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CREATION AND RESEARCH OF ENERGY-SAVING INVERTERS USED IN A MICRO-HPP

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Annotatsiya: Ushbu maqolada mikro-GESning bir qismi sifatida ishlatilganda yuqori samaradorlikka ega bo'lgan inverterlar uchun nazorat tizimlarini eksperimental o'rganish natijalari, elektr stansiyasining chiqish kuchlanishini barqarorlashtirish uchun statik chastotali konverterga ega bo'lgan gidroelektrik birlik keltirilgan.

Kalit so'zlar: muqobil, energiya manbai, mikro-gidroelektr stansiya, inverter, barqarorlashtirish, chiqish kuchlanishi, aylantirish, samaradorlik.

Аннотация: Представлены результаты экспериментальных исследований систем управления инверторами с высокой эффективностью при использовании в составе МИКРОГЭС гидроагрегата со статическим преобразователем частоты с целью стабилизации выходного напряжения электростанции.

Ключевые слова: альтернатива, источник энергии, микрогидроэлектростанция, инвертор, стабилизация, выходное напряжение, преобразование, эффективность.

Abstract: The results of experimental studies of control systems for inverters with a high efficiency when used as part of a Micro-HPP, a hydroelectric unit with a static frequency converter in order to stabilize the output voltage of a power plant are presented.

Keywords: alternative, energy source, micro-hydroelectric power station, inverter, stabilization, output voltage, conversion, efficiency.

Introduction. Alternative energy sources are constantly existing energy resources of natural processes, as well as waste products of biocenoses of plant and animal origin. A feature of alternative energy sources is their non-depletion, as well as the ability to restore their potential in a certain time. Alternative energy sources (AES) include the following types: solar energy, hydropower, geothermal, wind, sea wave and current energy, biomass energy and low potential thermal energy.

The main advantage of AES, which determines the interest in them, are: renewability, inexhaustibility; ecological cleanliness; availability, availability of one or another source. Along with the listed advantages, AES have the following disadvantages: low energy flux density, which affects the dimensions of power plants, and, consequently, their cost.

One of the main issues today is the creation of energy-saving devices that are economical in terms of technical and economic characteristics, used in practice. This requires the revision of existing devices, as well as the study of modern options for various design schemes.

Literature review. In this article, the author presents the results of a study of inverter control systems with high efficiency when using alternative energy sources in order to stabilize the output voltage of a power plant, based on an analysis of the inverter circuit diagrams.

The main efforts in the development of Micro-HPP are aimed at improving the systems for stabilizing the output voltage of the power plant, which makes it possible to use the most simple and cheap hydraulic equipment. For Micro-hydroelectric power plants operating in a free flow of water, stabilization systems are required that control at least two parameters of the output voltage: its value and frequency[1].

If it is necessary to convert an alternating or direct voltage of one rating into an alternating or direct voltage of a different rating, converters are used. This research work was studied by the following scientists: N.K.Govind[2], J.Shrestha and M.Byanjankar[3], R.A.Zakhidov[4] and others.

Converters are divided into two types. Converters that convert DC power to AC power are called inverters, and the conversion process consists of inverting.

If a constant voltage is required at the output of the converter, a rectifier and a filter are installed after the converter. A converter that converts one AC voltage to another AC voltage is called a converter, and the conversion process consists of converting [5].

The use of a hydroelectric unit with a static frequency converter as part of the Micro-HPP completely removes the problems with the quality of the output voltage and makes it possible to increase the utilization factor of its installed capacity. The principle of operation of the generating system consists in converting the voltage of a hydrogenerator with an unregulated turbine, unstable in magnitude and frequency, into direct current using a rectifier, followed by inverting by the inverter into alternating current of a stable frequency. To optimize the energy balance of the system, it is possible to use electric energy storage devices - more often electrochemical batteries [6].

Research methodology. In Micro-hydroelectric power station, the generator part, which consists of an asynchronous motor and a generator mechanically connected to it, the inverter is designed to power the motor, the built-in inverter controller provides the specified motor rotation speed by changing the output voltage frequency[7].

The advantages of such a Micro-hydroelectric power station are the high quality of the output voltage, determined by the inverter, and the ability to work under conditions of changing parameters of the working water flow.

High efficiency inverter design

Based on the experiments carried out, it can be noted that the overall efficiency of inverters can be increased by reducing the stages of the conversion process.

Therefore, in order to create an inverter with a high efficiency, the step of the modification process in the inverter must be shortened[8].

A block diagram of a similar inverter is shown in the following figure.

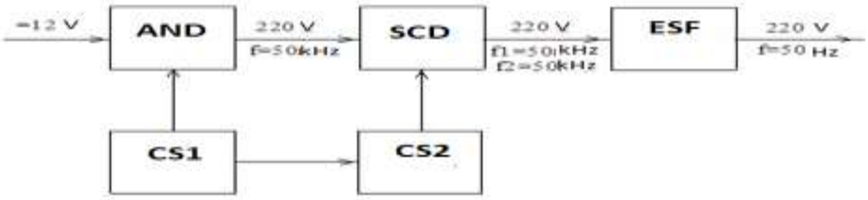

Figure 1. Block diagram of a high efficiency inverter

Here: AND - input inverter; SCD - a switch that controls the direction of currents; CS1 - input inverter control system; CS2 - switch control system that controls the direction of currents; ESF - energy storage filter.

