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# **Experimental study of characteristics of periodic pulse machine generator**

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**ABSTRACT:** This paper describes the task of developing a pulse generator, a power source for the power supply system of the electrstatic precipitators of the cotton-cleaning plants. The calculation of the source of pulse power was performed using the method of similarity. Experimental studies of the pulse generator with the characteristics of no-load, load characteristics at a constant frequency and constant excitation were carried out. Given the electrical circuit of the stand for the study of the characteristics of a periodic pulsed machine generator. And also shows the implementation through adjusting the excitation voltage of the machine generator and smoothly adjusting the speed of the rotor using a primary DC motor to maintain the voltage at the output of the generator.

**KEYWORDS:** A ginnery, an electrostatic precipitator system, a power source, a machine generator, various characteristics, excitation voltages, and a DC motor.

## **I. INTRODUCTION**

To generate high voltage pulses (GPV), a number of schemes have been developed, the principle of which is based on the accumulation of energy in reactive elements. Hence their definition follows: capacitive GPV; inductive GPV, inductive-capacitive GPV. These GPV s belong to relaxation-type generators. They are conventionally divided into dependent, limited dependent and independent. Relaxation GPV s are dependent, i.e. the parameters of the pulses generated by them depend on the physical state of the discharge gaps, therefore, they do not satisfy the above requirements and, accordingly, will not ensure the stability of the discharge processes in the discharge technological gap. This means that the achievement of the set goal of stabilizing the discharge processes is feasible only when powered by independent GPV, i.e. voltage pulses must be formulated before being applied to the discharge gap [1-3].

Generation of high voltage pulses with stable parameters can be carried out by switching DC voltages after a corresponding increase and rectification. However, controlled semiconductor devices are produced at a voltage of no more than 1500 V, and vacuum or gas-discharge high-voltage devices have complex control circuits, significant dimensions at a high cost.

The most realistic is the use of circuits operating on the principle of generating low-voltage periodic voltage pulses with subsequent increase and rectification.

Generation of periodic voltage pulses can be carried out using electronic devices of the second class, used in various systems and power supplies.

As many years of experimental research have shown, high-voltage spark discharges to grounded structures are difficult to avoid, due to work on pre-breakdown values of the electric field strength. Overvoltage waves are not extinguished at the fault location and can propagate along grounded structures, causing insulation breakdowns in its weak points. With regard to semiconductor elements, they are better at withstanding overcurrent than overvoltage. The latter cause breakdowns of junctions in semiconductors and lead to their failure. Further studies showed that there is a significant dependence of the characteristics of the electric field of a pulsed corona discharge on frequency. The easiest way to adjust the pulse frequency and voltage amplitude is when using a machine generator of periodic voltage pulses. Therefore, it is more expedient to use machine generators of periodic impulse voltages.



## II. SIGNIFICANCE OF THE SYSTEM

The paper mainly focuses on how machine-pulse generator has its characteristics to use it for air cleaning process at the ginneries in Uzbekistan. The study of literature survey is presented in section III, Methodology is explained in section IV, section V discusses the experimental results of the study, and section VI shows the future study and Conclusion.

## III. LITERATURE SURVEY

One of the low-cost ways to increase the efficiency of electrostatic precipitators in these cases is the use of pulse modulation of the power supply. The essence of such a power supply is to supply high voltage pulses to the standard electrode system of the electrostatic precipitator, which are superimposed on a constant voltage.

Currently, there is a long-term experience in operating pulsed microsecond power supplies at large power units, for example, in Denmark and Japan [1].

A large amount of research work on the creation of power systems for high-voltage gas cleaning devices based on electron-beam valves and gas-discharge devices was carried out at the Federal State Unitary Enterprise "All-Russian Electrotechnical Institute" [4, 8].

Until recently, the use of alternating and pulse voltages in the processes of electric gas cleaning was not considered as possible for wide practical use due to serious technical difficulties in the design of power supply units capable of providing reliable switching of high voltages with a sufficiently high frequency. Recently, thanks to the development of electronics, powerful high-voltage semiconductor switching devices have been created, which make it possible to solve the technical problems of creating reliable impulse power supply units. However, the information found in the literature does not give practical recommendations for the design of industrial devices, moreover, the lack of repeatability of experimental studies and the inconsistency of results generally lead to doubts about the advisability of pulse power supply. This is due to the lack of a convincing physical model that explains the very mechanism of the effect of pulsed power supply on the efficiency of dust collection.

## IV. METHODOLOGY

An analysis of the existing methods for calculating DC and AC electric machines showed that there is no method for calculating electric machines with the same number of evenly defined poles on the rotor and stator. We can not use their theoretical and graphoanalytic methods in the calculation of a 4 kW pulse generator. Therefore, a model of a machine generator was developed to determine the interdependence of their parameters on the basis of the development of a method for calculating the periodic pulse voltage generator using the method of similarity [1,2].

