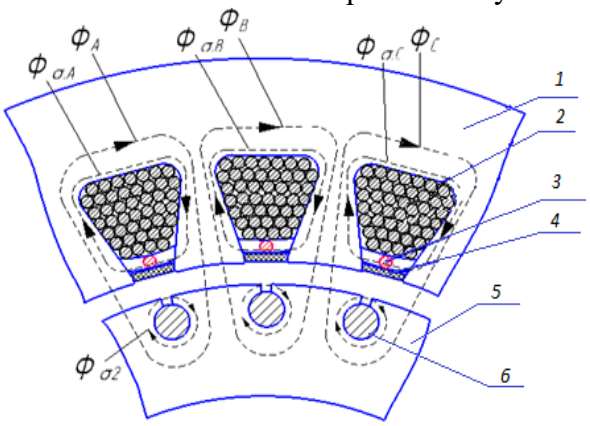

Figure 2. ***Device for converting the primary currents of the asynchronous motor to the secondary voltage, the structure of the electromagnetic current transducer.***

1 - stator - a fixed part of an asynchronous motor, 2 - stator wedges, 3 - air gap with sensitive elements, 4 - insulating wedge, 5 - rotating part of the rotor, 6 - rotating rotor wedges.

In order to research the possibility of preventing the indicated shortcomings of renewable energy sources and reducing their negative consequences, the electromagnetic current transformer, which is the main element of measurement and control, has been developed. For example, the single-phase current generated by the renewable energy source flows through the windings placed on the stator windings of

the asynchronous motor and generates the output voltage in the secondary winding of the electromagnetic current converter, which is the main signal conversion principle.

Voltages $u_{out.1}(t)$, $u_{out.2}(t)$, $u_{out.3}(t)$ are obtained at the outputs of the current-measuring measuring coils under the influence of magnetic currents generated by the passage of primary currents i_1, i_2, i_3 through the stator windings of a three-phase asynchronous motor. The voltages at the output of the current converter depend on the location of the measuring coils in the stator groove, the number of windings and the output voltages as follows [1-3]

Method: an asynchronous motor that consumes electricity from a renewable energy source, an electromagnetic current transformer that provides the transformation of primary currents flowing through the stator coil into signals in the form of secondary voltage is a device with different physical and technical parameters lib, controlling the process of signal conversion, obtaining complete information about the reactive power consumed by the motor, the coils placed and connected to the stator slots with special schemes and methods, generating primary currents, secondary output voltages, and being able to control power consumption allows.

Taking into account the electric, magnetic and other parameters of the asynchronous motor stator currents, as well as the physical and technical effects of the device, the parameters of the graph model were taken into account.

The currents flowing through the stator windings creating the output voltage in the secondary winding of the converter, and it is a graph model as shown in Fig. 3.

The analytical expression of the research of the output signals of the electromagnetic current converter used in the measurement and control of the reactive power of an asynchronous motor supplied from a renewable energy source is formulated as follows:

$$U_a = 4{,}44 f \omega_a \left(\frac{F_{\mu 1.2} - F_{\mu 1.1}}{\Pi_{0\mu 1.1}} + \frac{F_{\mu 1.2} - F_{\mu 2.2}}{\Pi_{0\mu 2.1}} + \frac{F_{\mu 1.2} - F_{\mu 3.2}}{\Pi_{0\mu 2.3}}\right)$$

$$U_b = 4{,}44 f \omega_b \left(\frac{F_{\mu 2.2} - F_{\mu 2.1}}{\Pi_{0\mu 1.2}} + \frac{F_{\mu 2.2} - F_{\mu 3.2}}{\Pi_{0\mu 2.2}} + \frac{F_{\mu 2.2} - F_{\mu 3.2}}{\Pi_{0\mu 2.1}}\right)$$

$$U_c = 4{,}44 f \omega_c \left(\frac{F_{\mu 3.2} - F_{\mu 3.1}}{\Pi_{0\mu 1.3}} + \frac{F_{\mu 3.2} - F_{\mu 1.2}}{\Pi_{0\mu 2.3}} + \frac{F_{\mu 3.2} - F_{\mu 2.2}}{\Pi_{0\mu 2.2}}\right)$$

in the expression: f-frequency constant, ω_a −angular frequency, F_μ- magnetic flux, $\Pi_{0\mu}$- magnetic parameters of the external environment.

