https://doi.org/10.1051/e3sconf/202021601096

EXPERIMENTAL RESEARCH OF THE POWER QUALITY AT THE PHOTOVOLTAIC POWER STATIONS IN THE POWER SYSTEM OF UZBEKISTAN

Allaev Kakhraman[1], *Musinova* Gulasal[2*]

[1]Tashkent State Technical University named after Islam Karimov, Department of Power Stations, networks and systems, Universitet – 2,Tashkent, 100095, Uzbekistan
[2]Tashkent State Technical University named after Islam Karimov, Department of Power Stations, networks and systems, Universitet – 2,Tashkent, 100095, Uzbekistan

Abstract. This article discusses the issues of ensuring the power quality. An analysis of the higher harmonics arising from the operation of photovoltaic power stations is made. The results of experimental research are presented. Based on the measurement and calculation data, time diagrams of changes in the parameters of the electrical system mode for the studied periods of time were constructed.

Introduction

The growth of the power of low-voltage electrical networks and the need for uninterrupted power supply to responsible consumers put forward increased requirements for the impact on the power quality both from the equipment for generation, transmission, distribution, and from the side of consuming equipment. In this regard, the issues that are included in a set of measures aimed at improving power supply in order to prevent the consequences of a possible deterioration of modes caused by a deterioration in the power quality are gaining relevance. Improving the power quality reduces the likelihood of accidents, increases the safety during the operation of electrical installations, the stability of power systems and their energy efficiency [1, 3, 6].

Particular attention in the design of electrical installations should be assessed the impact on the quality of nonlinear loads of consumers, designed on power semiconductor devices (diodes, thyristors, transistors, etc.). These converters (secondary power supplies) are part of computer and telecommunications equipment, household and audio-video equipment, which have non-linear characteristics. Non-linearities in loads cause higher harmonics in currents and voltages. Such currents lead to false alarms of some types of circuit breakers, burnout of neutral conductors, load asymmetry, interference in the transmission of data through information channels and, ultimately, to the creation of emergency situations (fires, unauthorized shutdowns of consumption beaters, reduced service life of electrical machines, communication disruption). Various methods can be used to try to mitigate the problems caused by higher current harmonics at loads with a high crest factor [2,4].

1.1 Theoretical part

In the case of unbalanced loads, only the resulting current flows in the neutral conductor due to the difference in loads. In the past, electrical installers, given the weak current in the neutral conductor, have used a smaller phase conductor for the neutral conductor with the approval of the relevant standards. However, if the currents of the fundamental frequency in the neutral wire are mutually compensated, then this does not happen with harmonic currents. Indeed, the amplitudes of the harmonics whose frequency is equal to three times the fundamental frequency multiplied by an odd factor (harmonics of the order of 3n) are added in the neutral wire [5, 7].

The flow of non-sinusoidal current through the elements of the electrical network creates a voltage drop in them, determined by the harmonic composition of the current curve, which is the reason for the distortion of the sinusoidal voltage waveform at one point or another in the network. In operating power systems supplying powerful nonlinear loads, there are conditions for resonant phenomena, leading to a significant increase in the higher harmonics of currents and voltages. This, ultimately, is reflected in the loss of electricity [2].

Distortions of sinusoidality and symmetry of currents and voltages in existing electrical networks, including high voltage networks, can reach ten percent or more. In most cases, the levels of distortion coefficients of sinusoidality do not exceed 10-12% for voltage and 15-20% for current [1].

Development of methods for taking into account losses caused by higher harmonics, that these components of losses should be assessed individually due to their different weight significance, a significant difference in propagation conditions, according to the equivalent circuits applied to them and their parameters.

It goes without saying that a special need to take into account such losses arises when the requirements of State Standarzation 13109-97 are violated, which establish different standards not only for each harmonic, but also depending on the rated voltage of the network.

It is from these positions that one should evaluate the existing methods for calculating capacities, their applicability for balance equations, calculating losses caused by the distortions under consideration.

The existing methods for determining the power components, depending on the mathematical apparatus used, can be conditionally divided into: spectral, integral, exchange power method, equivalent sinusoid method, fundamental harmonic method, energy flow theories, etc.