## V. EXPERIMENTAL RESULTS

Experimental studies were conducted to determine the characteristics of the generator:

- idle characteristics  $U_{ID} = f(U_E, n)$ ;
- load characteristics at constant frequency  $I = f(U_E, U)$ ;
- load characteristics at constant excitation  $I = f(U, f)$ .

The test stand of the machine generator is based on a squirrel cage three-phase asynchronous electric motor with a power of 2.2 kW. The following changes have been made in the design of the electric motor. The 36 slots in the stator of the electric motor are divided by such a calculation (Fig. 1) that the width of the slots is equal to the width of the poles. The stator slots have pole coils. Each coil consists of 7 windings of 1.5 mm diameter PEV-2 wire. All coils of the stator winding are divided into 2 sections of 18 coils. The coil of each section was connected in series and took out to the terminal box [5].

The studies were conducted with the schematic diagram of the stand shown in Figure 3. The electric drive of the generator was carried out by a 0.5 kW series-driven alternating current electric motor. To further adjust the speed of the generator, the rectifier is provided by a 3-phase autotransformer T2 via a bridge circuit.

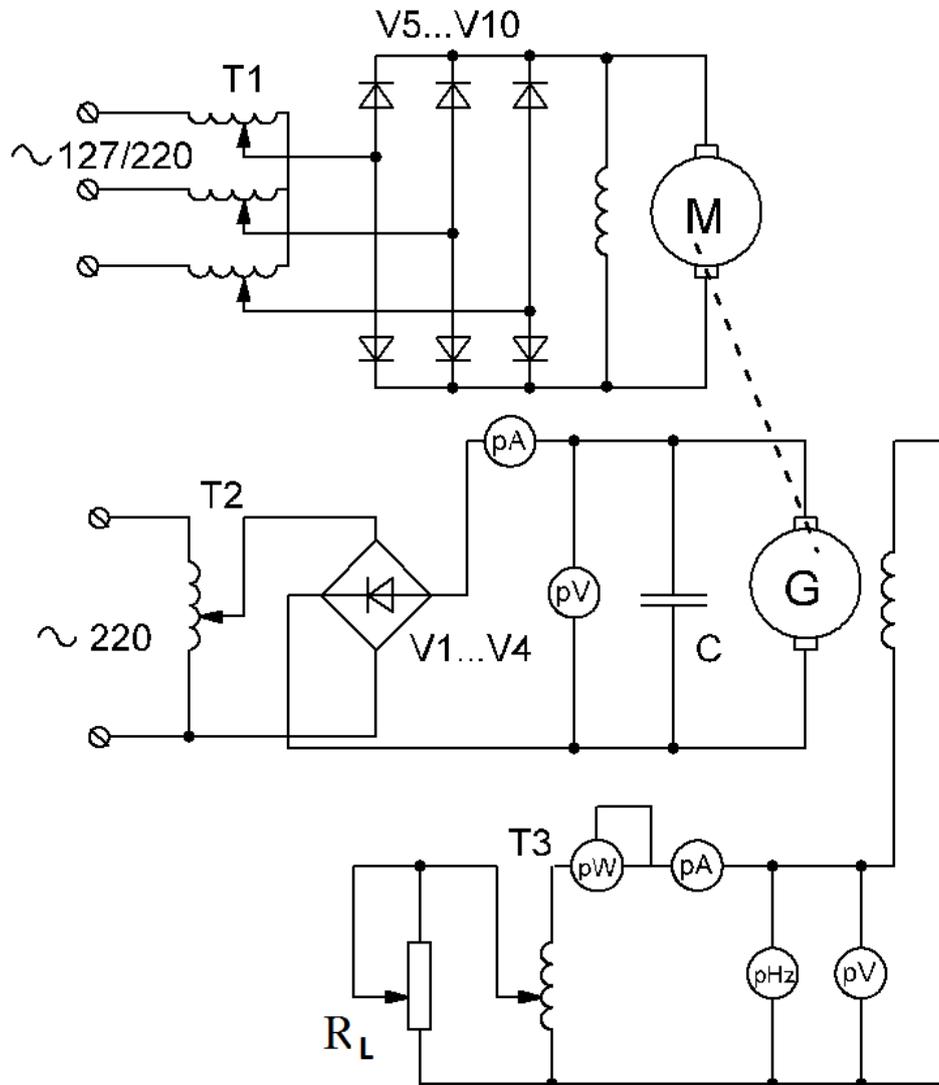
The shaft of the electric motor is connected to the generator shaft via a belt drive with a transmission coefficient of 1.5. The generator drive is provided by a transformer T1 via a diode bridge. In parallel, the excitation coil is connected to a filter C with a capacity of 2000  $\mu\text{F}$ . At the output of the unfiltered generator, the magnetization of the excitation coil in the form of voltage is broken by two half-cycle currents. As a load, a circuit consisting of an autotransformer T3 connected to a load resistor RL was used. Frequency is measured using a frequency meter Hz3-33.



