

# Research of Electrical Generator Model (Stage: Phase Differences Impact on Generation Processes)

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**Abstract**— The article presents the interim results of the ongoing research. At this stage, measurements are being made with a model in which two energy sources are already installed in the impeller with rotated wings. The main purpose of this research is to observe the impact of phase difference in the process of generating electricity and its efficiency by measuring the output power of a rectifier with voltage stabilizing circuits when changing the phase between the two generator sources. In the presence of two electrical energy sources, the voltage generated by these generator sources was measured, as well as the current when changing the phase (the mutual position of the coils relative to each other creates a phase difference in the generated current, and the magnets are connected to each other by a stationary mechanical connection). Methode - the phase change is measured when both sources have a common electrical connection and when both sources do not have a common electrical connection, at that moment they are connected only by the mechanical part. Research determines that when changing the angle between the coils, the phase between the voltage fluctuations generated by both sources' changes. But the angles between the coils does not depend either on the variant of connecting the sources or on the connected load.

**Keywords**— *electricity, electricity generator, regeneration, robotic systems, wind.*

## I. INTRODUCTION

This article publishes the data of a study that is part of an ongoing study and the initial results of which have already been published in previous publications [6] [7] [9] ... The investigation is ongoing with the consent and cooperation of the owners of the patent [4] in order to fully reveal the possibilities of the patented technology and possible additional effects.

For a start, we would also like to emphasize some of the nuances in the design of the impeller itself, which may not have been so clearly stated in previous publications. A general picture of the impeller currently in use is shown in Fig.1. In it, the cavity into which the magnetic ring is installed is clearly visible.

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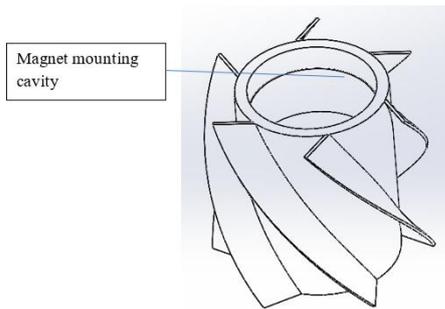


Fig. 1. Impeller used in the experiment.

However, these cavities are even more intelligibly depicted in the form of an impeller greying in Fig.2. In these cavities, magnets are installed in the impeller stationary and rotate together with the impeller. The starting position of the magnets with each other was not specially selected. It hasn't even been determined, so it's random and unchanging. It can be said that magnets are connected to each other by a stationary mechanical connection.

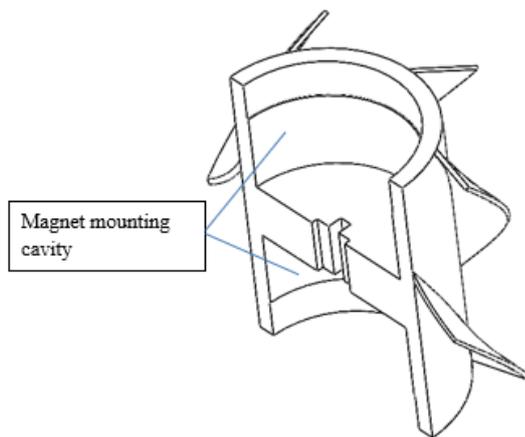


Fig. 2. Greying of the impeller used in the experiment.

The layout and impeller used in the experiment were designed using SolidWorks software, which is convenient to design in, since everything is in one space and it is possible to get an overall picture of the system in a 3D environment. Using a variety of SolidWorks features, it was possible to design a layout and an impeller rotating in it.

In previous experiments [6] [7] [9], it was observed that changing the positions of the coils changes the voltage generated, and changes in the curves observed during their fixation depending on the phase.

At this time, the simulation will not be used, since there is no possibility to make different phases between the reels for the sources and record their changes. Thus, all test results were obtained by measuring the design of the prototype used (experimental results).