1.2 Experimental research

Transformer station (TS) №216 of the Namangan photovoltaic (PV) power station with a rated power of 130 kW was selected as the object of research (Fig. 1).

The sample of the weighted average values of the measured values was carried out in accordance with [1].

The general view of the PVS and the meter switching circuit are shown in Fig. 2 a and b, respectively. Electricity is transmitted to residential buildings, workshops and shops.

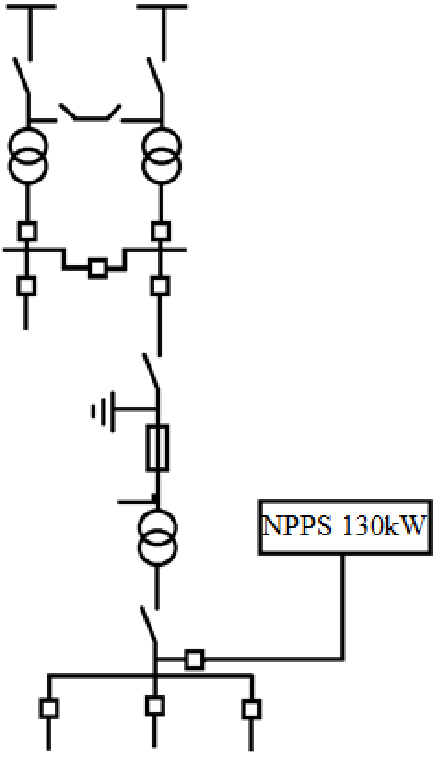


Fig. 1. Scheme of electrical distribution and connection of the Namangan PV powr station with a capacity of 130 kW

a) b)

Fig. 2. General view of Namangan PV power station (a) and meter switching circuit (b)

In fig. 3 presents an oscillogram of changes in active and reactive power, during the month TP No. 216 of the Namangan PV power station.

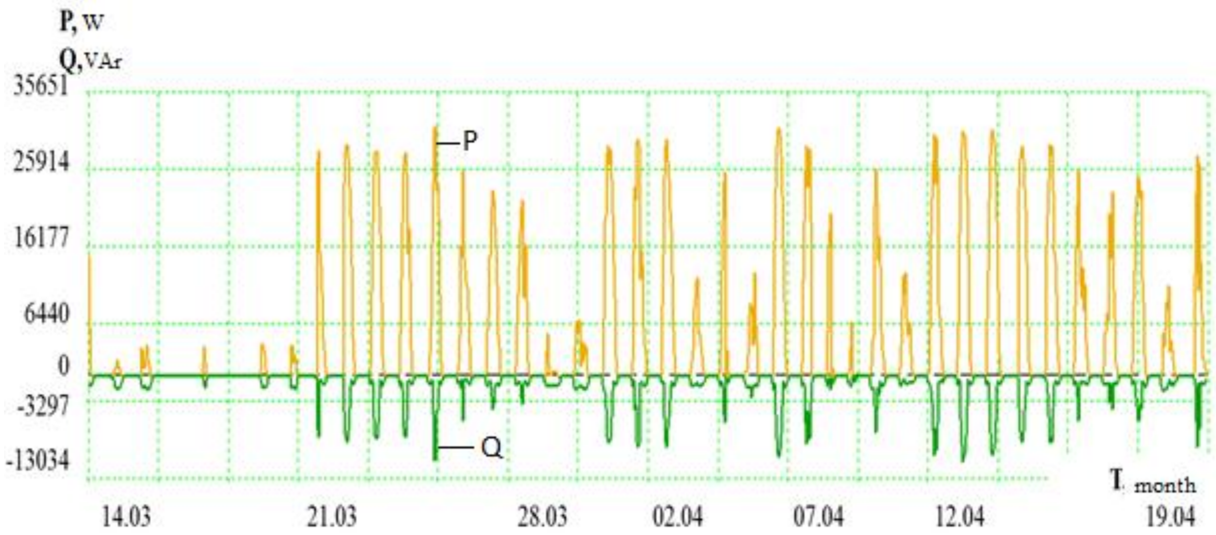


Fig. 3. Waves of change in active and reactive power

In fig. 4 presents a daily oscillogram of the power change.