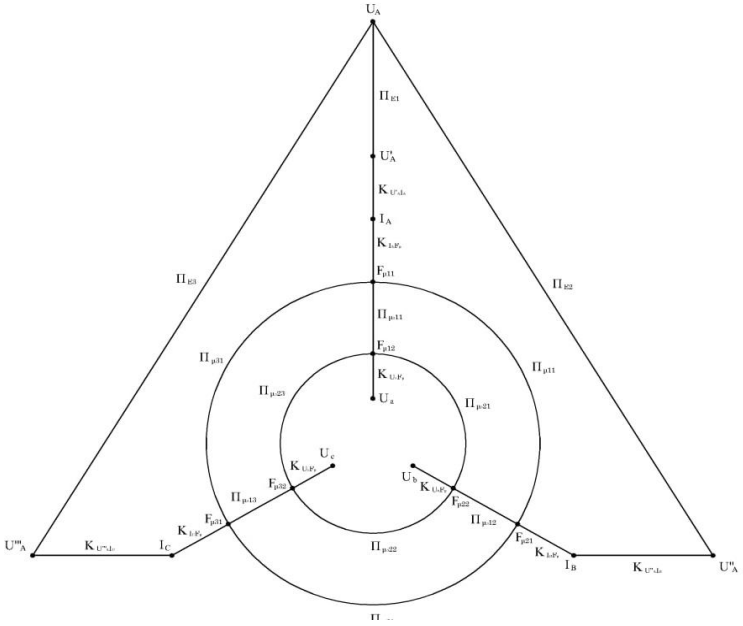

Figure 3. ***The power supplied to the stator windings of an asynchronous motor supplied from a single-phase current generated by a renewable energy source, the process of generating the output voltage in the secondary winding of the converter by the currents flowing through the stator windings is a graph model.***

The results of the study show that the measuring sensitive element loops placed in the stator slots of the asynchronous motor consuming renewable energy sources are suitable for each phase with one sensitive element or two sensitive element loops located in the stator slots and in series with each other, can be connected in parallel and differential form of differential measurement sensitive element loops on asynchronous motor stator wedges formed on the basis of research.

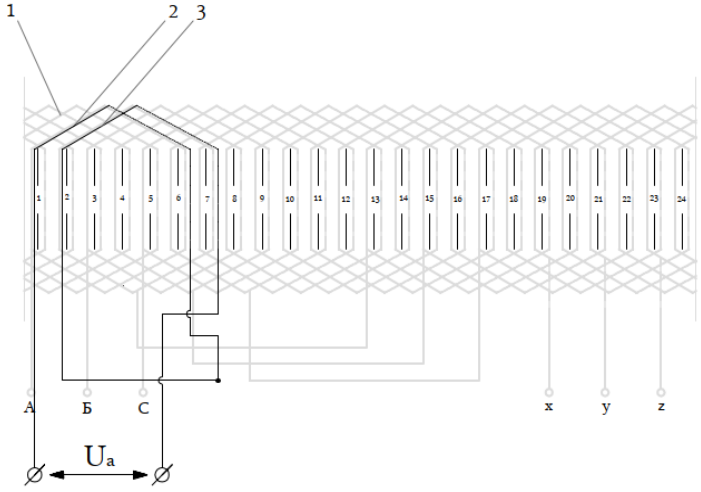

Figure 4. ***Schematic diagram of the connection between the stator windings of an asynchronous motor using a renewable energy source according to the differential circuit.***

Taking into account the interaction of quantities with different characteristics affecting the electromagnetic current converter, the dynamic characteristics of the voltage signal coming out of the sensitive element are studied, the differential equations characterizing the output signals and representing the transition processes were created. Determining the dynamic characteristics of an asynchronous motor electromagnetic current converter was carried out on the basis of theoretical calculations, i.e., the formed graph model, its analytical expressions, developed simulation models, and practical results determined by modern technologies.

According to the number and connection method of the sensitive elements of the electromagnetic current converter, it is possible to fully study the dynamic processes by analyzing the electrical and electromagnetic processes in the asynchronous motor. It is important to determine the dynamic characteristics of series, parallel and differentially connected electromagnetic current transformers with one sensitive element ring or two sensitive element rings and to compare them.