## II. MATERIALS AND METHODS

Since two energy sources are installed in the generator's current layout, in such a design we have the opportunity to change the positions of the source coils relative to each other from  $0^\circ$  to  $360^\circ$  degrees. By changing (rotating one coil when the other is fixed) the position of the coil of one of the sources every  $20^\circ$  degrees, changes in the voltage generated by the generator's sources (influence on generation processes) and in the output, when the load using the generated energy is already connected to the generators, will be measured. In order to notice the changes in the energy generated by the sources and how they interact with each other, we will make several different types of measurements. Studies begin with the change of the position (phase) of the coils in different energy sources in the absence of any electrical connection. Both sources work independently and are connected only by magnets installed stationary in the impeller. In this way, it will be observed whether changes in the mechanical position of the coils in the generated energy flow occur due to changes in the mechanical position of the coils. We will use an oscilloscope by connecting it directly to the sources for measurements.

To monitor the voltage generated by the sources and the current at the exit after the load, we will connect both sources to separate diode rectifiers with a voltage stabilizer (Fig.9 or Fig.10) and after voltage equalization we will measure the resulting values of currents and voltages (as if we had two dc sources). As a load after rectifying, we will use an indicative diode and an elementary resistance. We will make measurements by varying the possibilities of connecting these sources. We will connect them in parallel (plus with plus, minus with minus), in series (plus of one source with minus of another source, the remaining contacts for connecting the indicative load) and vice versa (plus of one source with a plus of another source, the remaining contacts for connecting the indicative load).

## III. RESULTS AND DISCUSSION

As we have already mentioned at the beginning it is measured when there is no electrical connection between the two sources of the generator. At this stage, only the angle of position of the coils is changed, which theoretically should create a shift between the fluctuations of the measured voltage at different sources of the generator. A two-channel oscilloscope was used to capture this difference. Channel A will check one of the power sources, the other channel B will check the other power source. Since it is not possible to make  $0^\circ$  as a reference point by mechanical means at this point, the angle of  $0^\circ$  degree will be conditional.

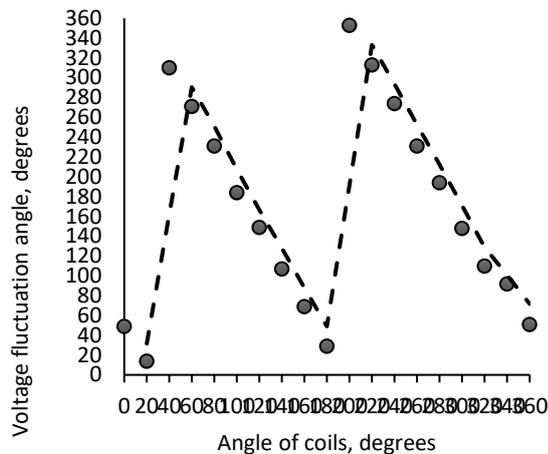


Fig. 3. Dependence of the phase of the electric signal on the angle of the coils.

According to the data presented in the graph (Fig.3), it can be seen that a direct relationship is formed between the angle of position of the coils and the fluctuations of the voltages between the existing sources. At the same time, we can note that the angle of the coils with the angle of voltage fluctuations passes and a displacement of 180° degrees is formed. From the theoretical side, such a phenomenon should have been obtained, since when changing (rotating) the positions of the coils relative to each other, when rotated at an angle of 180° degrees, the coils then simply change places, this can be seen in the drawing of the previously published impeller section [9]. And after turning the angle of 180° degree, the results should repeat and repeat. When analyzing this data and graphs, one should evaluate the human error and inaccuracies in the design of the layout, since access to the exact angle of rotation of the coil is not created. Although with a margin of error, the data corresponded to the forecast results, so increasing the accuracy at this point would not change the results.