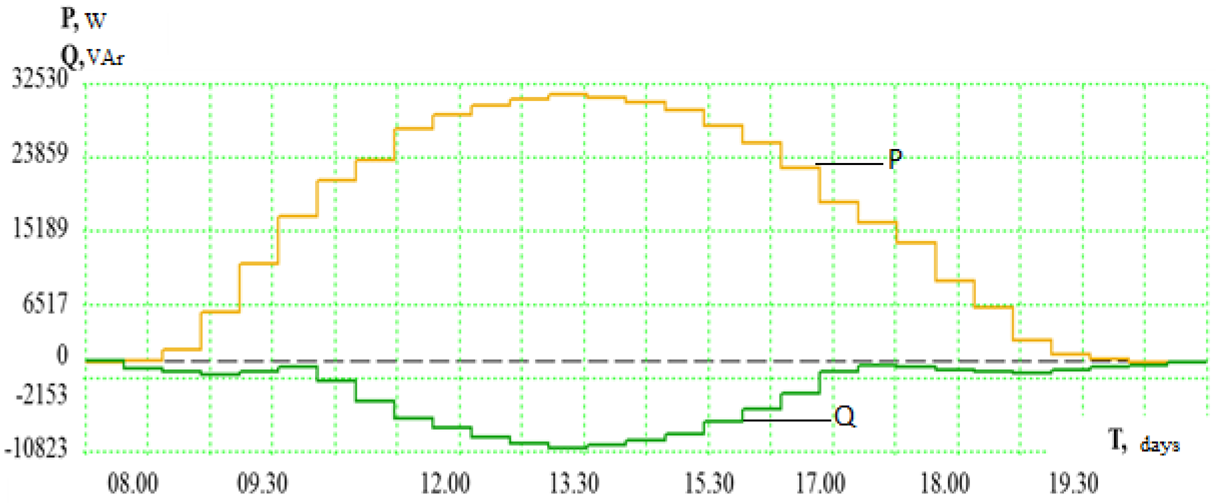
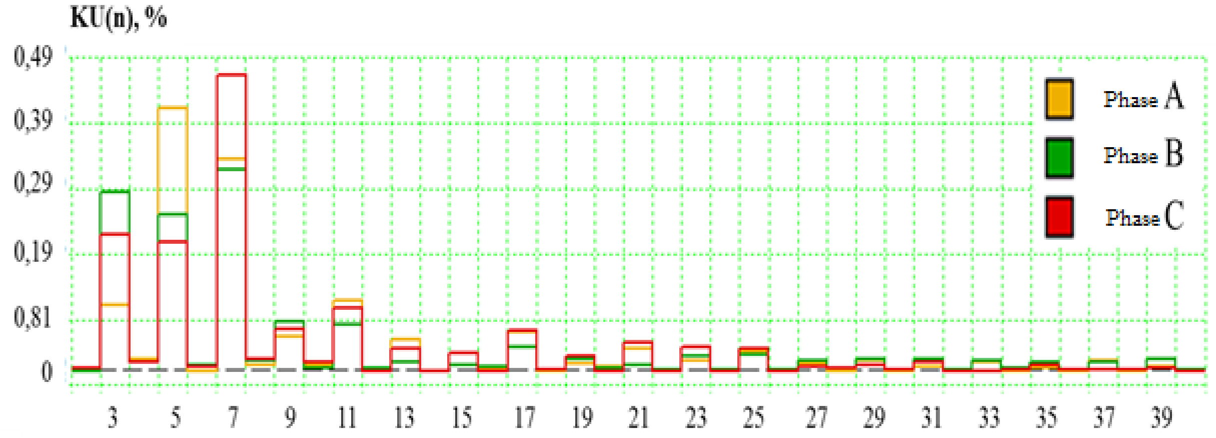
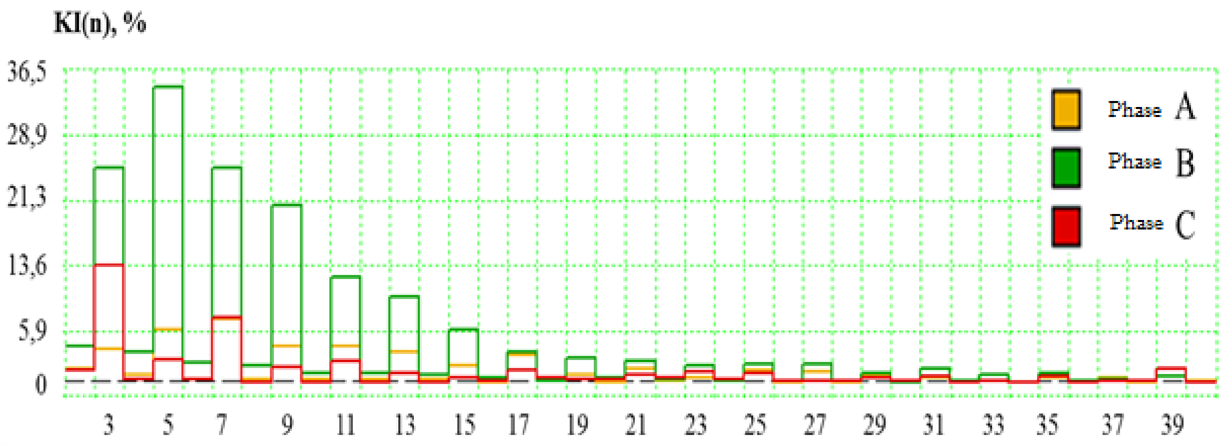