For the control and management of asynchronous motor filter-compensation devices, the number of sensitive element coils suitable for each phase of three-phase electromagnetic current converters is taken at an equal value, as a result, it is possible to determine the amplitude and phase asymmetries generated between phases.

Result. In the study of static characteristics, the characteristics of the dependence of the output voltage signals on the stator current of three-phase electromagnetic current transducers with mutual differential connection, which have two sensitive element loops suitable for each phase, are placed between the poles of the stator windings (Figure 4).

Graphs of the time dependence of the output voltage of a three-phase electromagnetic current converter with one sensitive element loop (Figure 5), two sensitive element loops and connected in differential using the CassyLAB device (Figure 6).

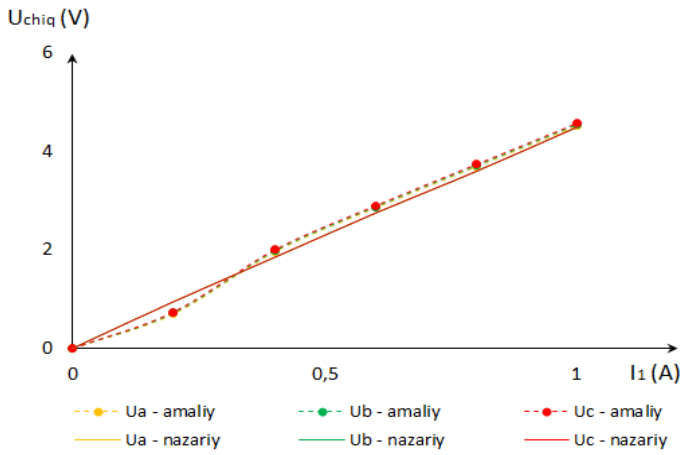

Figure 5. ***Static characteristics of the dependence of the output signals of the three-phase electromagnetic current converter of an asynchronous motor with two segir elements and connected in a mutual differential circuit (based on the condition M_1=const).***

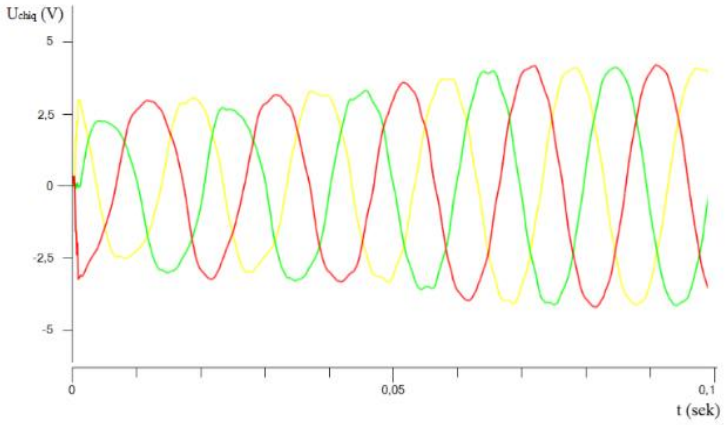

Figure 6. ***Time-dependent graphs of the output voltage of a three-phase electromagnetic current converter with one sensitive element loop (a), two segir element loops and connected in series (b), parallel (c) and differential (d) with the CassyLAB device.***

The entropy error of the electromagnetic current converter with one sensitive element loop is Δ_1 =0.414, the entropy error of the three-phase electromagnetic current converter with two sensitive element loops and connected in series is Δ_2 =0.372, for parallel Δ_2 =0.462 and for differential Δ_2 =0.327 was found to be equal to the amount. The standard accuracy class for three-phase electromagnetic current transformers researched according to standards is 0.5.

Conclusion:

In the process of supplying electricity of asynchronous motor from the nets, taking into account various external and internal parameters, the symmetrical magnitudes of reactive power consumed are expressed for each phase current.

The compact and distributed parameter model of the measuring sensitive element in the expression of symmetrical and non-sinusoidal of the motor, taking into account the internal and external parameters affecting the consumption of the renewable energy source of the asynchronous motor, was researched. If the indicators of asymmetry and non-sinusoidality of the asynchronous motor are connected to the differential form of measuring elements located on the stator slots, the accuracy of the research can be ensured even more.

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