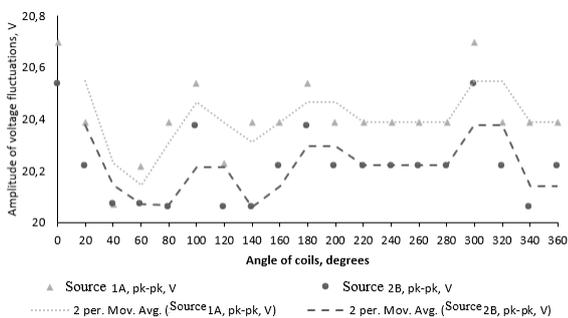


Fig. 4. The dependence of the amplitude of voltage fluctuations on the mutual angle of the coils.

When measuring the changes in the amplitude of voltage fluctuations depending on the angle between the coils (Fig.4), we can see from the results obtained and the graph that the voltage amplitude varies between 20.07 V and 20.54 V.

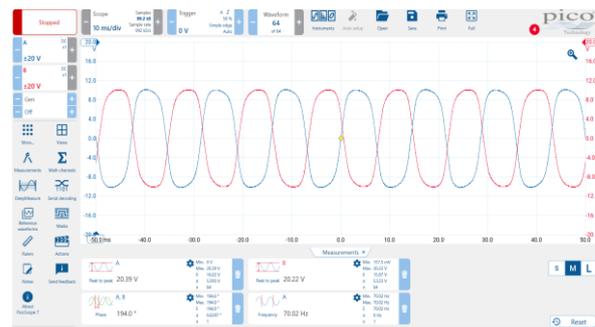


Fig. 5. Oscillogram of amplitudes of voltage fluctuation.

In the oscillogram (Fig.5), we see that in the absence of an electrical connection, the amplitudes of voltage fluctuations in both sources are approximately the same, and at the same time the frequency practically coincides. When changing the angle of position of the coils, one can see the phase shift between the fluctuations in the voltages generated by the sources. It is also noted that during the study, when the load is not connected, distortions in the shape of the signal do not appear. Further, variants of various connections of both sources were studied: parallel, sequential and vice versa. A parallel connection is formed when the wires of the positive pole of both sources are connected together, at the same time the wires of the negative pole of both sources are also connected together. A sequential connection is made when the wire of the positive pole of the first source with the load is connected, the cord of the negative pole with the wire of the positive pole of the second source, and the wire of the second negative pole with the load. The reverse or reverse serial circuit is formed by connecting the wire of the negative pole of the first source with the load, the wire of the positive pole with the wire of the positive pole of the second source, and the wire of the negative pole of the second source with the load thereby closing the circuit.

First of all, it will be studied when no load is connected (the outputs after the diode bridges are open), and the changes in the amplitude of the voltage oscillations generated by the sources depending on the angle of position between the coils will be measured. The results obtained are shown in Fig.6 graph.

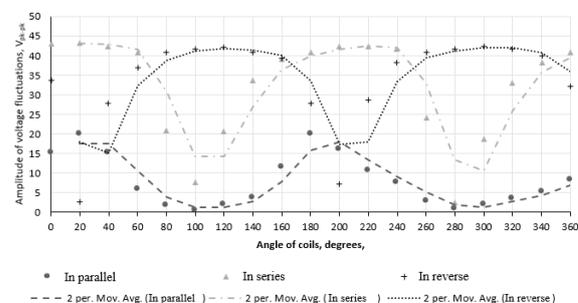


Fig. 6. Change in the voltage amplitude of different connections of two sources from the angle of the coils.

According to the data presented in Fig.6 graph, it can be seen that sequential and vice versa connections cause greater changes in the amplitude of voltage fluctuation compared to a parallel connection. In a sequential connection, the average amplitude of the generated voltage is about 32.42 V, the reverse connection is about 33.94 V, while the parallel one is only 8.08 V. According to the angle between the coils, it can be seen that in the case of a sequential connection, the damping occurs at the position from 80° to 160° degrees and from 240° to 340° degrees, and during the reverse connection at such angles, damping is not formed.