Fig. 4. Wawes of daily changes in active and reactive power, kW

In fig. 5 shows an oscillogram of changes in the higher harmonics of voltage (a) and current (b).



a)



b)

Fig. 5. Wawes of voltage (a) and current (b) harmonics

Conclusion

From the presented oscillograms it can be noted that the values of the parameters of the 5th and 7th current harmonics exceed 3-4 times. In operating power systems supplying powerful nonlinear loads, there are conditions for resonant phenomena that lead to a significant increase in the higher harmonics of currents and voltages. This, ultimately, is reflected in the parameters of the power system mode.

References

1. Allaev K.R., Mirzabaev A.M., Shaismatov S.E., Kholiddinov I.Kh., Makhmudov T.F., Musinova G.F., Kholiddinova M.M. Obespechenie kachestva elektricheskoy energii. // Monografiya. – T.: Izd-vo «Fan va texnologiya», 2019. 160 s.
2. Kholiddinov I. Kh., Akhmedov N. J., Musinova G.K. Information-measuring system for electric power quality analysis 0.38 kV distribution networks. // VI Internatioanl scientific confrence. Theoretical and Applied Sciences in the USA, New York 26 October, 2015. p.31-38.
3. Kholiddinov I.Kh., Ponomarenko O.I. Obespechinie pribornoy bazi sistemi kontrolya kachestva elektroenergii v sovremennix sistemax elektrosnabjeniya. // Universum: Texnicheskie nauki: elektron. Nauch. Jurn. 2016. №8(29). URL:*http://7universum.com/ru/tech/archive/item/3527*
4. Allaev K.R., Shaismatov S.E. Issledovanie vliyaniya visshix garmonik na fotoelektricheskoy stantsii. // Vestnik. TashGTU. 2018. №1-2. S.51-56.
5. Kholiddinov I.Kh., Musinova G.F., Kholiddinova M.M. Reactive power management to improve power quality. // ACADEMICIA. An international multidisciplinary research journal. India. 2020. P. 161-167.
6. Allaev K., Makhmudov T. Research of small oscillations of electrical power systems using the technology of embedding systems. Electrical Engineering, 2020; Issue 1: 309-319. DOI 10.1007/s00202-019-00876-9
7. Allaev K., Makhmudov T. Prospects of diversification and ensuring energy safety of Uzbekistan. E3S Web Conf., Volume 139, 2019, Rudenko International Conference “Methodological problems in reliability study of large energy systems” (RSES 2019). https://doi.org/10.1051/e3sconf/201913901002