**Figure 1. The stator of a periodic pulse voltage machine generator**



**Figure 2. The rotor of a periodic pulse voltage machine generator with a brush mechanism**



**Figure 3. Schematic diagram of the stand to study the characteristics of the machine generator of the periodic pulse voltage**

T1 - three-phase autotransformer; T2, T3 - autotransformers; V5... V10 - three-phase rectifier; V1... V4 - rectifier; M- AC motor; G- generator; RA- Ommeter; PV- voltmeter; PHz- frequency meter; RW- wattmeter

As can be seen from the graph of the dependence of the generator on the excitation voltage (Figure 4) at a frequency of 1000 Hz, the excitation voltage is practically linear in the range of 15-50 V. When the  $U_E$  voltage exceeds 50 V, the voltage at the generator output does not change practically. In this case, the generator's magnetic system switches to saturation. Here, the limiting value of the excitation voltage is 50 V for the generator of stand.

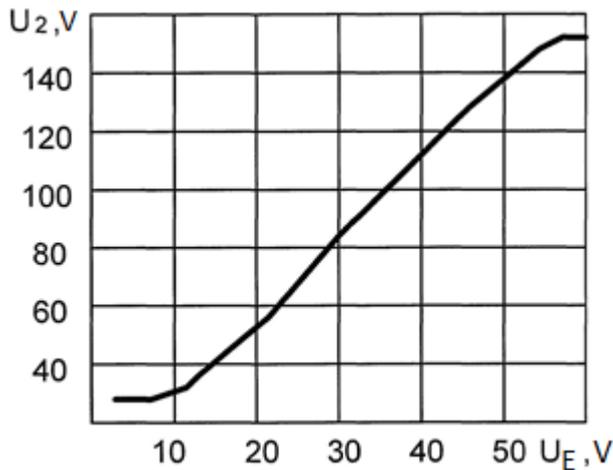
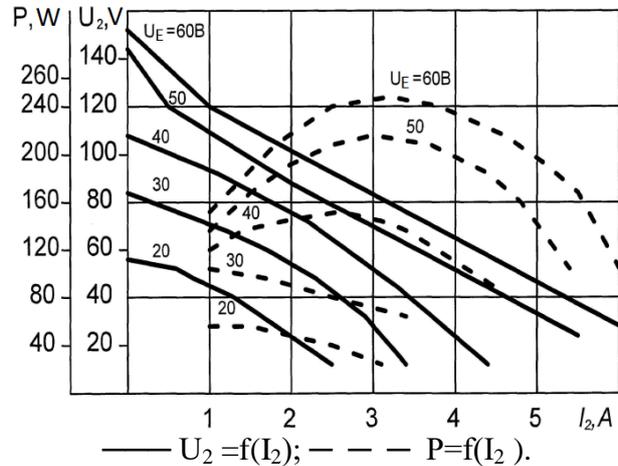


Figure 4. Graph of the dependence of the generator voltage on the excitation voltage at a frequency of 1000 Hz



Load characteristic of the generator at a frequency of 1000 Hz

As can be seen from Figure 5, the generator has a sharply decreasing output characteristic, where the maximum power is approximately equal to the average value of the current. Features of such a system of generators include safety of short-circuit mode. The softness of the generator output characteristic is determined by the need to stabilize the output voltage. Voltage stabilization at the generator output can be accomplished by adjusting the excitation voltage or by adjusting the rotor speed [6, 7].

To evaluate these methods, the dependence of the generator idle voltage on the rotor speed (Fig. 4) and the load characteristics at different frequencies (Fig. 5) were studied. In the first approximation, the change in frequency is brought to the same as the change in load characteristics in the same way as the change in voltage in the excitation winding [5-6].

In analyzing the possible use of rotor speed variation stabilization methods, we found several shortcomings related to the adjustment of the speed of the electric drive motor. Such a system of automatic adjustment will have great inertia. The best of these is stabilization by adjusting the excitation voltage.

## VI. CONCLUSION

In order to increase the efficiency of electrostatic precipitators, a periodic pulse voltage generator was developed. To study the characteristics of the developed generator, the load characteristics at constant frequency load and constant excitation voltage were studied using the stand-alone scheme of the stand.

## VII. THANKS

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