In the graph, we can quite clearly see such an angle of position of the coils with each other, in which the maximum amplitude of the voltage is obtained. That angle depends on the variant of connecting the two sources: if it is a sequential connection, it is the angle at the degree of 20°, at which 42.45 V is obtained; if it is a reverse connection, it is 300° degree, which also yields 42.45 V; in the case of a parallel connection, it is a rotation of 20° degrees at which the maximum amplitude of voltage fluctuations is measured at 19.95 V. Further studies are carried out when a constant load is already connected, to different variants of connections between the two sources. A 24-Ω resistor and a red LED were used to create the load. The resistor acts more as part of the load, and the diode as an indicator that shows or has enough power generated to illuminate the diode (visualization). During the study, using a multimeter, the voltage drop on the load and the unit of current flowing in the circuit is measured. The results of the current measurements are given in Fig.7 graph and the results of the voltage measurements in Fig.8.

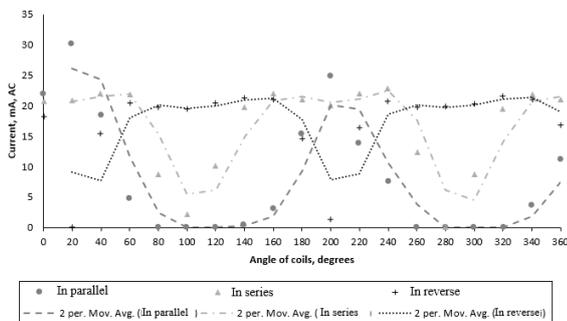


Fig. 7. The dependence of electric current on the angle between the coils under load.

From the graph of the dependence of electric current on the angle of the coils Fig.7 we can see that when changing the angle between the coils, the current at the corresponding points falls. The trend of current elevations and descents is associated with the Fig.6 graph, at the same angles there are changes in the current. Unlike the previous graph, all connections are approximately the same depending on how much current is generated, it is only a fundamental observation that at the moment of parallel connection, small permissible angles are obtained between angles of 200° and 220° degrees compared to other connections, in a sequential

connection the maximum current between 160° and 240° degrees is obtained, and in the reverse connection between angles of 80° and 160° degrees. According to this graph, it can be said that the maximum current is obtained under load during a sequential and reverse connection.

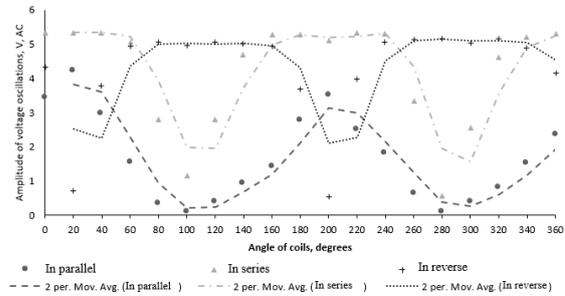


Fig. 8. Dependence of the amplitude of voltage fluctuations on the angle between the coils under load.

When examining graph in Fig.8, it can be seen that the trends observed when comparing the graphs in Fig.7 and in Fig.6 are repeated. The amplitude of voltage oscillation under load varies the same in all cases of connection -  $\pi$  (i.e. 180° degree) in a multiple. It has also been observed that the voltage amplitude settles at 5.35 V at a sequential or reverse circuit, and in the case of a parallel connection, the maximum voltage amplitude grows to only 4.22 V.

Summarizing all three graphs Fig.6, Fig.7 and Fig.8 and the data obtained from the study of the generator's source interconnections, both with and without load, it can be seen that the trends in voltage and current variation are related and repeated every  $\pi$  angle. Depending on the variant of connecting the sources, at the appropriate angles we observe inhibition, and in other cases, an increase in the amplitude of the oscillations. During a sequential connection, inhibitions occur at angles between degrees 80° and 160°, and at angles of 260° and 320° degrees. In the case of parallel connection, damping is observed at the angles between degrees 60° and 180° and at the angles between degrees 240° and 340°. It is noteworthy that during all stages of the study, in the case of a parallel connection, the minimum values of the data were measured in comparison with the sequential or reverse connection variant. During the inverse connection, damping occurs at the angles between degrees 0° and 60°, and at the angles between degrees 180° and 240°. Comparing these connection options, we can see that both with a sequential connection and inverse, the processes take place quite analogously.