Analysis and results.

As seen in the high efficiency inverter block diagram, the inverter replacement process is a two-step process (Figure 1).

In this case, the overall efficiency of the inverter is determined as follows.

$\eta_{total} = \eta_I \times \eta_{SCD}$ (1)

Where: η_i- input inverter efficiency; η_{SCD} - efficiency of a switch controlling the direction of currents.

Since the current control switches operate in the same pulse saturation mode as the input inverter switches[9], their efficiency can also be assumed to be equal to that of the input inverter, that is η_{SCD}=0.9.

In this case, the efficiency of inverters, consisting of two stages of the conversion process, is as follows.

$\eta_{total} = 0.9 \times 0.9 = 0.81$ (2)

If we compare the efficiency of the developed inverter with the efficiency of the RFA-1000 converter, then the gain in the efficiency of the developed converter will be as follows.

$\eta_{total} = \eta_{i1} - \eta_{i2}$ (3)

that is,

$\eta_{total} = 0.81 - 0.729 = 0.081$ (4)

This means that a one-step reduction in the conversion process in the inverters will increase the efficiency of the inverters to 0.081.

The graph of the dependence of the efficiency to power is shown in Figure 2.

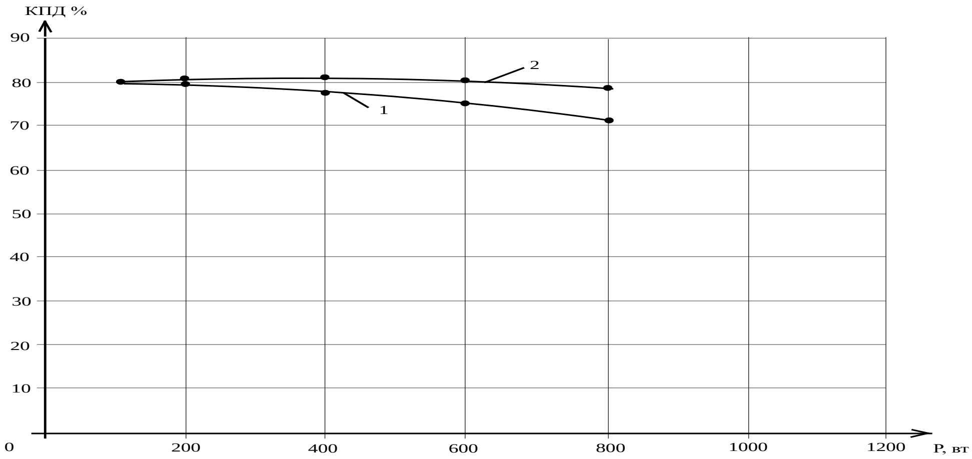

Figure 1. The graph of the dependence of the efficiency to power

The principle of operation of a highly efficient inverter is as follows.

Conclusion. The input inverter is connected to a DC source with an input voltage of 12 volts. In this case, the input inverter converts 12 volts DC to 50 kHz AC and 220 volts[10]. The alternating current generated in the input inverter is specially converted by the control switch in the direction of alternating currents into alternating current with a frequency of 50 Hz, and each half-cycle is filled with a pulse with a frequency of 50 kHz. The resulting alternating current is grounded in the PUN energy storage filter and converted to pure 50 Hz alternating current.

Thus, the efficiency of these inverters, which can be used in hydropower systems, has been increased to ηtotal = 0.81.

References

[1]Kostikov V.G., Parfenov E.M., Shakhnov V.A. Sources of power supply for electronic devices. Circuitry and design: Textbook for universities. - 2nd ed. –M .: Hot line - Telecom, 2001. –P. 344.

[2]Govind, N. K., et al., Design of Solar Thermal Systems Utilizing Pressurized Hot Water Storage for Industrial Applications, Solar Energy, (2008), Vol.82, pp. 686-699.

[3]Shrestha, J. and Byanjankar, M. Thermal performance evaluation of box type solar cooker using stone pebbles for thermal energy storage. International Journal of Renewable Energy, (2007),Vol.2, pp. 11–21.

[4]Zakhidov, R.A., Renewable Energy Source Are the New Way in Energy Engineering, Geliotekhn., (2002), no. 2, pp. 101–111.

[5] Sources of power supply for electronic equipment: Handbook / GS. Nivelt, K.B. Mazel, Ch. I. Khusainov and others; Ed. G.S. Nivelt. –M .: Radio and communication, 2005. – P.576.

[6]Lukutin BV, Sarsikeev E.Zh., Shandarova EB, "MicroHPP with a static frequency converter", Modern problems of science and education, 2014. - No.6.

[7]Zainutdinova, Kh.K., (Solar Energy Marketing in Uzbekistan), Tashkent: Science, 2011.

[8]Abdurakhmanov, A.A., Akbarov, R.Yu., Gulamov, K.G., et al., Exploitation Experience of Larger Solar Furnace of 1000 kW Power, Geliotekhn., (1998), no. 1, pp. 39–44.

[9]Paizullakhanov, M.S., Faiziev, S.A. Calcium carbide synthesis using a solar furnace. Tech. Phys. Lett.,(2006), Vol. 32, pp. 211–212.

[10]Proceedings of the 9th PACES International Symposium on Solar Thermal Concentrating Technologies, Font Romeu, 1999, J. Phys. IV (France) 9, Part 3 (1999).