Further, for experiments, an electrical connection is already being created between both sources of the generator at the output part. First, diode bridges with voltage regulators are connected separately for each source. Then two connections between them are possible: parallel and sequential.

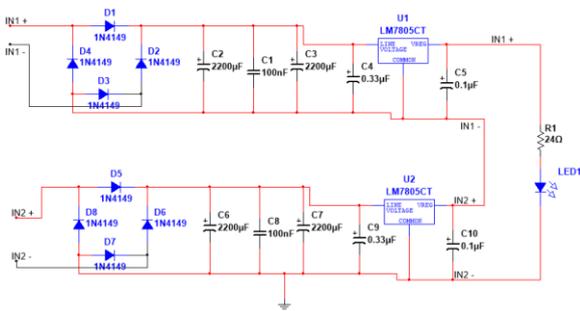


Fig. 9. Principle electrical diagram of the sequential connection of two sources.

To create a sequential connection, it is necessary to connect the wire of the negative pole of the first source with the wire of the positive pole of the second source. The wire of the positive pole of the first source with the load, which is then connected to the negative pole wire of the second source. Such a connection is shown in the figure Fig.9. The essence of this principle is similar to the connection of batteries in series, i.e. to increase the amplitude of the voltage without changing the magnitude of the current. In this way, in theory, the amplitude of the generated voltage oscillations, which falls on the load, should be doubled.



Fig. 10. Oscilloscope showing the changes in the generated voltage fluctuations (with diode bridges and load in the presence of a sequential connection).

In order to notice the changes in the load, a resistance of  $24 \Omega$  and a red LED (visualization) were used. Using these components, voltage and current are measured at the output. From the resulting oscilloscope Fig. 10, one can see the influence of the load on the fluctuations in the generated voltage when the mechanical angle of the position of the coils is formed at about 240 degrees. This means that the load affects the fluctuations in the generated voltage. Next, we will observe how this influence changes at the angles between the different coils. An oscilloscope and a multimeter were used to capture the data, and the data is shown in Fig. 11 graph.

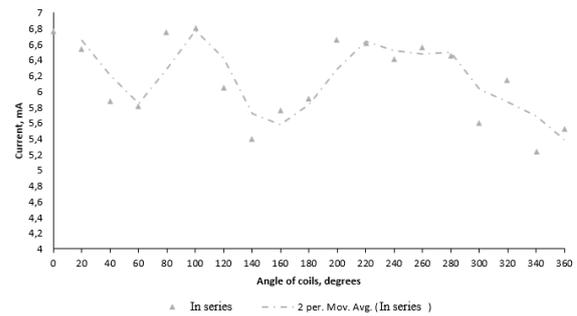


Fig. 11. The dependence of the current of two sources connected in series to the phase.

Fig. 11 shows that the change in current as the position of the coils changes is more than 20%. The current ranges from 5.25 mA to 6.75 mA.

Next, the parallel connection under the bridges with the load will be measured. By analogy with sequential connection, all measurement methods remain the same.

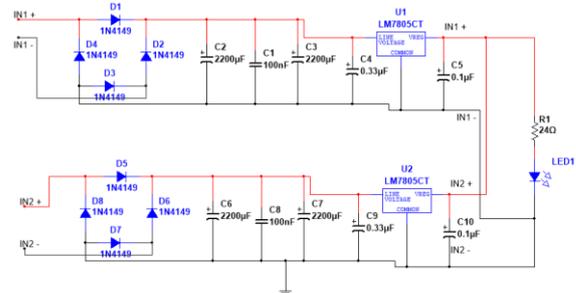


Fig. 12. Principle electrical scheme of parallel connection of two sources.

To make a parallel connection, it is necessary to connect the wires of the positive pole of both sources together and connect to the load. At the same time, the wires of the negative pole of both sources are also connected together and connected to the negative pole of the load. The parallel connection diagram is shown in fig.12.



Fig. 13. Oscilloscope showing the changes in the generated voltage fluctuations (with diode bridges and load at parallel circuits).

From the fig.13 graph, it can be seen that the load at parallel (Fig.12) connection of sources similarly affects the input signal as in a sequential circuit. In the presented case, the voltage oscillation curve, although more orderly, is also distorted and limited in a similar way to

the positive and negative maximums of the amplitudes of the oscillations. Since we see that changes are formed, further measured at different angles of the coils, the data obtained is shown in the graph below the text (Fig.14).

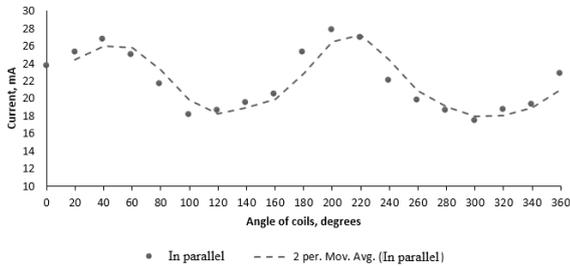


Fig. 14. The dependence of the current generated by two sources connected in parallel on the angle between the coils (with diode bridges and load).

According to the measurement data presented in Fig.14, we can see the observed trend of current change by changing the angle between the coils, at the same angles i.e. at the angles between 180° and 220°, as well as at the angles between 0° and 60° degrees, the maximum value of the measured current is obtained. In comparison with the sequential connection, the current increased three times more. The trend of oscillations between rise and inhibition has been maintained the same –  $\pi$  multiple.

Next, the change in the amplitude of voltage oscillations from the angle between the coils is measured. In the same way as with current measurements, the same circuits are maintained, sequential and parallel.

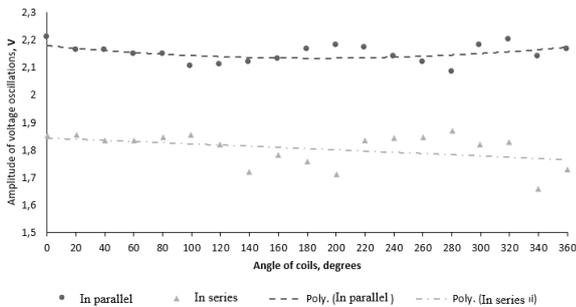


Fig. 15. Curves of the amplitudes of voltage oscillations on the angle of position of the coils at sequential and parallel connections of two sources (with diode bridges and load).

Analyzing the data presented in graph Fig15, we can see that the voltage changes with a slight change in the positions between the coils, the difference is about ~10% in both sequential and parallel connections. Comparing the results of both connection options, at this point we received a little more voltage in the case of parallel connection than in the case of a serial circuit (about 0.4 V more).

Summarizing the presented research results, we can say that the angle of position of the coils with each other influences the process of generating electricity. When changing the angle between the coils, the phase between

the voltage fluctuations generated by both sources' changes. It has been observed that the change is a  $\pi$  multiple. Since two energy sources are built in, after testing different combinations of their interconnection during the study, it was observed that inhibition occurs at the angles of the positions of some coils. Inhibition occurs at the same angles between the coils does not depend either on the variant of connecting the sources or on the connected load.

It was also noted that during a parallel connection, a lower power is obtained compared to the variants of sequential and reverse connection.

#### IV. CONCLUSIONS

We can see that the interrelationship of the coils quite significantly influences the process of generation when we have a generator of the presented design with two energy sources.

Effective use of the system of such a design requires appropriate alignment of the positions of the coils with each other;

The method of connecting the generator's two sources also has a fairly significant impact on the generation process itself;

The results of the measurements obtained are further systematized and analyzed in order to identify also the possibilities and trends of increasing the effectiveness of this step.

All the data presented was obtained by conducting experiments in laboratory conditions when the layout was placed on the path of a constant air flow. We tried to create the same air flow for each measurement and select it close to the air flow when the incoming car was driving at a speed of about 50 km / h. Next, it is planned to conduct these experiments in real conditions and at different air flow rates.

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